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Madagascar Country Environmental Analysis (CEA)

Taking Stock and Moving Forward

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Abbreviations and Acronyms

AAA	Analytic and advisory activities of the World Bank
AfD	*Agence Française de Développement* – French international aid agency
ALRI	Acute lower respiratory infection
ANS	Adjusted net savings
ASM	Artisanal and small-scale mining
BIME	*Bureau d'Inspection Minière et Environnementale* – National Inspection Office for Mines and Environment
BNGRC	*Bureau National de Gestion des Risques et des Catastrophes* – National Disaster Risk Management Office
C	Carbon
CAS	Country Assistance Strategy
CAZ	Corridor Ankeniheny-Zahamena
CCA	Climate change adaptation
CDM	Clean Development Mechanism under Kyoto Protocol
CEA	Country Environmental Analysis
CIMF	*Comité Interministériel des Mines et des Forêts* – Inter-ministerial Committee on Mines and Forests
CITES	Convention on International Trade in Endangered Species
CO	Carbon monoxide
COAP	*Code des Aires Protégées* – Protected Areas Code
COFAV	Corridor Fandriana-Vondrozo
CPGU	*Cellule de Prévention et Gestion des Urgence* – Emergency Prevention and Management Unit
CT-REDD	*Comité Technique REDD* – National REDD Committee
CTE	*Comité Technique d'Evaluation* – EIE Evaluation Committee
DALYS	Disability adjusted life years savings
DCBSAP	*Direction de la Conservation de la Biodiversité et du Système des Aires Protégées* – Direction of Biodiversity Conservation and Protected Areas
DCC	*Direction du Changement Climatique* - Direction of Climate Change
DEAP	*Droits d'entrée dans les aires protégées* – Protected area entry fees
DGE	*Direction Générale de l'Environnement* – Direction-General of Environment
DGF	*Direction Générale des Forêts* – Direction-General of Forests
DGM	*Direction Générale de la Meteorologie* – Direction-General of Meteorology
DREF	*Direction Regionale des Eaux et Forêts* – Regional level environment units
DRM	Disaster risk management
EIE	*Etude d'impact environnemental* – Environmental impact assessment
EITI	Extractive Industries Transparency Initiative
EP	Environment program
EP1	First Environmental Program Support Project
EP2	Second Environmental Program Support Project
EP3	Third Environmental Support Program Project
EPIC	*Etablissement public à caractère industriel et commercial* – public establishment with industrial and commercial function
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FAPBM	*Fondation pour les Aires Protégées et la Biodiversité de Madagascar* – Madagascar Foundation for Protected Areas and Biodiversity
FCPF	Forest Carbon Partnership Facility
FFEM	*Fonds Français pour l'Environnement Mondial* – French Global Environment Fund
FFN	National Forestry Fund
GCF	*Gestion contractualisée des forêts* – a form of community based natural resources management contract
GCM	Global circulation model

GDP	Gross Domestic Product
GEF	Global Environment Facility
GELOSE	*Gestion locale sécurisée* - a form of community based natural resources management contract
GFDRR	Global Facility for Disaster Reduction and Recovery
GNI	Gross national income
ha	Hectares
HDI	Human Development Index
ICDP	Integrated conservation and development project
ICZM	Integrated Coastal Zone Management
IDA	International Development Assistance
IPCC	Inter-governmental Panel on Climate Change
ISN	Interim Strategy Note
IUCN	International Union for Conservation of Nature
KfW	*Kreditanstalt Für Wiederaufbau* - German Development Bank
LDCF	Least Developed Countries Fund
LPG	Liquefied petroleum gas
MECIE	*Décret N° 2004-167 relatif à la mise en compatibilité des investissements avec l' environnement* – national environmental assessment legislation
MEF	Ministry of Environment and Forests
MNP	Madagascar National Parks
MOU	Memorandum of Understanding
NAP	*Nouvelle aire protégée* – new protected area
NAPA	National Adaptation Programme of Action
NEAP	National Environmental Action Plan
NGO	Non-governmental organization
NO_2	Nitrogen dioxide
NPV	Net present value
NTFP	Non-timber forest products
ONE	*Office National pour l'Environnement* – National Environment Office
PA	Protected area
PEE	*Program d'Engagement Environnemental* – program of environmental engagement
PGRM	*Projet de gouvernance des ressources minérales à Madagascar* – Madagascar Mineral Resources Governance Project
PM_{10}	Particulate matter with a diameter of less than or equal to a nominal 10 micrometers
$PM_{2.5}$	Particulate matter with a diameter of less than or equal to a nominal 2.5 micrometers
R-PP	REDD+ Readiness Preparation Proposal
REDD+	Reducing Emissions from Deforestation and Forest Degradation, and promoting conservation of forest carbon stocks, sustainable management of forest, and enhancement of forest carbon stocks in developing countries
SAPM	*Système des Aires Protégées de Madagascar* – national protected area network
SEA	Strategic environmental assessment
SIGE	*Système d'information pour la gestion environnementale* – information system for environmental management (in the mining sector)
SLR	Sea level rise
SO_2	Sulfur dioxide
SPI	Standardized precipitation index
TAI	The Access Initiative
tC	Tons of carbon
TDG	*Transfert de gestion* – community natural resource management contract
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change

USAID	Bilateral American international aid organization
VAT	Value-added tax
WAVES	Wealth Accounting and Valuation of Ecosystem Services
WCS	Wildlife Conservation Society
WWF	World Wide Fund for Nature

Executive Summary

1. Introduction

The Madagascar Country Environmental Analysis (CEA) has the following objectives: (i) to facilitate the integration of environment-development priorities in a future Country Assistance Strategy (CAS); (ii) to provide analytical information that can underpin the development of future World Bank operations in the environment sector; and (iii) to serve as an initial analysis of environment sector governance issues for future budgetary assistance lending to the Government if such an operation is pursued in the future upon resolution of the current political crisis. The CEA also aims to contribute to debate and dialogue with the Government and development partners on environment-development linkages and priorities in Madagascar. The current CEA is the first ever prepared for Madagascar. It also draws on a range of sector-based analytical work including a sector wide analysis undertaken by the World Bank in 2003[1], an environment sector Policy Note prepared by the World Bank in 2010[2], and work carried out by technical and financial partners in the sector[3]. It also draws on a range of analytical work carried out by the World Bank in related sectors including governance analyses of the mining and forestry sectors[4], a national public expenditure review[5], and a feasibility study of the development of a program for introducing ethanol cookstoves in households[6]. The CEA has been carried out in the context of the World Bank Environment Strategy 2012 and the World Bank Interim Strategy Note (ISN) for Madagascar.

2. Background and Context for CEA Preparation

Madagascar is a land of contrasts where unrivalled biodiversity rubs shoulders with one of the world's poorest human populations. More than 90 percent of Madagascar's terrestrial species are endemic and Madagascar harbors 1/20th of the world's known biodiversity. Simultaneously, the country ranks 151st out of 188 countries in the 2013 Human Development Index, 164th out of 173 countries in terms of GDP per capita and has a national poverty rate of more than 76 percent. With over two thirds of the population in rural areas, where the poverty rate climbs to 82 percent, and with more than three quarters of the population engaged in natural resource dependent livelihood activities, there thus exists a precarious human-environment balance.

The last thirty years have seen disappointing economic performance in Madagascar. The poverty rate remains at the same level as it was in 1980, and between 2001 and 2008 there were an additional 2 million poor people. Assuming population growth of 2.8 percent per year, GDP growth of at least 6 percent per annum will be required to start reducing poverty levels. Yet, GDP has decreased in real terms since 1990. Negative growth in GDP of -4.6 percent was observed in 2009 due to the effects of the political crisis, although growth was re-established to a modest 1.6 percent in 2011. Madagascar is currently suffering the effects of a prolonged political crisis that saw a de-facto Government come to power in early 2009; a pattern that has been periodically repeated in Madagascar since 1991. Successive periods of political unrest have created power vacuums within which there has been a near-total collapse of environmental governance leading to natural resource exploitation and dramatic reductions in revenues from tourism and other key natural resource based sectors. Current threats are likely to be compounded by demographic pressures, with annual population growth of around 2.8 percent and a doubling of the population projected in the coming 25 years, and climate change which will bring increasingly intense and frequent extreme weather

"The country's natural resources have the potential to generate substantial and tangible economic benefits but their management is affected by a lack of sustainable financing mechanisms and poor governance."

[1] World Bank. 2003. *Madagascar - revue du secteur rural et environnemental: Rapport No. 26106 – MG*. World Bank, Washington DC.
[2] Carret JC, Rajaonson B, Feno PJ & Brand J. 2010. *L'environnement: un atout à preserver, des enjeux à maîtriser.* In 'Madagascar: vers un agenda de relance économique', World Bank, Antananarivo.
[3] For example: PGM-E. 2009. Etat des lieux sur les transferts de gestion des resources naturelles: Orientations stratgeiques. KfW, Antananarivo & USAID. 2010. Paradise Lost: lessons from 25 years of USAID environment programs in Madagascar.
[4] World Bank. 2010. *Madagascar Governance and Development Effectiveness Review: A Political Economy Analysis of Governance in Madagascar - Report No. 54277-MG*. World Bank, Washington DC.
[5] World Bank. 2011. *Revue des depenses publiques. Madagascar: Politique budgetaire et investissement public en periode d'instabilité politique.* World Bank, Antananarivo.
[6] Practical Action Consulting (PAC). 2011. *Ethanol as a household fuel in Madagascar: health benefits, economic assessment and review of African lessons for scaling up.* Vols I – IV.

events to a country that has been identified as amongst the top five most climate change vulnerable countries worldwide.

Madagascar's natural resources contribute in a substantial manner to the overall wealth of the country; initial estimates indicate that the country's natural capital represents 49 percent of the country's total wealth (not including mineral assets). The country's natural resources have the potential to generate substantial and tangible economic benefits but to date there has been a failure to optimize the potential for the country's natural resource base not only to "pay its own way", but also to contribute more largely to poverty reduction and economic development. In a country with degraded and patchy infrastructure, and a poorly qualified workforce, the effective capture and management of revenues generated by renewable and non-renewable natural capital will be will be essential to future economic development.

2. Identification of Environment-Development Priorities

A. Status and Evolution of Environmental Challenges

In terms of its natural resources Madagascar is perhaps best known for its unrivalled biodiversity. The country contains 5 percent of global biodiversity on just 0.4 percent of the world's landmass. Despite its relatively small size, Madagascar harbors a wide diversity of vegetation types ranging from semi-arid spiny forest in the south, to dry forests in the west and far north, and humid forests in the northeast and along the east coast. The majority of remaining native vegetation cover - estimated at 9 to 11 million hectares - is contained in the national protected area network that covers 12 percent of the national territory. Forests are an important source of timber and non-timber forest products for both commercial and subsistence uses, and provide important watershed values, particularly along the eastern escarpment.

"Madagascar contains 5 percent of global biodiversity on just 0.4 percent of the world's landmass. 90 percent of terrestrial species exist nowhere else"

There is a great deal of debate surrounding historic causes and dynamics of deforestation in Madagascar. In recent years a counter narrative has emerged to challenge the prevailing assumption that Madagascar was almost entirely forested before human settlement. This alternative scenario hypothesizes that extensive grasslands and savannahs existed prior to human settlement. Current deforestation rates are in the order of 0.53 percent per year, a reduction from 0.83 percent per year in the decade from 1990 to 2000. Deforestation rates vary by ecosystem types with the highest rates suffered by the spiny forests in the southwest. Increased fragmentation of forests has also resulted from clearing. The persisting main causes of deforestation are slash-and-burn agriculture (accounting for 80 to 95 percent of deforestation) and collection of fuelwood and charcoal production using timber from non-plantation forests (accounting for 5 to 20 percent of deforestation).

In the last three years, illegal logging of precious timber has increased due to governance failures triggered by the onset of the political crisis in early 2009; the northeast forests including the Masoala and Maronjejy protected areas have been the focus of illegal logging activities. Indirect effects of logging have occurred through clearing of vegetation to remove and transport logs, hunting of endangered lemur species by loggers, as well as tarnishing of the country's reputation as a nature tourism destination. In this same period, illegal extraction of critically endangered species, most notably land tortoises, has increased and is threatening the viability of at least two endemic species - the Radiated Tortoise (*Astrochelys radiata)* and the Ploughshare Tortoise (*Astrochelys yniphora*) in the wild.

Marine and coastal biodiversity resources are significant, with 2,400 square kilometers of coral reefs in the south, northeast and northwest of the country, and up to 4,500 square kilometers of mangroves along the west coast that provide important coastal protection and habitat values. Fishing and collection of marine resources provides an important source of revenue or subsistence resources for a large part of the rural population. There are over 100,000 registered fishers; an underestimation of the true number that practice permanent or seasonal fishing. It is estimated that fish and fish products contribute roughly 20 percent of the population's animal protein consumption.

In recent years overexploitation of important products such as shrimp, sea cucumbers and reef fishes has been noticed. The shrimp fishery's value, one of the main sources of foreign exchange earnings for the country, has dropped in recent years; the value of exports decreased from approximately $US50 million per year in 2003 to

$US33 million in 2008. While no stock assessments have been carried out, the limited amount of data available indicates that most fisheries seem to be in decline with overfishing, habitat destruction, and pollution amongst the most commonly cited direct causes, and climate change and high rates of population growth inarguably amongst the most important penultimate drivers of decline.

An increasing number of marine protected areas are being established, often with the dual aims of conserving important conservation targets and managing stocks of natural resources including fish, octopuses and sea cucumbers that are exploited by local communities. In certain parts of the country such as the northwest and southwest, conflicts exist in the coastal zone between small-scale and industrial fisheries, and increasingly between communities and the tourism sector. Climate change will almost certainly pose increasing levels of threat to coastal and marine resources with coral bleaching events and sea level rise that can cause mangrove dieback potentially reducing the viability and productivity of already stressed ecosystems.

Indoor air pollution caused predominantly by solid fuel use has substantial effects on human health and economic development, and has links to deforestation pressures in certain zones where biomass is collected illegally from native vegetation forests. Burning solid fuels (i.e. charcoal and fuelwood) for cooking produces extremely high levels of household air pollution. Average concentrations of fine particulate matter in homes using biomass fuels exceed European Union standards by up to 100 times. Elevated levels of indoor air pollution have been proven to increase the risk of several life threatening illnesses including pneumonia and other acute lower respiratory infections and chronic obstructive pulmonary disease; these diseases are particularly prevalent in children and women over 30, two vulnerable groups from a public health point of view. The burden of death and sickness due to indoor air pollution exceeds that due to HIV/AIDS, diarrheal disease or tuberculosis in Madagascar. With more than 90 percent of the population in Madagascar using solid fuel, the burden of ill health stands at nearly 12,000 deaths per year, of which 10,000 per year are children under the age of five.

"The burden of death and sickness due to indoor air pollution exceeds that due to HIV/AIDS, diarrheal disease or tuberculosis in Madagascar and causes nearly 12,000 deaths per year, of which 10,000 per year are children under the age of five"

Urban environmental pollution, often associated with poor municipal solid and liquid waste management from households and small-scale industry, causes impacts on human health. Poor, urban communities are the most affected by such pollution and municipal authorities lack the resources to ensure access to safe drinking water or sanitation services, or to implement adequate pollution control measures. The large-scale mining sector is developing rapidly and will require robust environmental regulation and control to avoid future industrial pollution incidents. Small-scale mining and mining rushes are often unregulated; such activities cause local water and soil pollution and induced effects such as deforestation and hunting. Fortunately to date the unregulated use of polluting chemicals, such as arsenic, in these operations has not been observed.

The country is highly vulnerable to natural disasters - including cyclones, droughts and flooding; it is estimated that one quarter of the population, representing 5 million persons, currently lives in zones at high risk of natural disasters. Cyclones affect most of the coastal zones with the northeast, east and west coasts at highest risk. In 2008, the most recent year for which detailed data is available, cyclones caused economic losses equivalent to 4 percent of GDP and similar losses were experienced during the 2012 season. Madagascar has a mortality risk index associated with cyclones that is amongst the highest in the world. Drought is most prevalent in the semi-arid south of the country and causes widespread food insecurity. In 2010, the last recorded drought year, approximately 685,000 persons or 76 percent of the population in the deep-south of the country were affected by food insecurity. Droughts are likely to become more frequent and more severe in the south of the country as a result of climate change. Flooding is experienced throughout the country after cyclones and tropical storms and affects crops and transport infrastructure. The intensity and/or frequency of such events are expected to increase with the effects of global climate change which will also bring as yet poorly understood changes to inter-annual and intra-annual precipitation patterns.

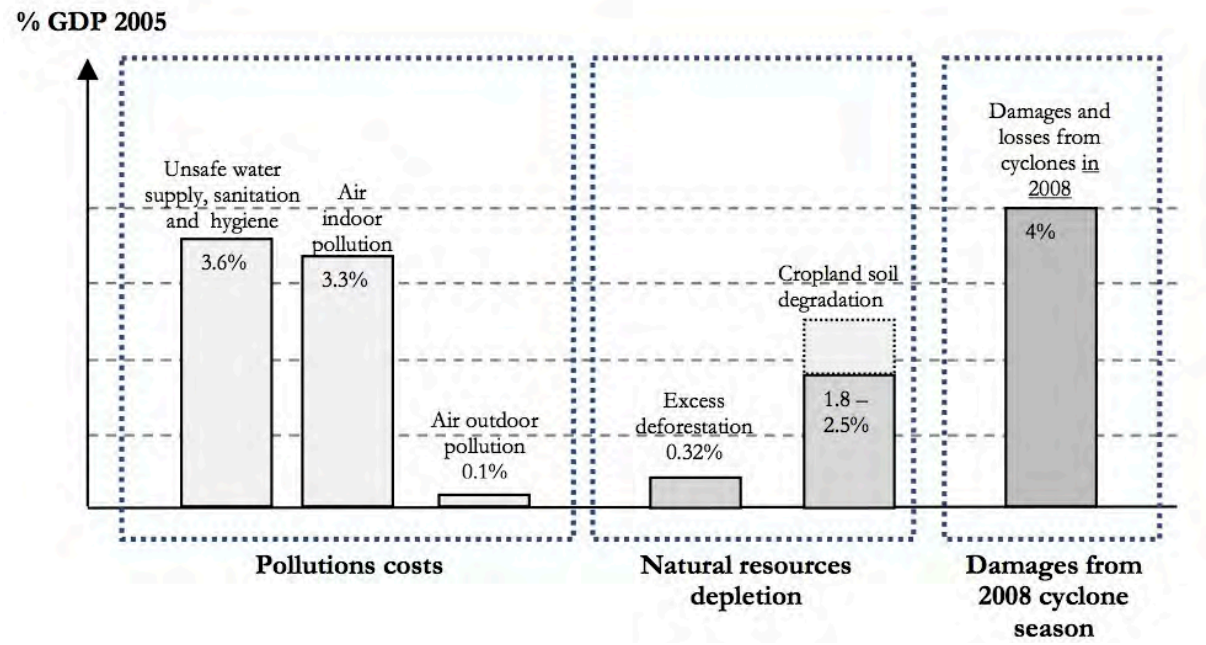
"In 2008 cyclones caused economic losses equivalent to 4 percent of GDP and initial estimates predict similar losses from the 2012 season."

B. Identification of Environment-Development Priorities in Madagascar

In Madagascar, environmental issues can be categorized as those issues that have a very high visibility (e.g. protected areas, biodiversity, illegal exploitation of natural resources and the effects of cyclones); those that have a lesser visibility but that are the subject of increasing attention (e.g. overexploitation of marine resources, coastal erosion and flooding, and industrial pollution from the mining sector); and those that remain largely invisible (e.g. indoor air pollution caused by fuelwood use that causes 12,000 deaths per year or the effects of recurrent droughts in the south of the country which affect more than 500,000 persons each year).

A key question for the CEA is the identification of environment-development priorities in the country and for future World Bank interventions. To assist in the identification of priorities the costs of environmental degradation both in absolute terms and as a percentage of GDP have been calculated; this is a method that allows comparison of the effects of different environmental issues on national economic development. Using data for 2005, the costs of environmental degradation are estimated at between US$457 million and US$495 million per year, equivalent to between 9 and 10 percent of GDP at that time (refer Figure ES.1). Damage to human health caused by indoor air pollution and water pollution is the largest cost component of environmental degradation and is equivalent to 7 percent of GDP. These costs largely outweigh other environmental issues including soil degradation, the second largest component of environment degradation at 2.1 percent of GDP, and deforestation of the eastern humid forests at 0.32 percent of GDP.

Figure ES.1: Costs of Environmental Degradation as percentage of GDP in 2005

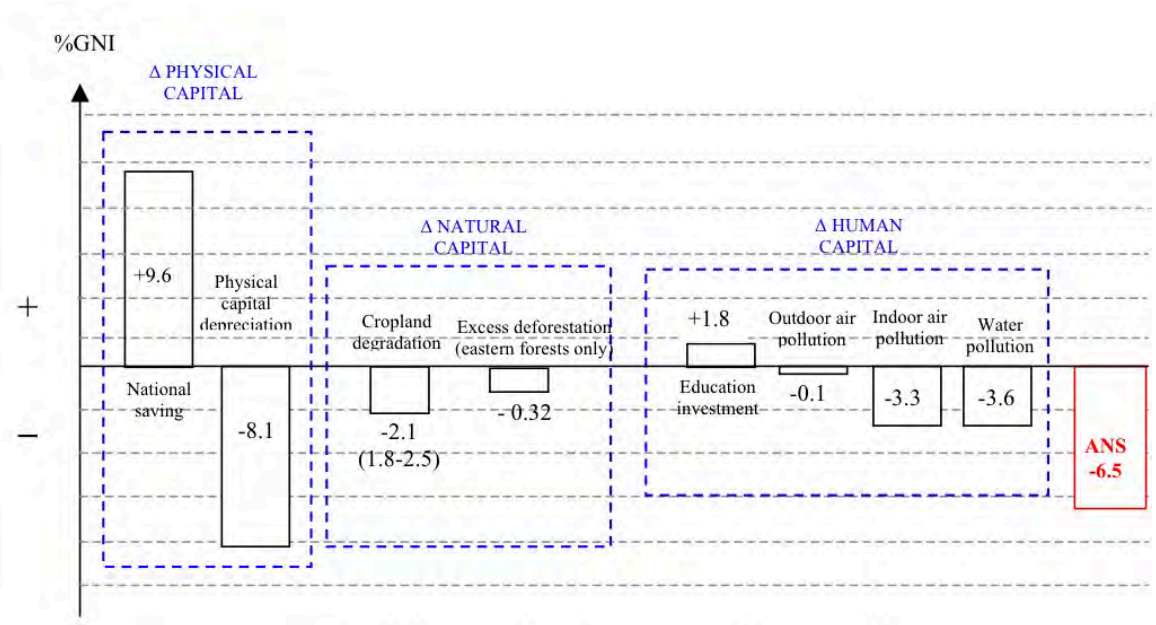


Source: Ollivier & Giraud, 2010

The cumulative effects of environmental degradation on economic growth have been considered through calculation of the Adjusted Net Savings (ANS). The estimation of ANS indicates that the combined effects of environmental degradation including soil degradation, deforestation, indoor air pollution and water pollution outweigh the influence of the degradation of physical infrastructure as the most significant influence on the depletion of total wealth. Indoor air pollution and water pollution are the largest contributors, yet while water and sanitation issues are the subject of interventions by a range of development partners, indoor air pollution remains largely unaddressed. A negative value of ANS, such as has been calculated for Madagascar (ANS = -6.5% of GNI) indicates that the country is depleting its total wealth in a consistent manner, and is thus not on a sustainable development pathway, even if GDP increases (refer Figure ES.2). ANS for Madagascar has been negative for most of the last thirty years indicating that Madagascar's growth was unsustainable in the 1980s, 1990s and certainly in recent years.

The analyses of the costs of environmental degradation and of ANS indicate that in the selection of environment-development priorities, certain 'hidden' priorities are of high importance in terms of their effects on economic development and their disproportionate level of impact on vulnerable populations, and need to be considered on equal terms with the more visible issues. For the purposes of the CEA, the environment-development priorities that are analyzed in further detail are as follows: (i) sustainable financing of the protected area network; (ii) climate resilient institutions and development, with a focus on drought in the country's south; (iii) environmental regulation of the mining sector; and (iv) indoor air pollution caused by fuelwood use.

Figure ES.2: Components of Adjusted Net Savings as Percentage of Gross National Income (2005)



Source: Ollivier & Giraud, 2010

3. Environmental and Natural Resources Sector Governance

A. Evaluation of Governance in the Sector

The World Bank considers that good governance is epitomized by predictable, open and enlightened policy-making, a bureaucracy imbued with professional ethos acting in furtherance of the public good, the rule of law, transparent processes, and a strong civil society participating in public affairs. The challenges faced in ensuring good environmental governance are influenced by a range of factors outside the environment sector itself including the political economic characteristics of the country, education and social welfare levels, and the legislative and political frameworks that determine the role that civil society can play and the degree of freedom of expression. This section aims to evaluate governance in the environment and natural resources sector in Madagascar using the World Bank's definition of good governance and in the context of these broad influencing factors.

Principle 1: Predictable, open and enlightened policy-making

The preparation of the original Environment Charter and the National Environmental Action Plan (NEAP) in the early 1990s provided the springboard for environmental policy development in Madagascar. Coupled with high level visibility at international summits including the United Conference on Environment and Development (the Rio Summit) in 1992 and the IUCN World Parks Congress in Durban in 2003, Madagascar was considered at that time to be a leader in natural resource policy in the African Region. However, these policies have not been updated for some time - the Durban Vision will soon celebrate its tenth anniversary. More recently, environmental policy making has been of lower priority and have failed to rally the same level of support within Government. Prior to the current political crisis, environmental issues were afforded a high profile within the national poverty reduction strategy – the Madagascar Action Plan. However, this Plan has not been replaced with a new national poverty reduction strategy. The national Environment Policy, which was developed in 2010, documents the guiding principles for the sector. The last two years have seen the

preparation of environmental policies related to climate change, pollution management and coastal zone management.

The Government has demonstrated its desire to create a strong environmental policy platform, however policy development processes and the content of national policies have been subject to criticism. Key critiques leveled at policy development processes include a lack of participation by civil society and communities in the preparation of policies, a lack of multi-agency input and poor cross-sector coordination resulting in duplication and contradiction amongst policies, and a lack of dissemination of adopted policies. Even policies such as the "Durban Vision" that are roundly accepted as being successful, have been criticized for having being developed without due consideration to the practicalities of policy implementation. From a content point of view, policies are typically criticized for having weak technical underpinnings (for example policies related to carbon finance or climate change adaptation), for being too generic or broad in their objectives, or for being overly ambitious. Finally, the successful translation of the policy platform into a robust and coherent legislative framework remains a challenge.

Principle 2: The rule of law

Environmental issues are accorded high-level recognition in the Malagasy Constitution and through the legislation implementing the national Environment Charter. In recent years the legal framework governing environmental protection in Madagascar has been characterized by its rapid evolution and its current largely reactive approach to the development of legislation. An extremely large number of laws, decrees and orders form the regulatory framework for the environment sector. An ad-hoc approach has typically been adopted to the development of new legislation and has led to a large number of instruments that have a narrow focus. The situation has been exacerbated by the fact that there is generally weak technical capacity in the drafting of legislation and limited physical access to existing legal instruments.

"The existing legislative framework is highly fragmented and incoherent, both within and across legislative instruments."

The existing legislative framework is fragmented and incoherent, both within and across legislative instruments. There is a lack of harmonization in the vertical hierarchy of Malagasy environmental legislation, with certain lower level instruments designed (intentionally or unintentionally) to override the provisions of higher-level instruments. There is also a high degree of horizontal inconsistency with ambiguity, conflict and duplication between different pieces of legislation, and in the responsibility for their enforcement. This situation leads to redundancy in the framework and general confusion in its implementation. It also creates loopholes that can be exploited by parties wishing to operate outside the regulatory framework.

Implementation and enforcement of the legislative framework remains problematic. Weak institutions and corruption plague the implementation and enforcement of environmental law in Madagascar. Regulators, particularly at the decentralized levels, have limited access to legislative instruments and low levels of capacity to understand their role and obligations in terms of enforcement. The requirement in the Constitution that management of public resources be decentralized poses tremendous challenges to already thinly spread environmental capacity.

Principle 3: A bureaucracy imbued with a professional ethos acting in furtherance of the public good

The Ministry of Environment and Forests (MEF) is the lead Government agency in the environmental and natural resources sector. The MEF's effectiveness in managing environmental issues is compromised by resource constraints, limited technical capacity and internal conflicts. There is duplication and ambiguity between the roles allocated to different directorates within the MEF and with external organizations. Since the onset of the political crisis in 2009, MEF is one of several national Ministries that have experienced budget cuts, and reduction of staff salaries; these cuts have affected the ability to train existing staff or recruit experienced technical staff on issues that are new to the Ministry, such as climate change adaptation and carbon finance.

Decentralized responsibility for environmental issues lies within regional level Regional Directorates of Environment and Forests (DREFs). The Government's focus on decentralization means that these authorities are mandated to carry out a range of environment related activities as well as facilitating public participation and access to information. However these authorities do not have the resources, nor the capacity to fully carry out their responsibilities. Capacity building activities are typically ad-hoc, uncoordinated and externally

financed and thus not sustainable over the long-term. Efforts are needed to support regional and local authorities in their mandated roles in facilitating improved environmental governance, both in terms of institutional capacity and resources, and to support locally based civil society to play a role in this process.

Within certain sector agencies - including the Ministry of Agriculture, Ministry of Fisheries and the Ministry for Mines - environmental units have been developed but these units function with varying degrees of effectiveness. Environmental units were widespread throughout the majority of Ministries before the onset of the political crisis, but many have become dysfunctional in recent years. Most environmental units now suffer from a critical lack of resources. The environmental unit in the Ministry of Mines remains an exception and is a functioning and generally effective unit.

"The legal status of ONE is not entirely in harmony with the nature of its environmental assessment review and compliance monitoring mission."

The *Office National pour l'Environnement* (ONE) has the mandated role of environmental regulator. Since 2009, ONE has had a status as an independent legal entity (a Public Establishment with an Industrial and Commercial Character – EPIC) and has financial and administrative autonomy. However, there is an incongruity between its current legal status, which allows it to generate profits and act as a service provider, and its mission as the national environmental regulator; a role that should typically be exercised by a public entity driven by objectives of compliance and not by the need to generate financial receipts to pay staff and other administrative costs. In addition, ONE has indicated that its functioning is hindered by the administrative and accounting obligations associated with its EPIC status. The legal status of ONE thus needs to be reconsidered in light of this incompatibility, and to allow optimization of operational efficiency.

Madagascar National Parks (MNP) was established in 1990 as a non-profit association to manage the national network of protected areas on behalf of the State. While created as an independent association, the statutes of MNP state that the Minister for Environment is the President of the Board, and that the Ministry selects a majority of other Board members. To address this issue the Board of MNP has recently launched a process of analysis and reflection on the functioning and status of MNP. Preliminary results of this analysis indicate that changes to the functioning and membership of the Board are required to reinforce the organization's independence from Government. A committee is being established by MNP to investigate options further and make recommendations for the future functioning and status of the organization.

"The legal status and functioning of Madagascar National Parks is being investigated to ensure continued flexibility and autonomy for the management of the organization, while facilitating clearer relationships with the Government."

Two trust funds operate in the environment sector – the Foundation for Protected Areas and Biodiversity (FAPBM) and the Foundation Tavy Meva. In 2012 the FAPBM supported the recurrent costs of fifteen protected areas covering 1.6 million hectares. The future challenge for FAPBM, which has now met its self-imposed target of a US$50 million capital by 2012, will be to strengthen its vision and strategic plan, and the functioning of its Board, to allow it to clearly implement its mandate as a protected area financier, target new sources of financing to supplement traditional donor contributions, and secure and maximize revenues from its capital. The current capital of Tany Meva is in the order of US$18 million and since 1996 it has funded 1170 projects for a total value of US$9.3 million. To date Tany Meva has been less effective than the FAPBM in terms of its visibility and its ability to secure large sources of financing from traditional donors.

Principle 4: Transparent processes, and a strong civil society participating in public affairs

The need for a strong, independent civil society that can actively participate in public affairs is never more apparent than during periods of political turmoil. During these periods when existing, already fragile 'supply-side' governance systems are overturned, the 'demand-side' of governance provided by civil society is called upon to play an increasingly important role. Civil society in the form of international and national NGOs, is a highly visible presence in the environment sector in Madagascar. In recent years, issues such as illegal exploitation of precious timber have galvanized civil society organizations and they have increasingly succeeded in making their common voice heard. National civil society in particular has started playing a more prominent role in the sector. There are now numerous examples of civil society's strength in drawing national and international attention to issues such as exploitation of critically endangered tortoise species or precious

timber[7]. The Alliance Voahary Gasy, a national platform of conservation and environment NGOs, has played a pivotal role in coordinating the harmonized communication by civil society organizations and is an increasingly visible player in the environmental and natural resources sector.

Nonetheless, challenges remain for the functioning of truly effective demand-side governance. Several internal characteristics of Malagasy civil society organizations affect their ability to play a genuine lobbying or advocacy role. While environment and natural resources sector civil society organizations are arguably more mature and robust than organizations in other sectors, certain of them share similar inhibiting characteristics including an overlap between political leadership and civil society, a predominant role of service provider rather than representative functions, weak financial sustainability and limited geographical coverage.

"In recent years, issues such as illegal exploitation of precious timber have galvanized civil society organizations and they have increasingly succeeded in making their common voice heard."

An evaluation undertaken by the Malagasy coalition of The Access Initiative in terms of three 'rights of access' that underpin good demand side governance found that in terms of rights of access to information, rights of public participation and rights of access to justice much work remains to be done[8]. Access to information is limited both due to the relative scarcity of information that is generated by Government and by the private sector, and also because of unequal power balances that exist between civil society and communities, Government and the private sector. The types and forms of information provided by Government and the private sector are not always conducive to interpretation by civil society and are thus limited in their utility. While public participation is embodied in legislation for certain types of developments, there is a gap between theory and practice, with a weak understanding of obligations and rights, and practical concerns such as accessibility and distances from major centers influencing low levels of real engagement. Public participation in strategy and policy development is not required by legislation and is virtually non-existent in practice. Finally, access to justice is weak for civil society and communities. Cost, distance and complexity of court proceedings put such access out of the reach of many, and the formal role that civil society is able to play in legal proceedings is often unclear. Coupled with problems of corruption and a lack (or perceived lack) of independence in the judiciary and the often low priority given to environmental proceedings, access to justice in particular is an area that requires substantial improvement.

Civil society will need to be encouraged in its objective to play a truly independent advocacy and watchdog role. Support for improved access to information and mechanisms for processing and disseminating information will be important, as will support for benchmarking of Government performance. International experience shows that such support should be 'organic' (i.e. defined by local civil society organizations and building on existing political and civil society structures) and 'experimental' (i.e. structured for careful assessment and monitoring of impact). Support will need to be complemented by modification of governance frameworks that clearly define the legal role and status of NGOs particularly in terms of their role in legal proceedings related to natural resource exploitation and environmental degradation.

B. Public Environmental Expenditure Review

Environmental revenues are fiscal and non-fiscal revenues, and international grants and credits for activities related to environmental and natural resource management[9]. Fiscal revenues generated by the environment sector totaled US$21.6 million between 2004 and 2011; revenues from fisheries outstripped other sources of fiscal revenues in the sector, contributing 80 percent of the total. In the environment sector, non-fiscal revenues remain low, and peaked between 2008 and 2010 due to the mining sector and exploitation of precious timber. External assistance to the environment sector has traditionally accounted for an important proportion of total environment sector revenues. With a peak of US$42 million in 2007, external assistance to the sector totaled US$75 million between 2004 and 2011. An 84 percent reduction in external assistance to the sector was experienced between 2010 and 2011 as a result of the ongoing political crisis. Between 2003

[7] See for example: "Lemur Forests Pillaged by "Gangs" as Madagascar Reels", National Geographic News, March 24, 2009, http://news.nationalgeographic.com/news/2009/03/090324-lemurs-looting-madagascar.html; "Million-dollar beds fuel Madagascar timber crisis", BBC News, 26 October 2010, http://www.bbc.co.uk/news/science-environment-11626412; "Slow and steady: A Manhattan night-life baron's race to save an ancient species", New Yorker, January 23 2012.

[8] The full report can be found at www.theaccessinitiative.org

[9] For the purposes of the CEA, revenues generated from the forestry and fisheries sectors and visitor entry fees to protected areas have been included in the analyses.

and 2011, revenues from the environment sector contributed in the order of 2.8 percent of the national budget annually. Revenues from the environment sector during this period averaged approximately 0.5 percent of GDP.

Environment sector expenditure has been considered in terms of amounts and defining traits of expenditure of the key organizations operating in the sector, and through comparison with the national budget and GDP. The budget and expenditure of the Ministry of Environment and Forests (MEF) has been highly variable over the last decade. The peak of US$12.7 million that was observed in 2008, following the merger of the then Ministry of Forests and Water and the Ministry of Environment, in both allocated budget and expenditure was quickly followed in 2009 by a significant drop in both allocated and expended budget with the onset of the political crisis. This downwards trend continued until 2011 for actual expenditure, despite an increased budget allocation. Expenditure of MEF is characterized by a relatively low rate of budgetary engagement. Before the political crisis, investments represented the largest expenditure of MEF; after the onset of the crisis the trend was reversed and salaries represented the largest expenditure.

Box ES.1: Examples of the impacts of governance failures in Madagascar's environment sector

The governance failures that have led to the ongoing illegal exploitation of precious timber, and the failure to implement a suitable governance structure to facilitate future participation in international carbon finance markets (e.g. REDD+ mechanisms) are two concrete examples of the degree to which the governance of the sector is inadequate to manage phenomena that are damaging the country's natural resources, and resulting in a loss of potential revenues for the country.

Over the last 20 years illegal logging of precious timber (i.e. rosewood and ebony) has been a recurrent trend in Madagascar with peaks in activity mirroring successive periods of political and social unrest. For several years the Direction-General of Forests has been preparing a system that would allow the sustainable management of the country's forests (including precious timber) including zoning and management plans, inventories and qotas, transparent allocation of forest exploitation licenses, and a related fiscal framework. While waiting for this system to become operational, logging of precious timber was nominally banned by national legislation. However, under the influence of timber barons, the Government has authorized an increasing number of "exceptional" permits for the exploitation and exportation of precious timber in recent years. The latest peak in illegal logging linked to the onset of the political crisis in 2009 was without precedent.

The timber logged in 2009 was estimated to have generated revenue in the order of US$220 million for timber barons, and revenue of US$21.7 million for the Government. While this is a not insignificant amount for a cash-strapped Government in a full political crisis, it is overshadowed by the half a billion dollar value of the predominantly nature based tourism industry that is suffering from the reputational damage caused by logging activities. Illegal logging also tarnishes the country's reputation in international forest carbon finance markets, which will be hindered in its development if illegal logging continues. Civil society while successful in drawing attention to this issue in national and international forums has largely been stymied in its attempts to bring the perpetrators of illegal exploitation to justice.

The situation observed for precious timber exploitation appears to be being reproduced in relation to forest carbon due to the lack of a robust regulatory framework for investment in this sector. As a result, there is no single, coherent policy on forest carbon sales; the institutional arrangements are ambiguous and weak in terms of capacity and resources; legislation does not treat issues associated with forest carbon in a robust manner; and there is little transparency in revenue sharing. NGOs have played an important technical role in the development of pilot projects, and have commenced negotiating sales of carbon with international buyers however such negotiations have to date largely been carried out independently of Government due to the lack of a regulatory framework.

The impacts of these governance failures have been real and significant for Madagascar. The lack of a clear governance framework means that there is a lack of certainty for investors. With the high level of global interest in generating financing through forest carbon sales, and despite the attractiveness of Madagascar due to its significant biodiversity values, there are enough other competitors in the market to translate this lack of certainty into a concrete loss of investment for Madagascar. In addition, governance failures affect community support for REDD+. In Madagascar there is a long history of natural resource rent capture by elites; there is a strong likelihood that unless a clear and consensual governance structure is put in place, carbon financing is also at risk of such capture, a scenario that would cause community dissatisfaction and potentially undermine the entire process which relies heavily on community involvement in, and support for, forest management.

The effects of the political crisis have highlighted the financial fragility of Madagascar National Parks and ONE. These organizations were established and heavily supported by donors as part of the Environment Program implementation and have been heralded as key successes by donors and Government. They both play inarguably essential roles in the sector, however after 20 years of existence, neither organization is financially independent. ONE was historically financed predominantly by external assistance through the Environment Program. Currently the only source of funding for ONE are the fees levied through the processing of environmental permits; initially intended only to cover the costs of evaluation of EIEs and follow-up monitoring, these fees are now also used to cover staffing and administrative costs of the organization. ONE does not generate adequate revenues to cover its costs and experiences recurrent financing gaps; between 2003 and 2011, the budget of ONE accounted for an average of 6 percent of annual spending in the environment sector.

Environmental spending as a proportion of GDP has decreased from a peak of 0.9 percent in 1999 to just 0.1 percent of GDP in 2011.

The budget of Madagascar National Parks represents a significant proportion of the environment sector budget - an average of 37 percent of the annual expenditure between 2003 and 2011. Despite over twenty years of existence, Madagascar National Parks remains strongly dependent on external assistance to meet its operating budget. In recent years, the Government has provided no financing for Madagascar National Parks from its internal budget, and tourism generated revenues represent only a small proportion of its budgetary needs. The remaining budget is provided by external donors, notably the World Bank through the Third Environmental Program Support Project (EP3), and to a lesser extent through a grant from KfW.

Overall, the proportion of environmental expenditure compared to the national budget rests modest, averaging 1.3 percent annually between 2003 and 2011. In Madagascar, environmental spending as a proportion of GDP has decreased from a peak of 0.9 percent in 1999, to an average of 0.25 percent in the period between 2005 and 2008. Following the commencement of the political crisis, environmental spending dropped to just 0.1 percent of GDP in 2011, well below the internationally recommended ratio of spending as a proportion of GDP of 1 percent. By way of comparison a conservative estimate puts the costs of environmental degradation at 9 to 10 percent of GDP. While global figures are patchy, estimates cite a range

Box ES.2: Suggested pillars for reform of governance in the environment & natural resources sectors

The following activities have been identified on the basis of the CEA analyses as being important steps in future improvement of environment sector governance in Madagascar. They can be used to inform debate and dialogue between Government, civil society and development partners in relation to future reform efforts.

- Audit of policy, institutional and legal frameworks for forestry, climate change adaptation / DRM and carbon finance, and environmental regulation at central, sectoral and decentralized levels, and technical support for improvement
- Capacity building of judiciary, administration and civil society in relation to the enforcement of environment sector legislation and strengthening of the roles, rights and responsibilities of these parties
- Policy dialogue with Government on change of legal status of ONE and future sources of financing
- Policy dialogue with Government on change of functioning of MNP and future sources of financing
- Support to benchmarking of MECIE legislation to international best-practice (including specific issues related to environmental regulation of the mining sector)
- Support to Government for the generation of robust environment datasets that are widely and freely available to interested parties.
- Support to civil society that builds on improving access to and dissemination of information and mechanisms for benchmarking Government performance
- Support to development of policy mechanisms to better capture non-fiscal revenues and to earmark environment and natural resource revenues for use in the sector

of 0.5 to 1.5 percent for the proportion of environmental spending as a function of GDP in developing countries; values that are significantly higher than in Madagascar despite the global importance of the country's natural resources and in particular its biodiversity.

Once external development assistance is removed from the calculation, environmental revenues are inferior to revenues generated by the sector. Earmarking of environmental revenues for use in the sector is limited. The contribution of non-fiscal revenues is not consistent and is heavily influenced by exceptional

circumstances, meaning that budgetary planning cannot assume a constant contribution from these revenues. The low contribution of non-fiscal revenues in the environment sector to the national budget belies the presence and rate of exploitation of the country's significant natural resources. Proper capture of non-fiscal natural resource revenues would allow the environment sector to contribute a greater share to the national budget.

Finally, the adage 'what is not measured cannot be monitored' applies to the economic and financial functioning of the environment sector. The problems encountered in terms of data availability due to the current political situation add to inherent and long-term problems in data collection and treatment in the sector and low capacity of Government officers in financial management. If monitoring of economic and financial data in the sector is not carried out in a transparent and coherent manner, then there is no means of ensuring that spending aligns with national sector priorities, and the accountability of decision makers who allocate budgets is greatly reduced.

4. Analysis of Selected Public Policies in the Environment Sector

A. Sustainable Financing of the Protected Area Network

Following the 2003 "Durban Vision" the expansion of the protected area network has been rapid and impressive; from 46 protected areas to 144 protected areas today. The political will underpinning the development and maintenance of Madagascar's protected area network is a significant achievement in such a poor country. Successive Governments have demonstrated a strong commitment to the creation and management of the protected area network, and NGOs and donors have been important partners in this process providing technical and financial support to the network over the last two decades. The network now contains between 65 and 77 percent of the remaining native forest cover; because of the unique nature of the biodiversity found in Madagascar, the network thus represents a global public good and its protection is a combined responsibility for international and national partners.

However, a significant financing gap persists for the network and its essential that a protected area financing strategy is developed to match the ambitious scope of the protected area creation strategy. The current management cost of the network is in the order of US$19 million per year; of which the 2.8 million hectares of protected areas managed by Madagascar National Parks cost US$8 million per year, and the remaining protected areas outside the Madagascar National Parks network cost US$11 million per year. In the future, the cost of the protected area is expected to grow to US$23 million, largely due to the increased costs of management outside of those protected areas managed by Madagascar National Parks. The costs of the management of the protected area network do and will continue to place a significant burden on the Government. Put in perspective, environmental sector expenditure in the period 2003 to 2011 averaged US$15.6 million per year.

Current sources of financing cover approximately eight percent of network costs and include tourism entry fees that contribute approximately US$0.5 million per year, the FAPBM which contributes US$1.0 million per year, and pre-sales of carbon credits that have generated relatively modest one-off funding for certain protected areas. The remaining 92 percent of the network's costs are currently met by external sources; notably donors, NGOs and private Foundations.

"The protected area network costs US$19 million per year to manage; only 8 percent of these costs are covered by internal financing sources i.e. tourism and the FAPBM."

External assistance will continue to play an important role in protected area management in Madagascar in the short to medium term given the status of the country's biodiversity as a global public good. In the long term there will continue to a contribution to network costs from external sources both for practical reasons – e.g. lack of resources available on the part of Governments and competing priorities for these scarce resources – and moral ones as developed countries benefit significantly from the biodiversity contained in the developing world; however, there will be a need for a public policy on protected area financing that anticipates a progressive reduction of such external assistance.

To complement external assistance, sustainable financing mechanisms for the network, focusing on tourism and international carbon markets, will require strengthening. Collaboration with the private sector to develop infrastructure that attracts increased numbers of tourists and thus allows an increase of tourist entry fees will

assist in increasing the financial returns generated by tourism, although the negative effects of repeated cycles of political instability on tourism sector growth must be recognized. The current World Bank funded Third Environmental Support Program Project (EP3) is supporting tourism development in ten high-priority national parks. Mechanisms for sales of carbon credits to generate significant financial returns for the network's management are still being tested in international markets, and caution should be applied in the estimation of potential future benefits. Madagascar will require support to develop the necessary institutional and legislative frameworks to support such mechanisms.

Madagascar has been a pioneer in trailing methods to involve local communities in protected area management that have anticipated co-benefits of reducing incursions into protected areas through providing alternative livelihoods to slash-and-burn agriculture, and offsetting the opportunity costs borne by local communities. The community related costs associated with protected area creation now represent the largest proportion of total costs, and there is a need for ongoing trialing and monitoring and evaluation of such methods to ensure that expected social benefits are realized in a cost-efficient manner. Lessons should be drawn from international experience and future efforts made to increase sharing of experiences between Government and technical and financial partners working in Madagascar.

B. Planning for Climate Resilient Development and Institutions

Modeling of future temperature in Madagascar indicates that by 2055 the country is expected to experience increasing temperatures and changes to inter-annual and intra-annual precipitation patterns. Droughts are expected to increase in severity and frequency in the south and possibly the west of the country and the east is likely to experience the most significant deficits in available water resources for crop production. Global sea level rise (SLR) estimates are in the order of 50 to 120 cm by 2100 and the urban centers of Toliara and Morondava could be the most significantly affected by rising sea levels. By 2100, the total number of cyclones affecting Madagascar is not expected to change significantly, but in keeping with observations of past trends, the number of intense cyclones is expected to increase and the north of the country is expected to be more frequently affected. The return period of cyclones in the major urban centers of Majunga and Toamasina could in fact decrease in coming years but further modeling is required to confirm this projection.

In Madagascar no detailed analyses of the social impacts or economic costs of climate change exist however consideration of the costs of past extreme climate events provides an indication of the possible scale of impacts. Since 1990, 41 major events have been recorded that have affected more than 8 million people - more than one third of the current population - and killed at least 1,800. In Madagascar tropical cyclones are the most frequent climate events and account for 65 percent of climate related disasters in Madagascar; on average 250,000 persons are affected and US$50 million worth of damage is caused by each cyclone event. Although no economic analysis of the effects of floods and droughts exists for Madagascar, experience in other southern African countries indicates that the economic impacts of such events can be significant.

"Short-term and medium term moderate droughts are expected to increase in the southeast and south of the country; medium term extreme droughts are expected to increase the west of the country."

A rough calculation of adaptation needs in 2050 in Madagascar based on future average per capita adaptation needs in Sub-Saharan Africa results in an estimate of US$300 to US$500 million per year[10]. The Madagascar National Adaptation Program of Action (NAPA) estimates a budget of approximately US$4 million for priority adaptation measures, a calculation that is nearly certain to underestimate even the most urgent adaptation needs. Similar trends in and influences on adaptation costs are likely to be observed in Madagascar as in other Sub-Saharan African countries. At approximately 0.6 percent of GDP between 2010 and 2019 the costs of adaptation as a percentage of GDP are expected to be higher in Sub-Saharan Africa than in any other region. The highest costs of adaptation in Sub-Saharan Africa are forecast to occur in the areas of water supply / flood protection and agriculture. The situation in Madagascar where no substantial climate change adaptation programs are being implemented is an anomaly when compared to other African countries where significant

[10] This estimate has been developed by the CEA Study Team based on an assumption of 2.8 percent population growth in Madagascar to 2050 and per capita adaptation cost data for Sub-Saharan Africa sourced from the '*Economics of Adaptation to Climate Change*' project led by the World Bank which can be found at http://climatechange.worldbank.org/content/economics-adaptation-climate-change-study-homepage

investments are already being made to build resilience in key sectors such as agriculture, infrastructure and protection of coastal development.

The stakes of climate change in Madagascar are substantial, yet the country lacks the data, institutions or policies to address the potential social and economic effects. In the short-term, Madagascar needs to improve understanding on future climate change projections, the associated economic and social effects of climate change, and the costs and benefits of different adaptation approaches. Such information will have a dual purpose of informing decision makers and the general public about the potential severity of climate change for Madagascar, and will provide strong technical underpinnings for policy, program and project development and decisions on resource allocation.

"Given the complexity and scale of the challenges that will be posed by climate change there is a clear need for high-level leadership and coordination on climate change issues, and support will be needed at the national and sector level to mainstream climate resilience building in development planning."

Madagascar needs to urgently develop a national adaptation strategy that identifies the priority actions to be implemented. This strategy needs to concentrate on building long-term resilience to natural disasters both now and under climate change scenarios. The most cost-effective adaptation approaches in developing countries have common characteristics that can guide Madagascar in its choice of adaptation strategies. The most cost-effective approaches are those that: (i) focus on low-regrets activities and delay investments in expensive, long-term adaptation measures; (ii) commence by targeting measures that tackle weather risks; (iii) emphasize the need to plan development to be climate resilient; and (iv) view 'soft' and 'hard' measures as integral parts of an overall adaptation package. Support will be needed to ensure that the policy on national adaptation priorities is mainstreamed into national and sector level development planning.

At an institutional level, given the complexity and scale of the challenges that will be posed by climate change there is in the longer term a clear need for high-level leadership and coordination on climate change issues. Climate change adaptation strategy development and activities are under the mandate of the Direction of Climate Change (DCC). The DCC is relatively new department that is still in the process of establishing its identity and role. Line Ministries need to be involved in high-level reflections and decisions on climate change adaptation to ensure that there is a strong alignment between sector priorities and adaptation priorities, and support will be needed at the national and sector level to mainstream climate resilience building in development planning. The issue of post-disaster contingency funding needs to be addressed in a coordinated manner.

C. Environmental Regulation of the Mining Sector

With its extensive mineral and non-mineral sub-soil assets, Madagascar is recognized as a geologically rich country with resources that have the potential to generate large economic gains over a relatively short period. The mining sector in Madagascar is characterized by several sub-sectors: unregulated mining rushes, a mixture of formal and informal artisanal and small-scale mines, and a nascent yet highly regulated large-scale mining sub-sector. Mining activity in all its forms has significant socio-economic importance. Mining rushes and artisanal and small-scale mines provide permanent or seasonal employment for up to 6 percent of the national workforce and large scale mines are of increasing importance to the national economy: With the recent development of the first two large-scale mining operations in Madagascar, the formal mining sector's contribution to GDP is expected to grow from less than 1 percent to 15 percent in coming years. However, mining activity simultaneously has the potential for significant impacts on the natural environment in terms of conflicts with the protected area network, direct effects on biodiversity, pollution of water and soil resources, and the effects of induced development.

"For a large-scale mining project with a lifespan of 30 to 40 years, around US$3,000 to US$4,000 per year is available to ONE for monitoring activities; such a budget is inadequate to allow more than a superficial monitoring exercise."

Regulation of the sector has been significantly improved in recent years on all aspects except those pertaining to environment regulation, where the regulatory framework remains out of step with the evolution of the industry. The current environmental assessment framework has struggled to fully keep pace with the scale of large-scale mining developments that are underway. However, the high visibility of large-scale projects combined with the companies' own environmental policies and engagements have ensured that there has

been systematic application of the environmental regulation framework, and certain companies have voluntarily adhered to international best practice standards on issues such as biodiversity offsets and pollution control. A key challenge will be to ensure that future large-scale mining operations that may be carried out by companies with fewer internal environmental engagements continue to be subject to a sound national environmental regulation framework. To this end, environmental assessment legislation and guidelines for the large-scale mining sector need to be updated and widely communicated within Government and the private sector and national environmental pollution standards – both ambient and discharge – should be developed.

The role of ONE in post-EIE environmental monitoring of large-scale mining projects is not adequately supported by the financial resources available over the lifespans of the projects. For a project with a lifespan of 30 to 40 years, around US$3,000 to US$4,000 per year is available for monitoring activities. Such a budget is clearly inadequate to allow more than a superficial monitoring exercise. Options to increase the financial resources available to ONE require investigation. ONE requires increased technical capacity on a focused range of issues such as socio-economic monitoring and evaluation, international best practice in pollution analyses and control, and data storage and treatment, and should be furnished with the appropriate equipment to allow it to carry out independent audits of mining projects.

Mining rushes – due to their illegal and covert nature – are arguably the most difficult component of the mining sector to control in terms of environmental regulation, yet the direct and indirect cumulative effects can be significant, particularly when a concentration of sites occurs in the vicinity of a sensitive environmental zone. Miners themselves are typically poor and economically and socially vulnerable as well as somewhat nomadic; it is thus difficult to organize them or engage them in improved environmental practices. It is unlikely that nationwide bans on mining rushes will be effective due to the limited resources for enforcement on one hand and the potential economic gains for miners and illegal networks on the other. There is a need to better understand the social and economic importance, as well as the environmental impacts of mining rushes and to support Government to develop an environment control regime that is aligned with the scale and nature of mining rush activities.

D. Reducing Indoor Air Pollution through an Ethanol Cookstove Program

Over 95 percent of households in Madagascar rely on woody biomass to meet their primary energy needs; fuelwood is the predominant source of energy in rural households with very few households using charcoal, while urban households consume predominantly charcoal. As well as causing deforestation and ecosystem degradation due to fuelwood harvesting from non-plantation forests, respiratory infections caused by burning of fuelwood and charcoal cause approximately 12,000 deaths per year, of which the vast majority of victims are children.

A feasibility study that investigated alternative cookstoves concluded that by 2040, 1.3 million households, representing 16 percent of the Malagasy population, could adopt ethanol cookstoves either as a substitute for, or as a supplement to, their current cooking facilities. Take up rates in urban centers are likely to be higher than in rural areas. Significant social benefits could occur in the form of health benefits, particularly for women and children, and labor savings. In Madagascar, 442,000 Disability Adjusted Life Years (DALYS[11]) could be saved over a 30-year period through reduced incidence of childhood respiratory infections, and adult chronic obstructive pulmonary disease and ischemic heart disease.

"By 2040, 1.3 million households, representing 16 percent of the Malagasy population, could adopt ethanol cookstoves saving 442,000 Disability Adjusted Life Years (DALYS) and between 670,000 hectares and 1.4 million hectares of non-production forest over a 30-year period."

Reduced deforestation has been identified as an important complementary benefit that could arise from the widespread adoption of ethanol cookstoves in Madagascar. The spatial pattern of fuelwood sources varies throughout the country with some zones almost entirely dependent on sustainably harvested plantation timber and other zones predominantly reliant on fuelwood sourced from native forests. If the above rates of adoption for ethanol cookstoves hold true, then over a 30-year period the loss of between 670,000 hectares and 1.4 million hectares of non-production forest could be avoided. The spatial distribution of these projected deforestation savings, and thus the benefits for different types of forest ecosystems, requires further detailed analysis. In addition, there is increasing understanding of the climate change mitigation benefits of improved

[11] DALY = Disability Adjusted Life Year; a standardized measure reflecting the number of years lost through ill-health and premature death.

cookstove use. Deforestation benefits could be enhanced through complementary activities to increase the sustainability of fuelwood production and harvesting such as sustainable resource use plans or increased development of plantation forests for fuelwood production in zones where extraction of native vegetation is predominant.

"An ethanol cookstove program could generate US$37.9 million to US$47.5 million in avoided deforestation benefits, US$368 million in time savings benefits and US$34 million in health savings benefits over 30 years."

An ethanol cookstove program in Madagascar could have net economic benefits in terms of avoided deforestation, time savings and health benefits. A calculation that uses conservative assumptions for deforestation savings and carbon stocks puts the potential benefits from avoided deforestation in the range of US$37.9 million to US$47.5 million over 30 years. The estimated benefits from time savings related to saved time in cooking and stove cleaning were calculated to be US$368 million over 30 years. Health benefits, in the form of saved DALYS, amount to US$34 million. Households would bear a cost of US$175 million for stove and fuel purchases; these costs would be outweighed by economic returns to the household through time savings, improved health and avoided medical costs. A large-scale household ethanol program is also projected to generate a net increase in employment of 571,000 additional jobs over a 30-year period.

The starting point for the successful implementation of a large-scale ethanol cookstove program would be for the Government to develop a clear and unequivocal public policy to promote such a program. It would be essential that the Government is the driver of program development and implementation and draw on technical support as necessary. The remaining steps in program implementation and development would require technical rather than political solutions including fiscal policy reform, land use planning, technical support to stove design and consumer education. High-level 'champions' within Government, NGOs, donors and the private sector could help to garner the required support and ensure policy dialogue between the various stakeholder groups. In parallel with measures to overcome institutional and technical barriers, innovative financing mechanisms would need to be identified and targeted to support program development. A range of financing sources that has come on-line in recent years, including carbon financing programs and public private partnerships, could provide potential future sources of financing for development of an ethanol cookstove program in Madagascar as part of social protection initiatives in the health, rural development and education sectors.

5. Moving Forward – Future World Bank Interventions in the Sector

Despite over twenty years of concerted efforts by successive Government in collaboration with a large number of technical and financial partners, Madagascar's environment sector remains in a fragile state: The prolonged political instability that has reigned since 2009 has only served to exacerbate underlying weaknesses in the governance framework. As with the political crises that have come before, the current instability is affecting previous investments and achievements in the sector and is undermining the ability to plan for the future thus allowing the concretization of past efforts and the pursuit of new and evolving priorities in the sector.

Over the last two decades the World Bank has been a primary source of development assistance to Madagascar's environment sector through the framework of the National Environmental Action Plan (NEAP), which was adopted in 1990. The NEAP, which was the first to be prepared in Africa, was hailed as a landmark example of integration of environmental concerns in national policy frameworks and donor coordination. It was implemented through a three phase Environment Program that drew together the support of a large number of technical and financial partners. With the closure of the third and final phase of the World Bank's Madagascar Environmental Program Support Project (EP3) programmed for 2014, and the withdrawal over the last three years of nearly all of the traditional financial partners from the environment sector due to the ongoing political crisis, it is a watershed moment for the country's environment sector and there is a pressing need to take stock of the wins and the losses and to identify future directions for support. In the short term, the World Bank's future operations in Madagascar will be guided by the Interim Strategy Note (ISN) 2012 – 2014.

The technical analyses in the CEA have generated a large number of suggested actions to improve environment sector performance in Madagascar; here those actions that may be suitable for future World Bank support in the short and long-term are identified. Such activities will form the basis of discussion with Government during the development of a future partnership strategy. The CEA recommends that future

interventions of the World Bank in the environment sector be structured around the following three broad themes:

I. Improved valuation of natural capital and development of market mechanisms for revenue generation

Madagascar's natural resources represent a substantial component of the country's total wealth. The country's degraded and patchy infrastructure and poorly qualified workforce, ensure that the effective capture and management of revenues generated by renewable and non-renewable natural capital will be essential to future economic development. No robust quantitative analyses of the scale of the country's total wealth exist and there are few policies to facilitate the transformation of economic benefits provided by natural capital in a way that could facilitate the country's progress along a more sustainable development pathway.

➔ ***Role of the World Bank:*** *In the short-term the World Bank will provide technical support to the Government to better understand the country's natural capital values in the mining, fisheries, water resources and forestry sectors, and integrate them into policy development through the WAVES Global Partnership. In the longer term, the World Bank will continue dialogue with the Government on the development of market mechanisms for the transformation of economic values of natural resources and environmental services into revenues that can support management of the environment sector. Such mechanisms represent one of the only means by which adequate revenues for sector management can be generated given the breadth of the challenges identified in the CEA.*

II. Improved environment sector governance

Robust governance in the environment sector has always been and will remain to be a challenge in Madagascar. However, as long as governance structures are weak, the ability to achieve sustainable outcomes across other facets of the sector risks being undermined. Additionally, weak governance undermines the ability to capture and transform economic values of natural resources to allow better management of the country's environmental riches and to support a sustainable development pathway for Madagascar.

➔ ***Role of the World Bank:*** *The World Bank is currently financing a technical assistance for the feasibility of the disposal of stocks of precious timber. In the medium term, and dependent upon resolution of the political crisis, the World Bank, through the Forest Carbon Partnership Facility, is also likely to resume funding for the development of a strategy on forest carbon. In the longer term, the World Bank may consider financing a governance project for natural resources. This project could take the form of budget support that would involve financing of ex post financing reforms, rather than financing ex ante activities. The same instrument could also be used to introduce the principles of reduction of pollution in domestic households into public policy, and prepare the foundations for a public policy related to adaptation to climate change.*

III. Reduction of social and climate related vulnerability

Madagascar is a highly vulnerable country. The wide range of natural disasters that occur in Madagascar, coupled with the high rates of dependence on natural resource based sectors such as agriculture and fisheries for the livelihoods of the predominantly rural population, compound climate related vulnerability. Global climate change is expected to increase current levels of vulnerability through increasing intensity and frequency of climate related natural disasters particularly in terms of more severe droughts in the south of the country, increasingly intense cyclones and rising sea levels that will threaten coastal development.

➔ ***Role of the World Bank:*** *The World Bank has for several years supported technical assistance in disaster risk management and intends to continue this assistance. The Bank is also supporting certain investments, especially in relation to early warning systems and disaster response investments through the multi-sectoral emergency operation that was approved by the Board of Directors at the end of 2012. In the longer term, the World Bank could fund a multi-sector operation aimed at enhancing the resilience of the population in southern Madagascar to the recurring droughts that are experienced in this region.*

Chapter 1: Introduction

I. Background and Context

Much has been written about the unique natural resources that exist in Madagascar; however words do not do full justice to the environmental wealth that is found in this island nation of 580,000 square kilometers located 400km off the east African coast. Unrivalled levels of species diversity and richness, extensive marine and terrestrial carbon sinks, and diverse ecosystems that provide essential goods and services, reinforce the status of the country's biodiversity and natural resources as a global public good, and highlight their importance to a 20 million strong, highly natural resource dependent human population.

However, the country's economic poverty is as profound as its ecological riches. The country ranks 151st out of 188 countries in the 2013 Human Development Index[12], 164th out of 173 countries in terms of GDP/capita[13] and has a national poverty rate of more than 76 percent[14]. With over two thirds of the population in rural areas, where the poverty rate climbs to 82 percent, and with more than three quarters of the population engaged in natural resource dependent livelihood activities, there exists a precarious human-environment balance. The poverty rate remains at the same level as it was in 1980, and between 2001 and 2008 there were an additional 2 million poor people. There is significant inequality in economic growth; the 20 percent of the population with the lowest incomes control just 6 percent of the national wealth and at US$430/year in 2010, gross national income per capita is well below that of the average for developing countries in the Sub-Saharan African region[15].

Madagascar is currently suffering the effects of a prolonged political crisis that saw a de-facto Government come to power in early 2009; this is a pattern that has been periodically repeated in Madagascar since 1991 and one that raises concerns for economic performance: After the 2002 political crisis it took 6 years to re-establish household income levels. While in recent years GDP growth had been positive at 6.2 percent in 2007 and 7.1 percent in 2008, negative growth of -4.6 percent was observed in 2009 due to the effects of the political crisis. Growth was re-established to 1.6 percent in 2011[16]. The 2010 GDP was US$8.7 billion and its composition reflected the importance of the natural resource base to economic development with natural resource sectors – agriculture, fisheries and forestry - contributing nearly one third of GDP[17].

There exists a conflicting economic – environment paradigm in Madagascar, which has just 1/10,000th of world's GDP, but 1/20th of the world's known biodiversity. The country's natural resources account for over half of the country's total wealth and thus have the potential to generate substantial, tangible economic benefits. There is enormous potential for the country's natural resource base not only to "pay its own way", but also to contribute to poverty reduction and economic development. Before the political crisis, nature based tourism was growing at 10 percent per year and was a US$0.5 billion industry. Carbon finance – predominantly through avoided degradation and deforestation - has the potential to generate, assuming that good governance structures are in place, more than US$6 million per year of revenues and the private sector has already demonstrated its keen interest in this market. Ecosystem services are vital for the country's natural resource dependent population; the protected area network provides water services worth US$4 million/year to downstream farmers and urban water users. These sources of financing already exist but need to be supported so that their feasibility can be demonstrated to decision makers and local communities alike, thus proving irrevocably that the loss any more of Madagascar's unique species and ecosystems would have serious economic consequences.

However, challenges remain, particularly in terms of governance in the sector. Successive periods of political unrest have created power vacuums within which there has been a near-total collapse of environmental governance leading to natural resource exploitation such as illegal logging and exploitation of critically

[12] This ranking represents a drop of two places since 2010 and 5 places since 2006 (UNDP, 2013).
[13] Based on a comparison of countries for which 2010 data was documented (World Bank, 2012)
[14] Instat, 2011a
[15] In 2010, the average GNI/capita for developing countries in Sub-Saharan Africa was US$1175/year (World Bank, 2011b)
[16] Instat, 2011b
[17] Ibid

endangered species, while revenues from tourism and other key natural resource based sectors have dramatically declined. Current threats are likely to be compounded by demographic pressures, with a doubling of the population projected in the coming 30 years, and climate change which will bring increasingly intense and frequent extreme events to a country that has been identified as amongst the top five most climate change vulnerable countries worldwide[18].

Undoubtedly, full protection of the natural resource base presents an insurmountable financial burden for the Government if it is carried out alone. Given their global importance, the preservation of Madagascar's natural resources is also an international responsibility and external development assistance will thus continue to play an important role in the sector. Over the last two decades the World Bank has been a primary source of development assistance to the environment sector through the framework of the National Environmental Action Plan (NEAP), which was adopted in 1990. The NEAP, which was the first to be prepared in Africa, was hailed as a landmark example of integration of environmental concerns in national policy frameworks and its successes, together with its failures, have been watched with interest. Implementation of the NEAP through the Madagascar Environment Program, a 20 year program supported by the Bank and a number of other donors, has resulted in significant gains: 6.9 million hectares, representing 12 percent of the country's surface, have been designated as protected areas; deforestation rates have slowed significantly to approximately 0.5 percent/year; institutions for management of protected areas and environment assessment and monitoring have been established; tourist entries have increased significantly (although numbers reduced as a result of the onset of the current political crisis, they are once more on the rise); trust funds for conservation and community development are operational; and the country has taken its first steps into the avoided deforestation market through pre-sales of carbon credits on the voluntary market.

With the closure of the third and final phase of the Madagascar Environmental Support Program Project (EP3) programmed for the end of 2014 , and the withdrawal over the last three years of nearly all of the traditional financial partners from the environment sector due to the ongoing political crisis, it is a watershed moment for the country's environment sector. Twenty years of multi-partner development assistance, totaling $400 million, is coming to an end and there is a pressing need to take stock of the wins and the losses and to identify future directions for support. There is growing recognition that sustainable and independent financing mechanisms are required for the sector, and that a collaborative process is required to look to the future to ensure that ensuing development assistance builds on the positive results and rises to the new challenges of coming decades.

II. CEA Objectives, Outcomes and Methodology

The Madagascar Country Environmental Analysis (CEA) is a country-level diagnostic tool prepared by the World Bank that has the following objectives: (i) to facilitate the integration of environment-development priorities in a future World Bank Country Assistance Strategy (CAS) that is likely to be prepared on re-engagement with a recognized Government; (ii) to provide analytical information that can underpin the development of high-level recommendations for future World Bank interventions and operations in the environment sector in the short, medium and long-term; and (iii) to serve as an initial analysis of environment sector governance issues for a potential future budgetary assistance lending to the Government if such an operation is pursued following the resolution of the ongoing political crisis. Importantly, the CEA also aims to contribute to debate and dialogue with Government and development partners on environment-development linkages and priorities in Madagascar.

The CEA has been carried out in the context of the recently prepared World Bank Environment Strategy[19] that is based around the three pillars of: a *green world* where natural resources are conserved and valued; a *clean world* that follows a low-pollution, low-carbon pathway and in which cleaner air, water and oceans enable people to lead healthy, productive lives; and a *resilient world* where countries are better prepared for more frequent natural disasters, more volatile weather patterns, and the long-term consequences of climate change.

[18] Maplecroft, 2012
[19] World Bank, 2012

The current CEA is the first ever prepared for Madagascar. It builds on previous analytical work in the country's environment sector including a sector wide analysis undertaken by the World Bank in 2003[20], an environment sector Policy Note prepared by the World Bank in 2010[21], and work carried out by technical and financial partners in the sector[22]. It also draws on a range of analytical work carried out by the World Bank in related sectors including governance analyses of the mining and forestry sectors[23], a national public expenditure review[24], and a feasibility study of the development of a program for introducing ethanol cookstoves in households[25].

The methodology that has been applied in the development of the CEA combined a literature review of both published and 'grey' literature, consultations and documentation of expert knowledge from within and external to the World Bank, and the commissioning of a number of technical studies including:

- Costs of Environmental Degradation and the Sustainability of Madagascar's Development Pathway[26]
- Sustainable Financing and Management of Madagascar's Protected Area Network[27]
- Understanding Climate Risks in Madagascar[28]
- Madagascar Public Environmental Expenditure Review[29]

World Bank specialists in environment and economics peer reviewed the document and their comments were used to improve the report. In April 2012, the key findings of the CEA were discussed with a wide audience of Government and non-Government stakeholders within the environment sector in Madagascar and their comments were taken into consideration in the finalization of the CEA.

III. Structure of the CEA

The remaining sections of the CEA report are structured as follows:

- *Chapter 2 - Environment and Development Priorities in Madagascar:* The assessment of environmental priorities commences with a discussion of the evolution and current status of Madagascar's key environmental challenges, discusses data on the costs of environmental degradation, and presents results of a prioritization of the environmental challenges facing the country.
- *Chapter 3 - Policy, Institutional and Regulatory Framework in the Environment Sector*: The institutional analysis focuses on the quality of environmental governance in Madagascar through an evaluation of the ability of environmental institutions to address key environmental challenges, an analysis of the policy and legislative framework, discussion of expenditures and revenues of the natural resources and environmental sectors and an assessment of the level of access to information and the role of civil society in the sector. This section includes several case studies on governance issues of particular importance to the environment sector.
- *Chapter 4 - Analyses of Selected Public Policies in the Environment Sector:* Following the prioritization of environmental challenges contained in the first part of the CEA, this section contains comprehensive analyses of selected environmental public policies: (i) sustainable financing of the protected area network; (ii) planning for climate resilient development and institutions; (iii) environmental regulation of the mining sector; and (iv) feasibility of a large scale improved cookstove program to reduce indoor air pollution and reduce deforestation.
- *Chapter 5 - The Way Forward: Future Support to the Environment Sector:* The final section of the CEA identifies the lessons learnt from past and present engagement by the World Bank in the sector, and draws on the analyses presented in previous chapters of the CEA to develop suggestions for future lending and non-lending assistance by the World Bank in the sector that could form the basis for discussions with Government in the context of a future sector partnership strategy.

[20] World Bank, 2003
[21] Carret et al, 2010
[22] Refer for example USAID, 2010
[23] World Bank, 2010a
[24] World Bank, 2011a
[25] PAC, 2011
[26] Ollivier & Giraud, 2010
[27] Agreco, 2012
[28] IEc, 2012
[29] Andriamarozaka, 2012

Chapter 2: Identification of Environment – Development Priorities

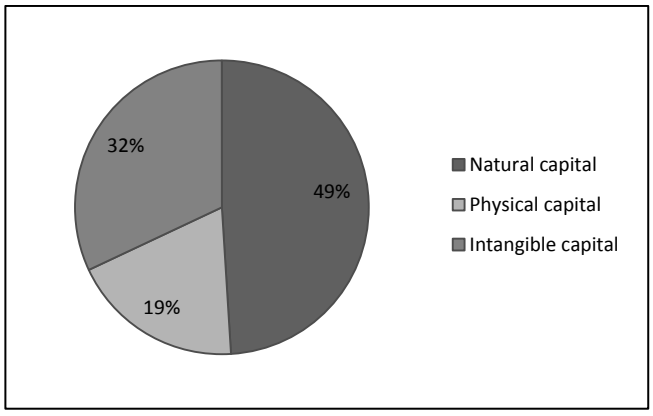
Chapter 2 of the CEA commences with a discussion of the importance of Madagascar's natural resources in terms of their contribution to Madagascar's total and the value of the country's natural capital. The Chapter then draws on a wide range of literature to present a discussion of the most pressing environment-development issues within the country. The Chapter then examines the costs of environmental degradation and the effects of environmental degradation on economic development. The Chapter presents an examination of the poverty-environment nexus in Madagascar and closes with the identification of four priority environment-development themes that are considered in greater detail in Chapter 4 of the CEA.

I. Evolution and Status of Environmental Challenges

1. Madagascar's Natural Capital

Natural capital[30] represents 49 percent of Madagascar's total wealth according to a preliminary estimate highlighting the importance of the country's natural resources for economic development. A country's total (or comprehensive) wealth is comprised of three types of capital: natural, social (intangible) and physical capital. In Madagascar, physical capital, a traditional economic concept that represents the value of physical assets such as buildings, machinery, and infrastructure accounts for 19 percent of total wealth: Physical infrastructure in Madagascar is sparse (the country has one of the lowest densities of roads per capita in the world), and poorly maintained. Intangible capital – or social and human capital - is also an important component of the country's total wealth, representing 32 percent of total wealth. However, the majority of the labor force is not qualified. This preliminary valuation of natural capital included consideration of (i) forest land which produces timber (roundwood and fuelwood), non-timber forest products, and bioprospecting values; (ii) protected areas; (ii) agricultural land, including cropland and pastureland; and (iii) fisheries. Ecosystem service values – notably water services and tourism values – are captured within the valuation of protected areas and agricultural land. Due to lack of robust datasets, mineral assets were not included in the analyses.

Figure 2.1: Components of Madagascar's Total Wealth (2005)



Source: Ollivier & Giraud, 2010

Agricultural land, and in particular cropland, is the most important contributor to the country's natural capital value representing 73 percent and is the largest single component of total wealth. Forestland accounts for nearly one quarter of the natural capital value, with timber values contributing in the order of 9 percent of the natural capital. Bioprospecting values contribute nearly 10 percent of natural capital value; although caution should be used in the interpretation of these results that are based on very limited datasets. Protected area values are notably low, accounting for less than 1 percent of natural capital value indicating

[30] Natural capital in its fullest sense includes sub-soil assets (e.g. minerals, petrol/oil reserves), agricultural land, forests, protected areas, fisheries and water resources.

that there exists significant untapped economic value in the protected area network. The inclusion of mineral resource values would certainly increase the overall natural capital value.

Table 2.1: Breakdown of Value of Madagascar's Natural Capital

Component	Sub-Component	Net Present Value (US$ /capita 2005)	Percentage Contribution to Natural Capital Value
Forest Land	Timber	192	9.3
	NTFP	80	3.9
	Protected areas	7	0.3
	Bioprospecting values	197	9.6
	Sub-Total	*476*	*23.1*
Agricultural land	Cropland	1318	64
	Pastureland	192	9.3
	Sub-Total	*1510*	*73.4*
Fish resources	Fisheries	70	3.4
	Sub-Total	*70*	*3.4*
Total		2056	100 percent

Source: Ollivier & Giraud, 2010

Natural capital accounting is a tool that can be used in a pro-active manner to better understand the potential economic benefits of natural resources. Natural capital accounting – including ecosystem services accounting – can be used to identify and support development of proactive policies to better manage natural resources and ecosystems before they become degraded, thus also generating environmental and social co-benefits[31]. In order to expand the use of natural capital accounting and ecosystem service valuation approaches in Madagascar and thus facilitate the inclusion of natural capital values in policy making, the country has been selected as a partner country in the *Wealth Accounting and Value of Ecosystem Services (WAVES) Global Partnership*. This four-year program has the overall aim of supporting Governments n partner countries to achieve sustainable development by expanding their national accounts systems to include natural resource values to guide sustainable development and policy making. The WAVES Preparation Phase commenced in early 2011 and culminated in the development of a detailed workplan for the WAVES Implementation Phase, which covers the period 2013 to 2016 (refer Annex 3). Priority themes identified in the workplan include improved valuation of the mineral resources and fisheries sectors, and improved valuation and capture of rents from watershed protection services and tourism in protected areas.

2. Terrestrial Ecosystem Degradation

The most commonly cited environmental problem in the popular and scientific literature relating to Madagascar is the degradation of the country's terrestrial ecosystems and the resulting loss of biodiversity, which has a status as a global public good, and ecosystem services, which are vitally important for local populations.

Madagascar is a mega-diverse country and a biodiversity hotspot. An impressive array of statistics provide testament to the extraordinary riches of Madagascar's terrestrial biodiversity. Characterized by high levels of species diversity in some groups and the complete absence of other groups[32], 84 percent of terrestrial vertebrate species - including 99 percent of amphibians, 92 percent of reptiles, 99 percent of non-volant mammals, 86 percent of invertebrates, 83 percent of plant species, and 93 percent of freshwater fish species, are endemic to this Island nation[33]. Endemism at family and genera levels is also elevated; for example, 23 out of 24 amphibian genera, and one out of four amphibian families are endemic to Madagascar. There are over 1,000 known terrestrial vertebrate species, and over 12,000 identified plant species[34]. While some groups such as the charismatic lemurs are relatively well studied, other groups such as amphibians and invertebrates that have been the subject of less intensive research await discovery of their full diversity. While total estimates of

[31] Lange et al, 2010
[32] Dewar & Richard, 2007
[33] Goodman & Benstead, 2005
[34] Ibid

biodiversity loss in Madagascar are rare, one estimate puts species loss at 42 percent up to 2000, with 9.1 percent of species lost due to deforestation between 1950 and 2000[35].

Despite its relatively small size, Madagascar comprises a broad diversity of ecosystem types. Three broad forest biomes - evergreen forests in the east, dry forests in the west and far north, and spiny thicket forests in the south and south-west - are generally recognized[36]; however, within these broad categories, distinct forest formations and ecosystem types exist that not only furnish a wide and diverse range of ecosystem services, but suffer differing threat dynamics and rates of degradation. The most recent, and arguably the most comprehensive, definition of vegetation types[37], identifies the two dominant vegetation types as *plateau grassland-woodland grassland mosaic* which covers approximately 65 percent of the country's surface, and *wooded grassland – bushland,* which covers approximately 23 percent of the country's surface. These two degraded vegetation types are found on the western and central plateau of Madagascar and the associated escarpments and although subject to high levels of burning, grazing and erosion are of high importance to local livelihoods and contain patches of specialized grassland habitats about which little is known.

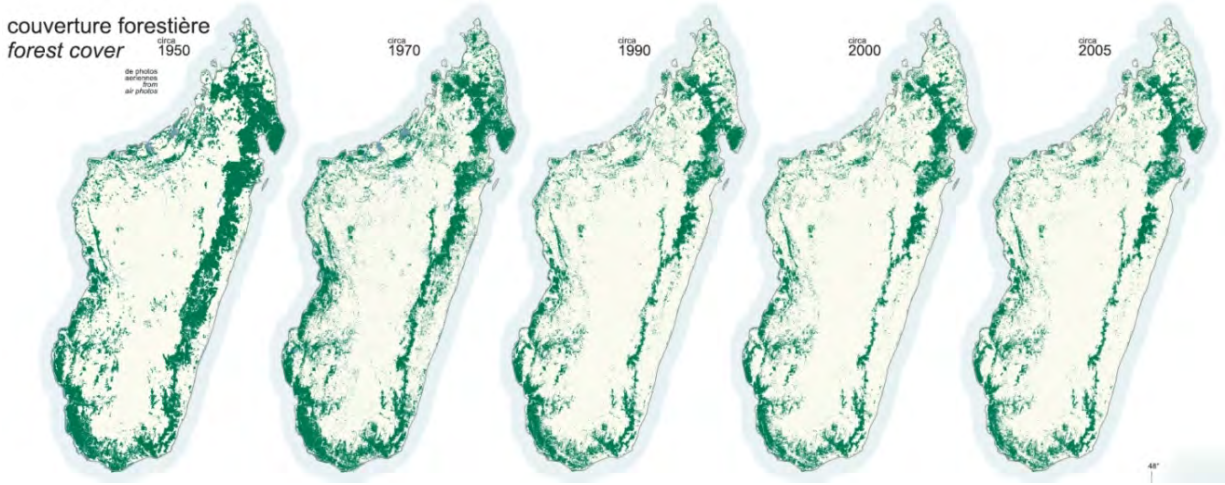
Recent estimates put remaining native forest cover in the order of 9.0 to 10.7 million hectares[38] and the national protected area network covers a surface of approximately 6.9 million hectares[39]. Native forest is dominated by humid forest, western dry forest and southwestern dry forest thickets. The largest blocks of remaining humid forest are located in the vicinity of the Masoala Peninsula in the northeast, and it is also present along the eastern escarpment in a narrow corridor from Tsaratanana Massif to Tolagnaro and in the northern mountain complex. Western dry forests are located in the western coastal plains of Madagascar, north from the Mangoky River to the northernmost part of the country. Southwestern dry forest thickets are a unique ecosystem form dominated by the Didieraceae family that contains four endemic genera. This ecosystem type is located on inland limestone plateau, sandstone/basement ridges, and sand dunes on the south and west coasts. Other, more spatially restricted natural vegetation types are found throughout the country including Tapia forest in the central southern part of the country, western sub-humid forest in a small area inland from the south-west coast, south-western coastal bushland forest in a narrow belt on the extreme southwestern coast, littoral forest found on the east coast, and western humid forest, found solely on the eastern slopes of the Analavelona massif in the country's southwest. The coverage of forest types in the protected area network is variable; eastern humid forest is the best represented, while the southwestern forest types, and the small patch of western humid forests are the least represented, although this latter vegetation type is afforded informal protection through its status as a sacred forest.

There is a great deal of debate surrounding early causes of deforestation following human settlement[40]. While it is accepted that forest degradation has occurred, the actual amount of forests cleared by human activity remains unknown as the baseline forest structure and extent of coverage prior to human arrival is not fully understood. Until recently it was assumed that Madagascar was mostly or entirely forested prior to human arrival over two millennia ago[41]. In recent years, a counter-narrative has emerged regarding the true extent of deforestation in Madagascar following human arrival[42]. This school of thought that criticizes the dominant narrative of progressive destruction of an entirely forested island by clearing for agriculture and grazing have been supported by scientific evidence[43] that, prior to human arrival, Madagascar contained woodlands, but also extensive regions of shrubland and grassland particularly in the west and on the highlands[44]. Where changes in vegetation appear to have occurred, research across a range of ecosystem types points to climatic factors as one possible cause.[45]

[35] Allnutt et al, 2008
[36] MEFT, USAID & Conservation International, 2009
[37] Moat & Smith, 2007. Refer Annex 1 for a more detailed description of vegetation classes.
[38] Harper et al, 2007
[39] This data refers to protected areas with permanent and temporary protection status and new protected areas as defined in Inter-Ministerial Decree 52005/2010. Refer Section 4.I for a fuller discussion of the definition of the national protected area network.
[40] Refer Annex 2 for a more detailed discussion of environmental myths in Madagascar
[41] See for example Klein, 2002; Klein 2004; Harper 2007
[42] See for example Kull, 2000; Klein, 2002, Klein, 2004, McConnell, 2004
[43] McConnell, 2009.
[44] McConnell, 2009; Willis et al, 2008
[45] Klein, 2002; Virah-Sawmy, 2009

The availability of aerial and satellite imagery for Madagascar since the mid-20th century has facilitated a visual appreciation of recent changes in forest cover (Figure 2.1). National loss estimates have been developed for different time scales and vary from 44 percent of remaining forests between the 1950s and 2000[46]; 33 percent between 1975 and 2000[47]; and 13 percent between 1990 and 2005[48].

Figure 2.2: Change in Forest Cover in Madagascar between 1950 and 2005



Source: MEFT, USAID & Conservation International, 2009

There is general consensus that national deforestation rates have decreased since 1990; the annual rate of deforestation in the period 1990 to 2000 was estimated at 0.83 percent and at 0.53 percent between 2000 and 2005[49,50]. The decrease in the national average rate of deforestation has been strongly influenced by a significant decrease in deforestation rates in areas of degraded humid forests, as well as decreases in deforestation rates in the degraded spiny forests and western sub-humid forests[51]. Deforestations rates in western humid forests remained stable during this period, while deforestation rates in all other forest types classified as non-degraded increased, with the most significant increases experienced in the southwestern spiny forests[52]. Deforestation within the protected area network was lower than outside the network, at approximately 0.12 percent per year within the network compared to 0.65 percent per year outside the network between 2000 and 2005[53]. Deforestation has also led to increased fragmentation of remaining forests. By 2000, over 80 percent of Madagascar's forests were within 1 km of the forests' edge, in contrast to 43 percent in the 1950s. Similarly, 45 percent of forest area occurred in patches smaller than 50,000 hectares in 2000, relative to only 26 percent in the 1950s.[54] Dry forests suffered the most from fragmentation, whereas humid forests only became slightly more fragmented over the same time period.

Population density is often cited as a major threat to Madagascar's forests, yet the data are mixed. Some studies have identified a statistically significant relationship between proximity and density of human population and deforestation[55], while other research has yielded mixed results[56]. In certain regions of Madagascar, population growth has actually been associated with positive initiatives such as soil conservation and reforestation[57] and deforestation rates have been found to be higher in remote areas with low population density and long distances to markets.[58] Accessibility to forests (i.e. elevation and slope) also appears to be an

[46] Harper et al, 2007
[47] Moat & Smith, 2007
[48] MEFT, USAID & Conservation International, 2009
[49] MEFT, USAID & Conservation International, 2009
[50] These data reflect the most recent period for which national level analyses of deforestation rates were undertaken.
[51] ibid
[52] ibid
[53] ibid
[54] Harper, 2007
[55] Green & Sussman, 1990
[56] McConnell, 2009
[57] Kull, 2000
[58] Elmqvist et al 2007; Thomas, 2007

important influence[59], and deforestation rates are often high in areas where the land is flat and easy to access, closer to roads for humid forests (although, counter-intuitively, the opposite is true for the spiny forests),[60,61] where soils are poor, where land tenure rights are weak,[62] and during times of political instability.[63]

The principal cause of present-day anthropogenic deforestation in Madagascar is slash-and-burn or swidden agriculture; nationwide, it is estimated that 80 – 95 percent of deforestation occurs as a result of the use of fire to convert forest to agricultural land. While *tavy* is used as the generic term; two stages in the process exist. The first stage, *tevy-ala* is of particular concern because it involves the initial clearing of the forest, followed by drying and burning, before rice cultivation. *Tevy-ala* often involves pioneer farmers going deep into the forest to select land with suitable characteristics such as slope and soils, eventually attracting other farmers to enter these areas[64]; the forests are literally eaten from the inside out. The second phase of the process is *tavy* - the slashing of secondary vegetation on previously used fallow land followed by the use of fire and then rice cultivation.

In both cases rice planting is carried out immediately following burning as the hot soil favors germination and this combined with the elimination of weeds and insects provides a comparative advantage to the crop. The ash contains mineralized nutrients which boost the initial growth, but which are washed out quickly during the rainy season, thus contributing to the nutrient degradation cycle. Following the initial clearing, crops are cultivated for two to three years (depending on the quality of the land), followed by a period of fallow-rice rotation, involving one year of cultivation and five to eight years of fallow periods. In some areas with high population pressures, the fallow period of the rotation has fallen to two to three years, but as the nutrients are lost from the soils, longer fallow periods are reinstated.

Tavy has fewer direct effects on forested land but poses indirect threats, not only in the form of escaped fires, but also because it reduces the fertility of soils and thus leads to clearing of new land when the previously cleared land is no longer productive. While *tevy-ala* is prohibited under Malagasy law, *tavy* is allowed in a regulated manner. *Tavy* has both practical and cultural components and the rural farmers' belief system connected with *tavy* has elevated the practice to a cultural tradition in many areas, especially on the east coast[65]. The main practical reason to be the first to clear forested land is in order to claim land rights to the cleared parcel which is otherwise collectively or State owned. Only 2 percent of the wealthiest quintile of farmers resort to *tavy*, compared to 12 percent of the poorest quintile.[66] Slightly more modest farmers, those that can afford the labor or generate a monetary surplus, appear to the most common perpetrators of *tavy*[67].

Claims that "a third of the country" burns each year are largely overestimated despite their repetition in the media and other reports. Burning occurs during the dry season generally from June to December and is carried out for the preparation of pasture or *tavy*. While data on burnt surfaces is approximate due to the lack of robust measurement techniques, data from 1992 to 2007 suggests that the annual burnt surface is highly variable peaking at approximately 1,300,000 hectares in 1999, and reaching a low of 42,108 hectares in 2008. There is similar variation in the area of native vegetation burnt each year. For the period 1992 to 2007, the area of natural forest burnt peaked at 29,841ha in 2001 and reached a minimum of 4,328ha in 2004[68]. As a proportion of the total area burnt, the area of primary vegetation burnt ranges from 0.4 percent to 10 percent over the same period; data that confirms that much of the burning occurs in areas outside of natural forests.

Extraction of wood, predominantly for fuelwood or charcoal production, accounts for approximately 5 – 20 percent of deforestation in Madagascar. Eighty percent of energy needs in Madagascar are met by timber products and more than 90 percent of the population relies on wood for their energy needs, either in the form of charcoal or fuelwood. Current estimates put domestic wood consumption at 21.7 million m^3/year of which

[59] Agarwal et al, 2004
[60] McConnell & Sweeney, 2005; Elmqvist et al, 2007
[61] Thomas, 2007
[62] McConnell & Sweeney, 2005; Elmqvist et al, 2007
[63] Vagen, 2006
[64] USAID, 2010
[65] Hume, 2006
[66] Minten et al, 2003
[67] USAID, 2010
[68] ONE, 2008

nearly 18 million m^3/year is for firewood or charcoal production. Theoretically forests outside of protected areas can produce 26 million m^3/year on a sustainable basis but demand is expected to start outstripping supply by 2025 – 2027. Deforestation associated with timber extraction varies by geographic region and thus by ecosystem and claims that natural forests furnish the majority of fuelwood to meet urban needs throughout the country are oversimplified. Three scenarios for the supply of fuelwood and charcoal to major urban centers exist: (i) in the main towns of the highlands and eastern coast (Antananarivo, Fianarantsoa and Toamasina) most fuelwood needs are met from plantation sources; (ii) in the main towns of the west and south (Morondava and Toliara) fuelwood needs are met by a combination of wood that is recovered as a byproduct when land (mostly containing natural forest) is cleared for agriculture, and wood that is exploited directly from natural forests; and (iii) in the remaining large towns (Antsiranana, Majunga) and smaller towns in the south, fuelwood needs are met predominantly by exploitation of natural forests, complemented by wood obtained as a byproduct through clearing of land for agriculture[69]. Evidently, the second and third scenarios are of the most concern, particularly as they result in exploitation of some of the most threatened and least protected ecosystem types including western dry forests and the southwestern forest formations.

Logging has effects both on forest cover and individual species viability. Both legal and illegal logging operations occur in Madagascar; although illegal operations outweigh legal operations in terms of the amount of wood extracted[70]. The northeast of Madagascar (particularly the Masoala, Makira, Mananara and Marojejy protected areas) is the hub of illegal exploitation precious timber due to the presence of mature specimens of the targeted species of ebony, rosewood, and palissander[71], and the relative proximity to the country's major ports. Since at least the 1990s illegal logging has followed a cyclical pattern with timber harvested on a continual basis and stockpiled until a natural disaster or political unrest creates an enforcement vacuum and facilitates export of collected products. Between late 2008 and 2010, there was a significant increase in the logging activities due to the national political crises. In 2009, it is estimated that around 100,000 trees were logged representing 52,000 tons of timber[72]. The logged timber disturbed an area of 4,000 to 20,000 hectares and up to 500,000 additional trees and countless vines were also cut to make rafts to transport the timber[73]. Surveys in late 2010 observed dozens of logging camps and depots in the eastern part of the Masoala National Park and it is estimated that up to 1,000 people were working in the Park logging and hunting fauna, particularly lemur species for subsistence and sale.

Illegal extraction of tortoise and lemur species for subsistence or commercial purposes is having significant effects on the viability of targeted species. Two tortoise species, *Astrochelys radiata* (Radiated Tortoise), and *Astrochelys yniphora* (Ploughshare Tortoise) of which only a few hundred individuals are left in the wild, have been the focus of poaching efforts to supply the domestic food market and the international pet trade. Together these two species are the most emblematic of Madagascar's chelonians and both species are listed as Critically Endangered on the IUCN Red List. Until recently there were few studies investigating the degree of hunting of fauna species for consumption. Several recent studies[74,75] indicate that while hunting is still only carried out at a relatively low level compared to other types of exploitation, and that the commercial trade in bushmeat is not well established for most species, there is a growing incidence of hunting in certain communities. Migration by itinerant workers such as artisanal miners or loggers is considered to be an important catalyst for an increase in hunting. In some zones, hunted animals provide important protein that is not readily available through other sources. Legal exploitation of flora and fauna species – such as exportations in line with the CITES convention - is rarely based on robust scientific inventories and thus can also lead to unsustainable harvesting practices.

Suitable regulation will be required to manage the potential effects of the mining sector on forest cover and biodiversity. The industrial mining sector is currently dominated by two major developments – the Ambatovy

[69] Bertrand et al, 2010
[70] MEEFT as cited in USAID, 2002
[71] Ebony refers to species in the *Diospyros* genus, while rosewood and pallisander are species in the *Dalbergia* genus. There are 43 species in the Dalbergia genus, of which 42 are endemic to Madagascar. Three species of particular interest for exportation are known as rosewood because of their deep red color – *D. baronii, D. louveli* and *D. maritime*, while *D. madagascarensis* is known as palissander as it lacks the deep red color of the other species.
[72] Randriamalala & Liu, 2010
[73] Ibid; Wilmé et al, 2009
[74] Golden et al, 2011
[75] Jenkins et al, 2011

mine in central Madagascar and the QMM / Rio Tinto mine near Tolagnaro. In the next five to ten years, a handful of new large-scale mining operations could come online in resource areas as diverse as coal, gold, iron, bauxite and petrol[76]. QMM/ Rio Tinto's ilmenite mining operation (6,000 ha) at Tolagnaro is located in one of the last remaining strips of littoral forest; this type of forest is a national conservation priority because of its very limited remaining cover, high biodiversity, and rates of floral endemism. Sherritt's nickel and cobalt mine operation in Ambatovy required clearance of a sensitive natural forest mosaic at the mine site, and the associated pipeline traverses a newly established protected area[77]. The project incorporates a Biodiversity Management Plan with goals including no species loss and a net increase in the conservation of rare habitats[78]. Artisanal mining of precious and semi-precious gemstones and gold is largely informal and has dispersed but potentially significant cumulative impacts on natural resources. Artisanal mining activities are carried out within the boundaries of numerous protected areas (e.g. Ankarana, Isalo, Zohimbe, Masoala, Makira) and have direct and indirect effects on biodiversity.

Climate change is likely to have significant future effects on the country's biodiversity. More frequent and more intense extreme climatic events and longer-term changes in average climate means are projected to affect the range and distribution of species. Particularly at risk will be those species restricted to narrow climatic or habitat ranges; which have phenological or physiological traits linked to climate; which have internal or external obstacles to dispersal; or which have long inter-generational breeding times and/or small, discontinuous populations[79]. Tropical species are likely to be particularly vulnerable. An appraisal of the Tsaratanana Massif in northern Madagascar recorded a trend for upslope distribution movements in 30 species of reptiles and amphibians between 1993 and 2003 as their habitats shift upward[80]. Cyclones, droughts and extreme rain have begun to adversely affect the precarious balance between the *Lemur catta* and their food sources in southern Malagasy forests, and reproductive success and lactation in this species has been impacted by changes to forest composition and rainfall[81]. By 2100, habitat losses of up to 50 percent across the country are projected if no dispersal is assumed possible and 11 – 27 percent if perfect dispersal is possible[82]. Humid littoral forest species face a similarly grim future: a dramatic reduction in distribution area, with essentially no suitable habitat by 2080[83]. These forest types are thought to have acted as climate refuges in the past[84] and have been identified as a priority for conservation based on multi-taxon analyses[85]. Protected areas on the east coast have been modeled to be more climatically stable and may play important roles as climate refuges, although further modeling is required to confirm this. Western and southern protected areas are of high concern in terms of future climate stability, and identification of micro-refuges and proactive protected area management planning will be required to maximize species retention rates.

3. Agricultural Land, Soil Fertility and Erosion

The performance of Madagascar's agricultural sector, which is vital to the national economy and local livelihoods, is dependent on soil conditions and fertility. Data on the natural and anthropogenic influences on soil fertility and erosion and the extent of these phenomena are limited and largely restricted to site specific studies; available data are discussed in this section.

Land degradation, defined as the temporary or permanent reduction in the productive capacity of land as a result of human action, affects 31 percent of the country. 70 percent of the country is classified as agricultural land and in 2000, 53 percent of the population lived in areas with a high proportion of land degradation[86]. The most severe areas of land degradation are in the southwest, the eastern coast and highlands; a pattern which corresponds to the presence of lower fertility, highly erodible ferralitic and ferruginous soils. Existing soil maps are based on global mapping which categorize Madagascar's soils into four broad classes: acidic ferralitic soils located on the east coast and highlands, and ferruginous tropical soils in the west and south, which together

[76] World Bank, 2010a
[77] Dickinson & Berner, 2010
[78] Ibid
[79] Foden et al, 2008
[80] Raxworthy at al, 2008
[81] Wright, 2007
[82] Malcolm et al, 2006
[83] Hannah et al, 2008
[84] Virah-Sawmy, 2009
[85] Kremen et al, 2008
[86] FAO, 2004

cover nearly 70 percent of the country and are highly subject to erosion due to the topography on which they are located and their physical structure; and peaty hydromorphic soils in valley bottoms and alluvial soils on floodplains in the west of the country that are less susceptible to erosion and have higher fertility, but which cover only approximately 30 percent of the country. Between 1993 and 2003, 48 percent of hillsides in one study in the east of the country had suffered loss of soil quality[87].

Loss of soil fertility is traditionally blamed on *tavy* practices that employ nutrient depleting fire, short fallow periods and enhance erosion rates. The primary effects of reduced fertility are hypothesized to be an increase in the rate of forest clearing to secure new agricultural lands. However, the relationship between this factor and others influences on the rate of clearing such as land tenure and demographic pressures are complex, and highly locally specific. Fertilizer use in Madagascar is very low and intensification of the use of agricultural products is not a common autonomous response strategy on the part of local farmers.

Data on erosion rates in Madagascar are highly variable[88]. Certain studies that class erosion as extreme and perhaps more potently, media quotes referring to a 'bleeding island' paint a picture of catastrophic erosion[89]. There is, however, growing criticism of this extremist view of human induced erosion[90]. Estimates range from 200 – 400 tons/year (20 – 40 times the global average) to 0.16 – 0.54 tons/year. Key reasons for the wide range of estimates of erosion rates appear to be linked to the scarcity of data and the loss of accuracy when local field based studies are scaled up to the regional or national scale. *Lavakas*, deep gullies formed by hillside erosion that can reach 300m in length and 70m in width, are a distinctive and highly visible feature of erosion in Madagascar[91]. It has become part of the accepted discourse that *lavakas* are due to human activity, notably deforestation, grassland burning, and overgrazing.[92] However, recent geological studies suggest that this is not always the case. Research indicates that the central highlands were already marked by *lavakas* before human settlement,[93] which aligns with the fact that newly deforested areas reveal the outline of ancient *lavakas;* the cause of the majority of *lavakas* studied could not be definitively determined.

Erosion also leads to sedimentation of waterways that can impact natural ecosystems (e.g. coral reefs and mangroves) and agricultural activities both positively and negatively, but tend to have predominantly adverse impacts on settlements through flooding and landslides, and infrastructure (e.g. ports, dams and irrigation systems). Sediment yields in Madagascar's major rivers are not inordinately high compared to other rivers worldwide[94], however the effects of sedimentation are felt in areas such as Lake Aloatra in the center of the where 30 – 60 million tons of sediment are estimated to be washed into irrigation infrastructure in this prime rice-producing area.

4. Degradation of Coastal and Marine Ecosystems

Knowledge of Madagascar's marine and coastal ecosystems and biodiversity, comprising coral reefs, mangroves, seagrass beds and pelagic waters, has traditionally been poor when compared to that of terrestrial zones. However, these ecosystems are economically important and highly biodiverse, and increasing attention is being paid to their conservation and economic importance.

Although exhibiting lower degrees of endemism than terrestrial ecosystems, marine ecosystems in Madagascar display high levels of species richness and diversity and are of regional importance. Madagascar's coastline of 4,800km is the longest of all the Western Indian Ocean Islands and harbors a diverse range of species and habitats. More than 6000 coral reef species have been recorded in Madagascar including more than 750 species of fish[95], more than 300 species of sponges, more than 400 species of hard and soft corals, and 1500 species of mollusks[96]. Eight species of mangroves are found in Madagascar, concentrated on

[87] Minten & Ralison, 2003
[88] Refer Annex 2 for a more detailed discussion of differing environmental narratives related to erosion.
[89] Helfert and Wood, 1986
[90] Bertrand et al, 2009; Kull, 2002
[91] Kull, 2000
[92] Cox et al, 2009
[93] Refer Annex 2 for more detailed discussion of research.
[94] Kull, 2000
[95] McKenna & Allen, 2003
[96] Goodman & Benstead, 2005

the country's west coast in the vicinity of Majunga and Morondava[97]. Although large seagrass beds are found in the northwest and northeast very little is known about seagrass ecosystems. Similarly little information is available on pelagic waters; 25 species of whales and dolphins, five marine turtle species, two seal species and one dugong species have been identified[98].

Important coral reef ecosystems are found in the southwest, northeast and northwest of the country and cover approximately 2400km^2. Historically research into reef ecosystems in Madagascar was focused in the southwest of the country on the Toliara Reef. At 23 km in length and 3km in width, this reef system is one of the five largest in the world, but the most degraded reef in the country due to a long history of overexploitation of fish and coral for construction and increasing land based sedimentation. A comparative study of the reef's health over thirty years found a 50 percent reduction in reef species, and a 10 percent decrease in areas of reef growth. 35 percent of the reef surface is thought to be damaged by reef gleaners annually[99]. An estimated 18 tons per square kilometer of resources are estimated to be removed from the Toliara reef annually, an amount which exceeds the reef's regenerative capacity[100]. Until 2006 / 2007 offshore coral banks remained in relatively good condition compared to the inner reef areas, however as fish stocks become less abundant the exploitation zone is expanding meaning that these outer reefs are likely to be subject to the same fate in coming years. In addition to human exploitation, the southwest reef system was strongly impacted by a 1998 coral bleaching event. Large stands of intact, but dead, corals exist covered by algae

Coral reefs in the northwest harbor a rich and varied marine fauna and the majority of sites in this zone are in relatively good condition. The richness of coral species approximates the predicted total of 340 species for the entire Western Indian Ocean region, while both coral and mollusk species rival that of renowned coral hotspots such as the Indo-Pacific Coral Triangle or Australia's Great Barrier Reef. Sites on reefs with extensive or well-developed reef flats have the highest coral diversity, while submerged reef banks have the lowest. Approximately 463 reef fish species, including 55 species that are targeted by local fishers are present; targeted reef shark species and commercially important holothurians are apparently declining. Sedimentation is most apparent around Nosy Be especially during the rainy season due to increased land based runoff[101].

Coral reefs in the northeast cover large areas but exhibit lower diversity than those in the northwest. 277 species of corals and 271 species of reef fishes were inventoried in this zone[102]. Abundance of reef fish species is relatively low, especially for commercially important species indicating strong fishing pressures. Large seagrass beds in relatively good condition are present in the zone. The area is subject to strong wind and wave action and experiences ocean upwelling. Sedimentation affects a number of coral reef sites.

Mangrove stands are concentrated on the west coast, with degraded remnants present in the northeast. Mangrove species richness in Madagascar is less than in other regions, such as Southeast Asia, with eight species commonly recognized[103]. Estimates of the surface covered by mangroves range from 217,000ha to 453,000ha; with the most recent vegetation classification mapping estimating a coverage of 243,000 ha, of which approximately 16 percent was included in protected areas as of 2006. The vast majority of mangroves, 98 percent across 23 sites, are found on the west coast of Madagascar in a 1300km discontinuous band from Antsiranana to south of Toliara. The zone of Mahajamba to the north of Majunga contains the most extensive stands of mangroves and 10 percent of the national mangrove coverage[104]. The remaining 2 percent of mangroves are found across four sites on the east coast. Mangroves have consistently seen lower rates of deforestation than terrestrial forests and have faster regeneration rates. Land use conversion (for agriculture, shrimp farming or salt production) is the largest contributor to mangrove deforestation, accounting for 35 percent of destruction followed by logging with 16 percent.[105] Between 7 and 9 percent of mangroves were lost in Madagascar in the period between 1975 and 2005[106]. Mangrove surface is thought to have increased

[97] Spalding et al, 2010
[98] Goodman & Benstead, 2005
[99] Vasseur et al, 2000
[100] Bigot et al, 2000
[101] Ibid
[102] Conservation International, 2010
[103] Spalding et al, 2010
[104] Giri & Mulhausen, 2008
[105] Giri and Mulhausen, 2008
[106] Ibid

from 1975 to 1990 (+5.6 percent), then to have decreased by 14.3 percent from 1990 to 2000, and then again by 2.5 percent from 2000 to 2005.[107] Mangroves that occur along the eastern coast are particularly threatened; mangrove remnants at Maroantsetra in the northeast have been almost entirely wiped out.

Based on official statistics, the fisheries sector contributed US$146 million or nearly 2 percent of GDP in 2010[108]; this is a decrease of 2006 when the fisheries sector is thought to have contributed in the order of 7 percent of GDP[109]. The Malagasy fisheries sector is comprised of large-scale and small-scale, commercial and non-commercial sectors that target a range of species. In the last ten years, it is estimated that domestic fishers caught an average of 135,000 tons annually, and foreign fishers an additional 80,000 tons annually[110]. Official data states that there are 102,000 fishers in Madagascar, largely concentrated along the west coast, although this is certainly a gross underestimate as there has been no recent census and many rural households practice fishing as seasonal or part-time occupation or as a means of supplementing their subsistence needs. Nearly 90 percent of fish production is consumed locally and fish and fish products contribute in the order of 20 percent of the population's animal protein consumption.

While no stock assessments have been done, the limited amount of data available indicates that most fisheries seem to be in decline with overfishing, habitat destruction, and pollution amongst the most commonly cited direct causes, and climate change and high rates of population growth inarguably amongst the most important penultimate drivers of decline. Shrimp production has traditionally been the main fisheries export product and an important contributor to national export earnings. Despite initially positive efforts by the Government to improve management of this sector, shrimp capture has decreased in recent years as has exportation. Tuna production, another high value export product, has similarly decreased in recent years.

Coastal and marine ecosystems are also important drawcards for foreign tourists, another important source of foreign exchange earnings. Many of the high-end tourist resorts are concentrated in coastal areas (i.e. Nosy Be in the north and Ile Sainte Marie in the east) and diving, whale watching and sport fishing are increasing in popularity.

Sedimentation is a major cause of degradation of reef and mangrove ecosystems. The erosion of watersheds has a direct effect on coastal and marine ecosystems, particularly along the west coast. While rates of erosion are subject to debate, research into individual river deltas points to at least localized occurrences of hypersedimentation and extreme turbidity, especially during periods of peak river discharge along the west coast.[111] Systematic evaluation of the effects of sedimentation has not been carried out and is likely to be locally variable. While sedimentation is viewed as a negative phenomenon due to smothering of reefs and mangroves, in certain cases inshore sedimentation has proved beneficial to reefs, apparently shading them from bleaching[112]. Sedimentation deposition in mangroves may also prove beneficial in some locations through facilitating landward expansion in response to sea level rise[113]. River discharge during peak rain periods contributes nutrients to coastal waters that cause increased chlorophyll concentrations. Fertilizer and pesticide use in Madagascar is relatively low as is coastal industrial development; however, localized incidences of land based pollution of coastal and marine ecosystems in the vicinity of ports or other major infrastructure is possible.

Overfishing and the use of destructive fishing practices remains one of the most significant threats to coastal and marine ecosystems. There is little data on by-catch from industrial fisheries, including shrimp trawlers, long line fishers and purse seine fishers, but certain groups such as sharks are thought to be adversely affected[114]. Recent improvements to management in the shrimp industry through the development of a licensing system and establishment of an industry association have contributed to improvements in the impacts of this industry on marine ecosystems. The adoption of turtle excluder devices has significantly

[107] Ibid
[108] Le Manach, 2012
[109] FAO, 2008
[110] Le Manach, 2012
[111] Cooke et al, 2003
[112] Obura, 2010
[113] Gilman et al, 2008
[114] Cooke et al, 2003

reduced the by-catch of these species[115]. Traditional fishers use a range of destructive practices including poison however dynamite use is rare. Gleaning of reefs causes physical damage; 22 to 36 percent of the Toliara Reef flats are estimated to suffer physical damage annually from reef gleaners[116].

Mangroves are also threatened by overexploitation of timber and clearing for agriculture. Timber is used for fuel wood, house construction, as well as for building boats, fish traps and fences. Mangroves often have cultural implications being used in some areas for sculptures and traditional medicines; while in other areas taboos have traditionally provided informal protection to mangroves[117]. Clearing of mangroves for rice fields is common along the west coast; such fields often have a relatively short life span as sedimentation and salinization quickly reduces their suitability forcing farmers to find new areas for clearing[118]. Reduction in freshwater inputs linked to upstream irrigation and sedimentation of watercourses also damages ecosystems. The shrimp aquaculture industry to date has played a relatively minor role in mangrove deforestation, having contributed only 3 percent of the total loss of mangroves[119]. However, there is recognized potential for a significant expansion of this industry which represents a potential future threat to mangroves.

Certain species or groups of species are targeted for exploitation leading to disturbance of coastal and marine ecosystems. Sea cucumbers are harvested in the southwest surrounding Toliara and in the north-west in the vicinity of Nosy Hara and Sahamalaza protected areas for export to Asian markets. The activity has high local economic importance and is often exploited as a family activity. As far back as 1997 overexploitation of sea cucumbers was recognized as a potential problem. Following a rapid expansion of the industry that started in 1990, exports had started declining from a peak of 539 tons in 1994 and foot fishing was in decline. Divers were needing to go to increasing depths, specimens were becoming smaller and new fishing areas were being sought. Local expiration of sea cucumbers has been observed with attendant ecological and socio-economic impacts. In 1999 a sea cucumber mariculture project was launched near Toliara and currently produces 200,000 individuals/year for export with the involvement of local NGOs and villagers. Shark fin exploitation is another issue of concern although little data is available on the scale of the problem. In 1987 exports of shark fin from Madagascar to Asia were just 3000 kg but by 1992 they were almost 50 metric tons[120]. Exports have since declined to around 15-20 metric tons per annum[121]. Since 2008, the Government has not provided any permits for commercial shark fin exploitation. This has meant that commercial operators do not appear in official statistics although many have continued their activities.

Climate change, including rising sea temperatures and changes in sea levels, poses a significant future threat to coastal and marine ecosystems. Coral bleaching due to increased ocean temperatures has already been observed in Madagascar, most notably in 1998, and is considered to be a likely future effect of climate change. The southwest coast has been identified as being highly susceptible to thermal stress, and possibly the most susceptible in the country largely because of the influence of sedimentation[122], and thus to future bleaching events[123]. Outer reefs are less vulnerable as they are less affected by sedimentation[124]. Low incidence of coral bleaching was observed in surveys in the northwest in 2003 although this area has been identified as being highly susceptible to thermal stress; there is a divergence between the results of this analysis and the lack of reported mortality in this region following the 1998 beaching event[125]. Corals on the northeast coast are classified as being of low to moderate susceptibility to thermal stress and the most resilient to climate change[126]. This zone exhibited extensive bleaching but very low mortality following the 1998 regional bleaching event. Seabed upwellings are thought to protect parts of these reefs from coral bleaching events[127].

[115] Pedrono, 2008
[116] Cooke et al, 2003
[117] Roger & Andrianasolo, 2003
[118] Edmond, 2010
[119] Taylor et al, 2003
[120] Blue Ventures, 2010
[121] Cooke, 2003
[122] Maina et al, 2009
[123] Maina et al, 2008
[124] Maina et al, 2009
[125] Maina et al, 2008
[126] Ibid
[127] Conservation International, 2010

Rising sea levels, changes in precipitation and increased human pressures linked to growing human vulnerability to climate change, are likely to affect the productivity and conservation values of mangrove ecosystems. Very little analysis of the vulnerability of mangrove stands to climate change in Madagascar has been carried out however a comparative vulnerability analysis of the mangrove stands in the Tsiribihina and Manambolo deltas confirmed that the level of anthropogenic pressures on mangrove ecosystems is a major influence on their ability to cope with climate shocks, and in particular sea level rise[128].

5. Environmental Pollution

Within Madagascar urban and industrial pollution has received little attention to date. However, increasing urbanization of the population, with estimates that in the next decade 50 percent of the population will live in urban areas and urban growth rates that exceed those of many major cities in continental Africa[129], combined with growing international interest in the country's mineral resources mean that these emerging issues warrant further consideration despite the limited baseline datasets that exist.

Indoor air pollution caused predominantly by solid fuel use has the potential for substantial effects on human health and economic development, and has links to deforestation pressures in certain zones. Burning solid fuels (i.e. charcoal and fuelwood) for cooking produces extremely high levels of household air pollution. Average concentrations of fine particulate matter (PM_{10}) in homes using biomass fuels typically range from 300 to 3,000 $\mu g/m^3$, with peaks during cooking as high as 10,000 $\mu g/m^3$. By comparison the European Union standard for average annual PM_{10} levels is 40$\mu g/m^3$. Elevated levels of indoor air pollution have been proven to increase the risk of several life threatening illnesses including pneumonia and other acute lower respiratory infections and chronic obstructive pulmonary disease; these diseases are particularly prevalent in children and women over 30 respectively, two vulnerable groups from a public health point of view. There is also evidence of associations between indoor air pollution and lung cancer, asthma, cataracts, tuberculosis and adverse pregnancy outcomes.

The burden of death and sickness due to indoor air pollution exceeds that due to HIV/AIDS, diarrheal disease or tuberculosis in Madagascar; an estimated 5.3 percent of the burden of disease is attributable to solid fuel use. With more than 90 percent of the population in Madagascar using solid fuel, the burden of ill health stands at nearly 12,000 deaths per year, of which 10,000 per year are children under the age of five, and more than 370,000 DALYs[130] and 40 percent of respiratory infections are thought to be linked to indoor air pollution[131].

While 75 percent of the population regards urban air pollution as a major problem[132], there is very little evidence to support the oft-cited claim that Antananarivo is amongst the most polluted cites in Africa. Very few studies into urban air pollution have been carried out and the focus of the few available studies has been on heavy metals and particulate matter (PM_{10}). The most comprehensive study to date, identified a range of fixed and mobile sources influence pollutant levels and carried out monitoring of carbon monoxide (CO), particulate matter / dust (PM_{10} and $PM_{2.5}$), nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) at three sites within Antananarivo[133]. Primary fixed pollution sources include a diesel run thermal power plant, boilers in industrial premises, brickyards, domestic sources, stone quarries, landfills and oil storage facilities. Fires close to Antananarivo are likely to impact concentrations of particulate matter depending on the proximity of the fire and the direction of the wind. Road transport is the most influential of the mobile sources; the generally decrepit vehicle fleet, undulating topography and low travel speeds influence the level of mobile pollutants. Concentrations of both fine and large particulate matter were exceeded at the measurement sites. In terms of CO, clear peaks in concentrations were observed during morning and afternoon peak traffic hours, but average maximum values did not exceed international standards. NO_2 and SO_2 concentrations were largely within international standards. Notwithstanding the limitations of the study in terms of duration, parameters

[128] Clausen et al, 2010
[129] World Bank, 2011a
[130] DALY = Disability Adjusted Life Year; a standardized measure reflecting the number of years lost through ill-health and premature death.
[131] PAC, 2011
[132] Fouret-Guerin, 2007
[133] Commission Europeene & Banque Mondiale, 2008

measured and geographic scope, particulate matter and CO pollution, particularly for receivers located near transport routes are of potential concern and merit further monitoring.

Little data exists on solid waste generation and management in Madagascar. Generation rates are estimated at between 0.2 and 0.4 kg/person/day[134], an amount typical of a developing country but one that is likely to increase with industrialization and urbanization. Waste generation rates in tourism hubs such as Nosy Be and Ile Sainte Marie are likely to be higher than the national average. Solid waste management systems in Madagascar are largely undeveloped with solid waste management the responsibility of municipal authorities. Between 6 percent and 25 percent of solid waste is estimated to be collected each day[135]; however, collection systems only serve Antananarivo and other large towns such as Toamasina and Majunga. Un-engineered landfills exist in the vicinity of Antananarivo and other large towns. However, these facilities, which constitute essentially open pits where burning of waste is common, are major sources of air and water pollution and represent hazards to public health due to vermin generation and pollutant emissions. No hazardous waste collection, transport or treatment facilities exist and there is significant mixing of waste streams, which reduces the opportunities for recycling. Over half the population has no access to collection or disposal services and uncontrolled dumping is prevalent[136]. There is an informal recycling sector driven by economic demand but no large-scale recycling facilities. A recent project in Majunga has established a composting plant for municipal organic waste that has been certified as a source of carbon credits; but this remains a rare example of a more sustainable approach to solid waste management.

Degradation of water resources is most pronounced in urban areas and has significant human health impacts. Low rates of access to sanitation exist throughout Madagascar; only 15 percent of the urban population had access to sanitation in 2010. Uncontrolled domestic wastewater discharge, poor solid waste management practices (including dumping in canals and waterways), and unregulated small-scale industrial discharges combine to degrade water supplies. Despite limited water quality data, visual and olfactory evidence of pollution is evident throughout major urban centers; bacterial pollution, solid waste and sedimentation / turbidity are the most common forms of pollution[137]. In 2010, 45 percent of households had access to a secure water supply; although the rate was significant higher in urban areas (70 percent) than in rural areas (39 percent)[138]. The effects of poor water quality on health are pronounced; diarrhea remains the second highest cause of mortality and affects 51 percent of children under five. 14,000 children under five die each year due to lack of access to clean water and sanitation. On the economic front 3.5 million schooldays and 5 million workdays are lost each year due to these largely preventable illnesses.

To date industrial pollution in Madagascar has been limited to small-scale industrial activities in urban centers, although large-scale developments are underway in the mineral sector. Numerous small and medium semi-industrial and industrial enterprises operate in Antananarivo and the other main urban centers. Regulation of these industries is minimal and poor solid and wastewater management practices contribute to urban pollution. Two large mineral exploitation projects, which are the likely harbingers of an increased international interest in Madagascar's mineral resources, are under development: QTT Madagascar Minerals (a subsidiary of Rio Tinto) is developing an ilmenite extraction project in the south-west near Tolagnaro; and Sherritt is developing a nickel and cobalt extraction project at Ambatovy 100km to the east of Antananarivo. Numerous other projects are in the pipeline including coal in the Soaka area, gold in Betsiaka, Maevatanana and Dabolava areas, iron ore near Soalala and a tar sands project at Bemolanga on the country's west coast which is being explored by Total[139]. Each of these projects has undergone (or is scheduled to undergo) environmental assessment in line with Madagascar's legislative requirements and will bring economic development to the country. However, each also carries a risk of significant environmental pollution. Such risks are exacerbated by the limited technical capacity and human resources of the *Office National pour l'Environnement* (ONE) that is charged with the environmental monitoring of these projects, and which to date has not been required to address projects of this nature and scope.

[134] UNEP, 2004
[135] Ibid
[136] Ibid
[137] ONE, 2008
[138] Instat, 2011
[139] At the time of writing the status of Madagascar Oil's rights to several other tar sands deposits on the west coast was unclear.

6. Natural Disasters and Climate Change

In the African region, Madagascar is the second most vulnerable country to natural disasters. The country's vulnerability is a function of its high exposure levels due to its geographic position, and its low adaptive capacity, which is driven by high rates of poverty and unsustainable land and natural resource use practices.

One quarter of Madagascar's population, representing 5 million persons, lives in zones at risk of natural disasters and the country has been identified as the second most exposed country in Africa to current multi-disaster risks[140]. The country's vulnerability is exacerbated by its low adaptive capacity, influenced by high poverty rates, rapid population growth, high dependence on natural resources, and weak institutional capacity. Four major types of natural disasters impact Madagascar: (i) cyclones, predominantly in the north, central east coasts and west coasts; (ii) flooding in the wake of cyclones and tropical storms; (iii) droughts in the south; and (iv) locust invasions in the country's south. Since 1990, 41 major events have been recorded, affecting at least 8 million people (more than one third of the current population) and killing at least 1,800. However, statistics on the damage caused by such events are incomplete and it is likely that the real scale of the effects of natural disasters is much higher.

Tropical cyclones account for 65 percent of climate related disasters in Madagascar, and on average 250,000 persons are affected and US$50 million worth of damage is caused by each cyclone event. Each year, three to four cyclones on average make landfall on Madagascar, which is ranked amongst the top ten countries worldwide with the highest mortality risk index associated with cyclones. Between 1990 and 2011, 31 major cyclone events were recorded, affecting at least 5.5 million people. In a single cyclone season the cumulative effects can be significant.

Flooding is widespread throughout the country and most commonly occurs after cyclones or tropical storms. Between 1990 and 2011, five major flood events were recorded, affecting more than 135,000 people. However, these data do not account for smaller scale events that can have significant effects on livelihoods and infrastructure at the local and regional level. Adverse effects of flooding events are significant in urban centers due to a lack of early warning systems, inadequate urban planning and poorly maintained drainage infrastructure.

The semi-arid deep-south region, which receives on average less than 500 mm of rainfall annually, is regularly affected by droughts; between 1988 and 2011, 5 major drought events were recorded that affected at least 2.5 million persons. Each drought event lasted two to three years and occurred against a background of naturally high intra-annual and inter-annual rainfall variability. Of the 104 communes that are subject to drought monitoring in the South of the country, 53 communes with a population of 720,000 people (or 4 percent of the national population) were in a state of food insecurity during the last drought event in 2010.

Locust invasions also affect the southern region of Madagascar during the rainy season and cause widespread crop damage. In the last ten years, 120,000 hectares of crops have been affected, contributing to persistently high levels of food insecurity in the southern region of the country. At the time of writing there were strong concerns for the extent of cricket infestations in the coming year, as the conditions appear to be highly favorable for an extensive infestation.

Madagascar has been consistently ranked among the top five most vulnerable countries globally in terms of future climate change[141], but country specific information on future climate conditions is limited. Preliminary modeling indicates that in the next 40 years, the national average annual temperature will increase by up to 3°C compared to the period 1961 to 1990. The most significant increases are projected for the southern region of Madagascar, with lesser increases in the north and on the coasts. Modeling of future rainfall patterns is inconclusive and with regionally distinct projections across the country; coarse scale modeling indicates that in the next 40 years a general increase in rainfall will be experienced between November and April, and that in the rest of the year rainfall will decrease in the southeast but increase

[140] United Nations, 2009; this analysis ranked Madagascar second after the Comoros in the African region.
[141] Refer for example Maplecroft Global Climate Change Vulnerability Index http://maplecroft.com/themes/cc/

elsewhere. In the semi-arid deep-south of the country, the severity of droughts is likely to increase with attendant impacts on food security.

The most worrying near term effect of global climate change is an expected exacerbation of extreme events through increased frequency and intensity of occurrence of natural disasters. Preliminary modeling of cyclone tracks for 2100 indicates that while the total number of cyclones affecting Madagascar is unlikely to significantly increase, the frequency of intense cyclones is likely to rise and that trajectory of these cyclones is likely to move to the north[142]. Further information on the expected evolution of the frequency and intensity of extreme events under future climate change scenarios is presented in Section 4.II.

II. Evaluation of the Costs of Environmental Degradation

A key question for the CEA is the identification of environment-development priorities. To assist in the identification of priorities the costs of environmental degradation both in absolute terms and as a percentage of GDP have been calculated; a method that allows comparison of the effects of different environmental issues on national economic development.

Environmental degradation has been generating significant costs in Madagascar for at least two decades. At the time of the preparation of the NEAP in 1990, the costs of environmental degradation in Madagascar were estimated to be $100 - $300 million annually, representing 5 to 15 percent of the GDP[143]. Loss of revenues from sustainable timber harvests due to deforestation caused by *tavy* were the major source of environmental degradation costs, accounting for 80 percent of the total calculated costs. Other costs were linked to costs of pasture degradation from burning and costs of on-site soil degradation due to hillside clearing for expanded rice production.

A more recent estimate put the costs of environment degradation between US$457 million and US$495 million/year in 2005, equivalent to between 9 and 10 percent of GDP at that time[144]. The costs of environmental degradation were calculated from estimation of the costs of natural capital depletion related to:

(i) Deforestation, the costs of which were calculated through analysis of the difference between the net present value of one hectare of forest before and after deforestation. Only eastern humid forests were considered because of poor datasets, and forest degradation (i.e. loss of forest productivity without land use change) was not considered despite its potential to be a major influence on environmental degradation costs. It was not possible to assign values to biodiversity or other non-marketed forest services despite the critical importance of these data to the overall deforestation values.

(ii) Degradation of soil, the costs of which were calculated through the valuation of the cost of replacing lost nutrients. Soil degradation data was based on local studies and inaccuracies are likely to have arisen during scaling to the national level.

(iii) Human health impacts of pollution, through analysis of costs linked to the health impacts of indoor and outdoor air pollution and water pollution. This analysis was necessarily based on incomplete datasets and thus was thus subject to important limitations and assumptions.

Damage to human health from pollution represents 7 percent of GDP, and is the largest cost component of environmental degradation. In particular, unsafe water supply and indoor air pollution that each have a cost of more than 3 percent of GDP. The estimated costs associated with soil degradation – estimated at 1.8 to 2.5 percent of GDP - are likely to be overestimated; while those associated with deforestation – estimated at 0.32 percent of GDP - are likely to be underestimated. A range of potentially influential contributions such as mineral extraction, fish stocks, forest degradation and groundwater depletion are not included in the analyses of environmental degradation.

[142] Direction Generale de la Meteorologie, 2008
[143] Larson, 1994
[144] While differences in the methodologies used in 1990 and in the current analyses do not allow direct comparison of results, these data serve to underlie the fact that environmental degradation was generating important costs even two decades ago.

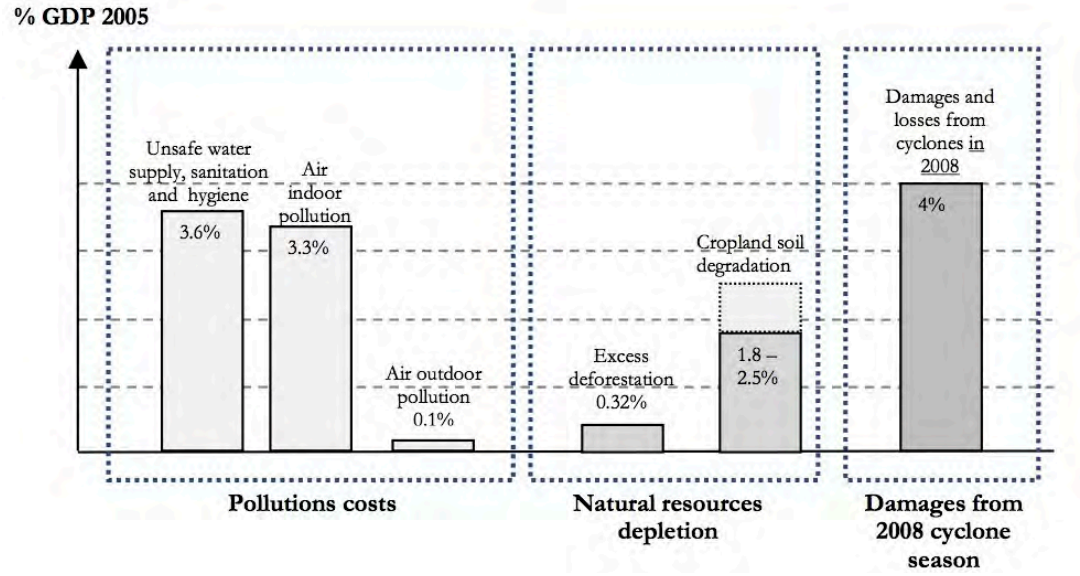
Table 2.2: Estimated Costs of Environmental Degradation

Component	Sub-Component	US$ million / year (2005)	Percentage of 2005 GDP
Natural capital depletion	Deforestation (eastern forests)	16	0.32
	Cropland soil degradation	90 – 127	1.8 – 2.5
	Sub-Total	*106 – 143*	*2.1 – 2.9*
Costs on health	Unsafe water supply, sanitation and hygiene	182	3.6
	Indoor air pollution	165	3.3
	Outdoor air pollution	4.5	0.1
	Sub-Total	*351.5*	*7.0*
Total		**457.5 – 494.5**	**9.2 – 9.9**

Source: Ollivier & Giraud, 2010

Costs associated with cyclone damage, a form of non-human induced damage, provide an interesting point of comparison. An estimate of damages from the 2008 cyclone season is provided to give an order of magnitude (Figure 2.3). This data shows that the damages and costs of cyclones in 2008 – estimated at 4 percent of GDP - were higher than the environmental degradation costs associated with unsafe water supply or indoor air pollution. No data is available on the costs of droughts, which are prevalent in the south of Madagascar, or floods, which occur throughout the country, but experience in other southern African countries indicates that these events can have significant economic impacts and be a driving factor of poverty (refer Section 4.II.3). Such exogenous factors thus have potential to augment the costs of environmental degradation and adversely affect economic development. However, their management will need to be based on a resilience building / risk management approach as the root causes of these factors are outside the control of the Government.

Figure 2.3: Costs of Environmental Degradation as percentage of GDP in 2005



Source: Ollivier & Giraud, 2010

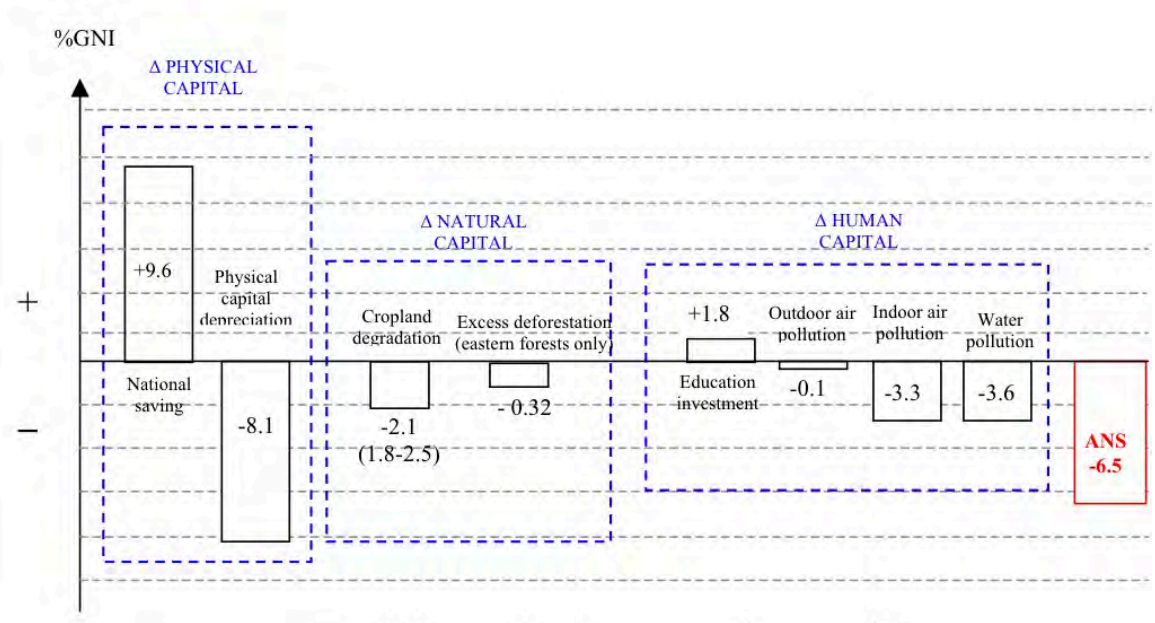
III. Sustainability of Madagascar's Development Pathway

The cumulative effects of environmental degradation on economic growth have been considered through calculation of the Adjusted Net Savings (ANS), which also provides an indication of the sustainability of the country's past and current development pathway. Further evaluation of the sustainability of the country's development pathway has been carried out through analysis of Madagascar's 'ecological footprint'.

There is a strong link between changes in wealth and the sustainability of development; if a country is depleting its total wealth in a consistent manner, then it is not on a sustainable path, even if GDP is increasing[145]. The standard national accounts measure change in a country's wealth by focusing solely on produced assets. A country's provision for the future is measured by its gross national savings, which represents the total amount of produced output that is not consumed. Gross national savings can say little about sustainable development however since assets depreciate over time. Net national savings – equal to gross national savings minus the depreciation of fixed capital moves one step closer to measuring sustainability. However to further enhance consideration of sustainability net national savings need to be adjusted for accumulation of other assets – human capital, the environment and natural resources – that underpin development. The resulting indicator is referred to as the adjusted net savings (ANS) of a country.

Based on a calculation of adjusted net savings, Madagascar is experiencing declining total wealth and there are concerns for the sustainability of the current development pathway. Adjusted net savings (ANS) in Madagascar is estimated at - 6.5 percent of Gross National Income (GNI); a negative figure which implies that total wealth is in decline. As indicated in Figure 2.4, the combined effects of environmental degradation including soil degradation, deforestation, indoor air pollution and water pollution outweigh the influence of the degradation of physical infrastructure as the most significant influence on the depletion of total wealth. ANS for Madagascar have in fact been negative for most of the last thirty years indicating that Madagascar's growth was unsustainable in the 1980s, 1990s and certainly in recent years. Further analysis of ANS indicate that while investment in human capital (through education) has been relatively high, efforts to build up human capital are being hindered by water and air pollution.

Figure 2.4: Components of Adjusted Net Savings as Percentage of Gross National Income (2005)



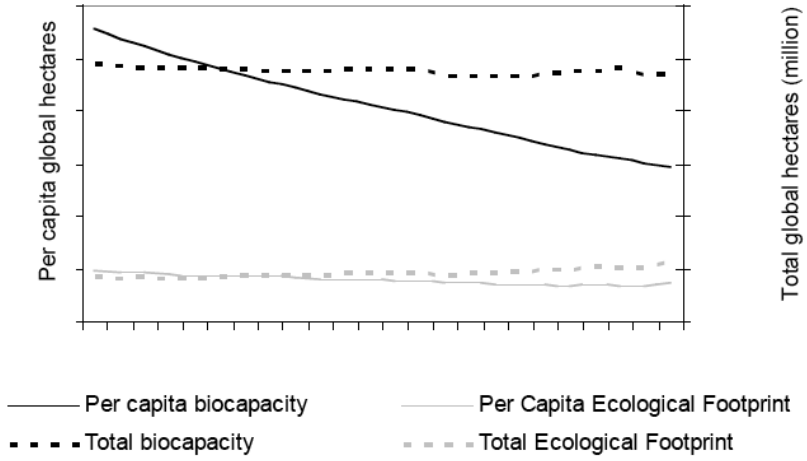
Source: Ollivier & Giraud, 2010

The ecological footprint is another way of looking at the sustainability of current levels of development by comparing current human consumption of natural resources with the carrying capacity of the earth[146]. A relatively simple and easily understandable indicator, having an ecological footprint lower than a country's biocapacity can be seen as a minimum criterion for sustainability, while an ecological footprint higher than biocapacity indicates a lack of sustainability. Analysis of a country's ecological footprint can assist in the development and evaluation of policy options on both the supply side (i.e. how to increase the biocapacity) and on the demand side (i.e. how to improve the sustainable consumption of natural resources).

[145] World Bank, 2011b
[146] Wackernagel & Rees, 1996

The ecological footprint of Madagascar is small indicating that current natural resource use is less than the country's biocapacity[147]. In Madagascar in 2000, the supply of biologically productive land was 3.15 global hectares, while average demand for ecological services was 0.7 global hectares. Agricultural activities (0.29 global hectares for crops and 0.15 global hectares for pastureland) and fuelwood collection (0.12 global hectares) account for the largest share of the ecological footprint. This breakdown aligns with the costs of environmental degradation linked to natural capital, which highlights the importance of soil degradation linked to agriculture. While on first view these figures suggest that the use of natural resources in Madagascar is on a sustainable pathway, however per capita results for ecological footprint between 1980 and 2004 indicate an increasing footprint due to population growth. Thus while large reserves of natural resources may exist now, the country's rate of population growth (currently estimated at 2.8 percent with a doubling of the population forecast by 2040) and age distribution imply that the country's ecological footprint is likely to increase rapidly. Equally important, the ecological footprint is a broad scale analysis that does not investigate finer scale patterns of overexploitation that may lead to permanent loss of unique local resources.

Figure 2.5: Biocapacity vs. Ecological Footprint between 1980 and 2004 for Madagascar



Source: Adapted from Global Footprint Network, 2006 by Ollivier & Giraud, 2010

IV. Poverty-Environment Linkages in Madagascar

An important part of the environment-development priority setting process is a consideration of poverty-environment linkages. Such an analysis provides a clearer understanding of how environment-development issues affect the more vulnerable sections of the community.

In the order of 76 percent of the Malagasy population is poor and poverty is more severe in rural areas than in urban areas. While accounting for approximately 70 percent of the population, 82 percent of the rural population is considered poor compared to 54 percent of the urban population[148]. Rural poverty is associated primarily with low agricultural yields and crop failures, as well as lack of access to transportation, and limited credit, public services and human capital. Urban poverty is linked to increased rural-urban migration, access to social services (including clean water and sanitation), and lack of employment opportunities; income inequality is most pronounced in urban areas. A literature review and expert knowledge has been employed to evaluate poverty – environment linkages to feed into the overall selection of environment-development priorities for detailed analyses in later sections of the CEA (Table 2.3).

[147] All data on Madagascar's ecological footprint is taken from Global Footprint Network http://www.footprintnetwork.org/en/index.php/GFN/

[148] Instat, 2011

Table 2.3: Poverty – Environment Linkages of Key Environmental Challenges

Environmental Challenge (as discussed in Section 2.I)	Implications for Poor Households	Importance to Poverty Reduction Efforts
Terrestrial and coastal/marine ecosystem degradation	The links between poverty and terrestrial ecosystem degradation in Madagascar are complex and not fully understood; it is thought that on one hand poverty is a driver of degradation and that on the other hand, the effects of this degradation are most strongly felt by poor households. Data indicate that areas with high forest cover have low population densities but high poverty rates[149]. Data also indicates that deforestation is negatively correlated with wealth and areas of greater inequality in income distribution[150]. Non-costed ecosystem services provided by forests including water supply, timber and non-timber forest products are arguably more important to poor households. Coastal and marine resources are often a 'fallback' in times of failure of agriculture production for households that have no alternatives sources of income, either through supplementation of diets with fish products or permanent migration to coastal areas and change of livelihood strategies. In the same manner, protected areas are likely to impose higher opportunity costs on poor households as they are less able to support the restriction of access to natural resources.	High
Urban pollution	The predominant effects of urban air and water pollution are on public health. Poor households are more susceptible to the effects of urban pollution due to their limited access to preventive or curative health services, their often limited knowledge on matters of sanitation and disease control, their concentration in zones where pollution rates are higher and clean water and sanitation delivery rates are lower, and their limited economic ability to choose alternative 'clean' products or services (e.g. to replace polluting indoor fuels with clean alternatives).	High
Industrial pollution	To date in Madagascar industrial pollution is less widespread than other types of environmental problems and results from small scale unregulated industries in the main urban centers, and a small number of mining mega-projects. As for urban pollution, the vulnerability of poor households to the health effects of industrial pollution is likely to be higher than for other income groups, and equally their ability to lodge complaints or protest against industrial pollution events is more limited.	Medium
Natural disasters and climate change	The degree of vulnerability of a household to natural disasters or climate change is a function of exposure, sensitivity and resilience. Poverty is thus a key factor in determining the level of vulnerability as it affects all components of vulnerability. Exposure of poor households is often the highest as they are located in the most geographically exposed locations. Sensitivity is also typically higher due to the type of housing or the health of household members as is the resilience or ability of that household to recover from a shock, due to availability of food reserves, access to credit, access to health services etc. The effects of natural disasters and climate change are thus more keenly felt by poor households.	High

Source: World Bank CEA Study Team

[149] UNEP et al, 2009
[150] Gorenflo et al, 2007; Thomas, 2007.

V. Identification of Environment-Development Priorities

The identification of environment-development priorities in Madagascar has been based on a consideration of: (i) the issues that are most likely to affect economic growth including consideration of both costs of environmental degradation / influence on adjusted net savings, and preliminary information on the value of ecosystem services; and (ii) those issues that are likely to have the greatest effects on the most vulnerable sections of the community, notably poor households.

The CEA heralds a new phase of support to the environment sector and thus the identification of future environment-development priorities needs to look past the 'traditional' highly visible issues and identify additional issues that while less visible may have significant effects on economic development or vulnerable populations. In Madagascar, environmental issues can be categorized as those issues that have a very high visibility (e.g. protected areas, biodiversity, illegal exploitation of natural resources and the effects of cyclones); those that have a lesser visibility but that are increasingly becoming more visible (e.g. overexploitation of marine resources, coastal erosion and flooding, and industrial pollution from the mining sector); and those that are largely invisible (e.g. indoor air pollution caused by fuelwood use that causes 12,000 deaths per year or the effects of recurrent droughts in the south of the country which affect more than 500,000 persons each year). The analyses of the costs of environmental degradation and of ANS indicate that in the selection of environment-development priorities, certain 'hidden' priorities – notably indoor air pollution and water pollution - are of high importance in terms of their effects on economic development and need to be considered on equal terms with the more visible issues. In addition to traditional questions of biodiversity and natural resource management, the management of other renewable natural resources and the revenues that they generate, the control and regulation of environment pollution, and the reduction of damages caused by natural disasters thus exert a central influence on the effectiveness of policies for national economic growth.

The biodiversity values of Madagascar's protected areas are undisputed and preliminary data indicates they also have a potentially significant, albeit largely unrealized, economic value both at the national level and for poor, rural households. Protected areas are the largest drawcard for foreign tourists and contribute significantly to the country's foreign exchange earnings. Water services provided by protected areas are essential for downstream urban water users and hydroelectricity generation. At the local and regional scale, they also provide vital and tangible ecosystem services to largely rural and poor households, and generate rural employment in the tourism industry for communities situated in their vicinity. Notwithstanding their importance, sustainable financing for their future protection remains a challenge.

The mining sector has the potential to become one of the primary motors of sustainable national economic development if an appropriate environmental regulation framework is developed and implemented. Failure to develop and enforce such a framework could potentially large-scale environmental damage, with vulnerable rural, poor households likely to be more at risk than well-off urban households. The sector is undergoing significant expansion and there is a need for analyses and improvement of the environmental regulation aspects of the mining sector to keep pace with this expansion.

Economic costs associated with natural disasters are significant and poor households are most at risk from these events. The limited economic analyses that are available undoubtedly underestimate the economic and social costs of natural disasters. Climate change will act to increase the intensity and/or frequency of these events and their impacts, particularly on poor and vulnerable households. To date cyclones have been the focus of most climate related interventions, but as understanding of drought effects increases in terms of the scale of effects and the types of vulnerable households that are affected, this issue is considered to require further attention.

The effects of air and water pollution on public health represent the highest environmental degradation costs, are a strong influence on genuine savings rates, and have disproportionate effects on poor households. Indoor air pollution caused predominantly by fuelwood use is a particular issue of concern given the significant disease burden that it causes, its economic effects on national development, and its unequal impacts on poor, rural households. The selection of this issue for detailed analysis in the CEA was strongly influenced by the fact that, contrary to water pollution and sanitation issues, there is no public policy in place and very little action by technical and financial partners in relation to this issue throughout the country.

The environment-development priorities that have thus been identified for Madagascar and that are considered in detail in the remaining sections of the CEA are:

i. **Sustainable financing of the protected area network**
ii. **Planning for climate resilient development and institutions, with a focus on drought incidents**
iii. **Environmental regulation of the mining sector**
iv. **Indoor air pollution and measures to reduce its effects on human health**

Chapter 3: Environmental and Natural Resources Governance in Madagascar

The World Bank considers that good governance is epitomized by predictable, open and enlightened policy-making, a bureaucracy imbued with a professional ethos acting in furtherance of the public good, the rule of law, transparent processes, and a strong civil society participating in public affairs. The challenges faced in ensuring good environmental governance are influenced by a range of factors outside the environment sector itself including the political economic characteristics of the country, education and social welfare levels, and the legislative and political frameworks that determine the role that civil society can play and the degree of freedom of expression. Chapter 3 of the CEA commences with an evaluation of governance in the environment and natural resources sector in Madagascar that analyzes existing policies, legislation, and institutions against the Bank's definition of good governance and in the context of these broader influencing factors. It investigates, in detail, examples of the application of the governance framework to two highly topical issues: (i) environmental governance of forest carbon stocks with specific reference to carbon credits generated through avoided deforestation performance payment mechanisms (REDD+); and (ii) environmental governance issues associated with illegal exploitation of precious timber in Madagascar. Chapter 3 of the CEA then presents the results of a public expenditure review of the environment sector. This Chapter of the CEA concludes with suggestions for improving governance in Madagascar's environment and natural resources sector.

I. Evaluation of Environment Sector Governance

1. Policy Framework and Policy Making Processes

Principle 1: Good governance is characterized by predictable, open and enlightened policy making.

The preparation of the original Environment Charter and the National Environmental Action Plan (NEAP) in the early 1990s acted as the springboard for environmental policy development in Madagascar. Strong Government, civil society and donor support was provided to the Government to assist with policy development and many of the resulting policies - for example those related to forestry, natural resources management and environmental assessment - remain in force today or underpin subsequently revised versions of national policy. Coupled with high-level visibility at international summits including the United Conference on Environment and Development (the Rio Summit) in 1992 and the IUCN World Parks Congress in Durban in 2003, Madagascar was considered at that time to be a leader in natural resource policy in the African Region. The resulting policies developed in the period of the 1990s and early 2000s, including the NEAP, the 2004 'Madagascar, Naturellement' (a high-level vision for national development that highlighted the role of the environment) and the 2003 Durban Vision (refer below), were ambitious policy statements that were seen as progressive and groundbreaking. Since that time however, more recent policies developed by the Government have failed to have the same impact in rallying support on the national and international stages. In terms of environmental policy, therefore, the country seems to have stalled after an ambitious start in the early 1990s.

Prior to the current political crisis, environmental issues were afforded a high profile within the national poverty reduction strategy – the Madagascar Action Plan. However, this strategy has now expired and the current transitional Government has neither replaced it with a new national poverty reduction strategy nor has it announced any plans to do so. The national Environment Policy was developed in 2010 and documents the guiding principles for the sector. The current Environment Policy is being translated into legislation through a current revision of the Environmental Charter, it identifies ten priority challenges and a series of strategic responses to inform the direction of environment sector initiatives in coming years (refer Table 3.1).

Table 3.1: Madagascar's Environment Policy – Priority Challenges and Proposed Responses

Priority Challenges	Proposed Responses
Pollution management Deforestation eradication Soil erosion management Natural resource management and biodiversity protection Fire management Implementation of international conventions Climate change responses Environment awareness and mainstreaming Public-public and public-private partnership development Strengthened responsibility for environmental management at national and sub-national levels	Increased sharing of responsibilities for environmental management and effective institutional organization Improved application of legal framework Establishment of incentive schemes for environmental protection initiatives Development of sustainable financing mechanisms Improved information, education and communication at the national level Strengthened actions for prevention and surveillance Increased efforts in control and inspection Improved mechanisms for control and inspection of environmental impacts of developments

Source: Adapted from: MEFT. 2010. *Politique nationale de l'environnement – Declaration de politique.*

The national policy on protected areas was first revealed in a 2003 Presidential declaration - commonly referred to as the "Durban Vision". The Durban Vision expressed a commitment to a tripling of the surface of protected areas to cover 10 percent of the country's surface by 2012. The protected area network under creation in line with this policy now covers 6.9 million hectares and 12 percent of the national territory. Despite the political turmoil, the current transitional Government has not renounced the Durban Vision and has shown its continued support for protection of the network through the adoption of an inter-ministerial order prohibiting development within the boundaries of the network[151]. It has not however issued any new temporary or permanent protection orders for protected areas since 2009.

Box 3.1: What is 'governance' and how is it measured?

Governance consists of the traditions and institutions by which authority in a country is exercised. This includes the process by which governments are selected, monitored and replaced; the capacity of the government to effectively formulate and implement sound policies; and the respect of citizens and the state for the institutions that govern economic and social interactions among them. The World Bank measures governance at the national level through six aggregated indicators:

1. Voice and accountability
2. Political stability and absence of violence
3. Government effectiveness
4. Regulatory quality
5. Rule of law
6. Control of corruption

The World Bank measures country performance against these indicators on an annual basis. An evaluation of Madagascar's performance indicates steady improvement across all indicators between 2000 and 2007 until the political crisis in 2008, from which time onwards a predictable and sustained downturn in all indicators was recorded.

Source: www.worldbank.org/wbi/governance

National policy on natural resources management is centered on principles of community based natural resource management. The genesis for this policy approach was the development of the original Environment Charter in 1990 which recognized that the State was unable to effectively and single-handedly control illegal exploitation of natural resources, and that that local communities were successfully managing natural resources in some areas without the intervention of the State. The outcome was that the previously exclusive mandate of the State to manage natural resources was overturned in favor of principles of shared management with local communities. While initially community based natural management policies applied solely to forest resources, gradually provisions have been made for the inclusion of other resources notably marine and coastal resources and pasturage lands[152].

[151] Inter-ministerial Order 52005/2010 modifying Inter-ministerial Order 18633 of 17 October 2008 relative to the global protection of sites targted by Order No. 17914 of 18 October 2006 and lifting of the suspension of granting of mining and forest permits for certain sites

[152] Further analysis of this issue is provided in Section 4.I.5.

The last several years have seen the preparation of environmental policies related to climate change, pollution management and coastal zone management. The Integrated Coastal Zone Management Policy and Strategy was prepared in 2009 and has for its global objective the promotion of sustainable development of coastal and marine zones. The Climate Change Policy was developed in 2010 and has for its objective the promotion of measures to reduce the vulnerability of Madagascar to climate change and emissions of greenhouse gases, and the development of behaviors that aid in the combat against climate change. This Policy is based around five strategic axes namely: adaptation to climate change, mitigation actions, mainstreaming of climate change, sustainable financing sources and research, development and technology transfers. The Pollution Management Policy was also developed in 2010 with the overall goal of preserving environmental integrity through the prevention, mitigation and management of pollution. The Policy focuses on surface water and groundwater pollution; pollution of marine and coastal resources including coral reefs, sedimentation and impacts of effluent discharge; air quality; soil contamination and solid waste management practices and infrastructure.

The Government has demonstrated its desire to create a strong environmental policy platform, however policy development processes and the content of national policies have been subject to criticism. Key critiques leveled at policy development processes include a lack of participation by civil society and communities in the preparation of policies, a lack of multi-agency input and poor cross-sector coordination resulting in duplication and contradiction amongst policies, and a lack of dissemination of adopted policies. Even policies such as the "Durban Vision" that are roundly accepted as being successful, have been criticized for having being developed without due consideration to the views of Government and external stakeholders on the content of policy or the practicalities of policy implementation. From a content point of view, policies are typically criticized for having weak technical underpinnings, for being too generic or broad in their objectives, or for being overly ambitious. Finally, the successful translation of the policy platform into a robust and coherent legislative framework remains a challenge for the Government.

2. Institutional Structure, Capacity and Resources

Principle 2: Good governance is characterized by a bureaucracy with a professional ethos acting in the furtherance of the public good.

The Ministry of Environment and Forests (MEF) is the lead Government agency in the environmental and natural resources sector. The MEF's role is to define the national environmental policy, assure its implementation and its integration in the overall economic development of Madagascar as well as to coordinate its activities with other economic sectors. The MEF is responsible for the implementation of environment related projects and programs and for the management of environment related financing agreements. The MEF is responsible for monitoring the environmental implications of projects or programs carried out by other agencies, and is consulted during preparation of legislative instruments that may have environmental implications. The MEF represents Madagascar during meetings and negotiations on international conventions. A number of directorates exist within the MEF under the auspices of the two General Directorates – that of forests and that of environment (refer Table 3.2).

The MEF's effectiveness in managing environmental issues is compromised by internal conflicts, resource constraints and limited technical capacity. The MEF is a highly politicized Ministry that has traditionally been charged with administering large amounts of external funding through the Environment Program. Created through a merger of the Ministry of Water and Forests and the Ministry of Environment in 2008, there remain internal conflicts and power struggles over key issues between the two General Directorates (DGF and DGE). To a certain extent, these General Directorates continue to operate as separate entities, albeit within a single Ministry. The result is an environment Ministry that does not play a strong, coherent and leading role across the environment sector and that is increasingly risking becoming sidelined on issues driving national economic development such as large-scale mining and coastal resource management.

There is duplication and ambiguity between the roles allocated to different directorates within the MEF and with external organizations. For example, in the case of REDD+ preparation activities where the responsibility for these activities lies with the DGF, despite the general mandate of the DCC in climate change issues, its housing of the National Designated Authority with the lead role in Clean Development Mechanism projects related to reforestation activities, and a decreed role for sales of carbon credits on the voluntary market.

There are also conflicts with the roles assigned to external agencies - for example between the Directorate of Pollution Control, the Directorate of Environmental Data and Information, and ONE; between the DCBSAP and the Ministry of Fisheries in relation to marine protected areas; and more recently between the DGF and the ONE in terms of leadership in the REDD+ preparation process (refer Section 3.II.1 below). There is generally poor inter-sector coordination and communication between the MEF and other Ministries or agencies with responsibilities for environmental issues.

Table 3.2: Key Directorates within MEF

Directorate General of Forests (DGF)	Directorate General of Environment (DGE)
Directorate of Biodiversity Conservation and Protected Areas Network (DCBSAP), responsible for creation and management of the protected areas network and for activities relating to biodiversity conservation	*Directorate of Environmental Education (DEE),* charged with education and awareness raising
Directorate of Valorization of Natural Resources (DVRN), charged with policy and operational aspects of community based natural resources management	*Directorate of Pollution Control (DGP),* charged with policy on pollution control
Directorate of Internal Inspection (DCAI), charged with control and monitoring of forestry and natural resources activities	*Directorate of Climate Change (DCC),* charged with operational and policy aspects of UNFCCC implementation
	Directorate of Environmental Information and Data (DIDE), charged with collection and dissemination of environmental information

Source: CEA Study Team

Since the onset of the political crisis in 2009, MEF is one of several national Ministries that have experienced budget cuts, and reduction of staff salaries – with a 28 percent reduction between 2009 and 2010[153]. These cuts have affected the ability to train existing staff or recruit experienced technical staff on issues that are new to the Ministry, such as climate change adaptation and carbon finance and the Ministry relies heavily on externally funded technical assistance in certain areas. The budget cuts have also forestalled the recruitment of additional environmental or forestry inspectors. The political crisis has also delayed policy and legislative developments that were envisaged by the MEF in terms of pollution control and strategic environmental management. The staff of the MEF is aging and there is a need to recruit and train new staff to replace those leaving on retirement; while such a strategy was planned to be implemented before the onset of the political crisis, there is currently inadequate budget to effectively do this.

Decentralized responsibility for environmental issues lies within regional level Regional Directorates of Environment and Forests (DREFs). Twenty-two DREFs exist within Madagascar located in the regional centers. The DREFs are mandated to administer, enforce and control environmental and natural resources issues within the regions. The effectiveness of the DREFs is undermined by a crucial lack of capacity and resources. Typically staffed with one or two persons, the DREFs are responsible for areas with an average size of 27,000 square kilometers. Staff have little training in technical issues or in the legislative framework applicable to the sector, and lack basic resources such as computing hardware and software that would allow access to environmental databases and GIS mapping, monitoring or control equipment, or even access to vehicles to visit sites outside the regional centers. Furthermore, ambiguous relationships exist both vertically between the DREF, which is directly accountable to the MEF at the central level, the head of the region (chef du region), and horizontally between the DREF and other related technical services such as Regional Directorates for Fisheries, Agriculture or Land Use Planning, which are in turn responsible to their central level ministries. During the implementation of the second and third phases of the Environment Program, efforts were made to provide support and training to DREFs; however, the results were variable and most achievements have been undermined by the onset of the current political crisis[154].

[153] World Bank, 2011
[154] USAID, 2010

Within certain sector agencies - including the Ministry of Agriculture, Ministry of Fisheries and the Ministry for Mines - environmental units exist but function with varying degrees of effectiveness. Decree No 2003-439 provides the framework for the establishment of an Environmental Unit in each Ministry. Environmental Units are mandated to evaluate and approve relevant Programs of Environmental Engagement (PEEs)[155] and work towards integrating environmental considerations into sector policies to achieve sustainable development. One of the principles underlying the establishment of these Environmental Units was to better distribute environment decision-making across many different ministries and build a higher level of environmental consciousness in all sectors. However, it has been observed that this process has been a cause of dilution of expertise and responsibilities.

Environmental units in other Ministries were widespread before the onset of the political crisis, but have become dysfunctional in recent years. Most environmental units now suffer from a critical lack of resources. For instance, staff are not typically assigned to these units full-time but take on environmental responsibilities in addition to their regular duties, units meet irregularly, and they do not have well defined work plans or mandates. Additionally, in most units, there is no dedicated budget for salary or non-salary expenses, and few training opportunities. The largely informal nature of these units means that there is high staff turnover and loss of institutional knowledge and opportunities for capacity building.

The Office National pour l'Environnement (ONE) has the mandated role of environmental regulator. ONE was established in the early 1990s in the first phase of the Environment Program in the absence of a Government ministry dedicated to environmental issues. Following the establishment of the MEF, ONE was restructured as an environmental protection agency, with a focus on the management of environmental risks linked to private and public development and pollution control. The mission of ONE is to ensure that economic activities and development are not detrimental to the environment. To achieve that objective, ONE is equipped with the mandate to: (i) develop and propose regulations for the development and management of the environmental assessment processes as set out in the national environmental assessment legislation (known as the MECIE); (ii) pollution control and prevention; (iii) marine and terrestrial environmental quality monitoring; (iv) coordination of the collection, treatment and dissemination of environmental data, information and tools; (v) development and implementation of environmental awareness training programs; and (vi) preparation of national and regional State of Environment reports.

One of the key roles of ONE is as the 'one-stop shop' for public and private investments that require a full environmental impact assessment (an EIE) under the national legislation. In this role, ONE is responsible for the review and assessment of environmental impact assessments prepared under the MECIE through the establishment of an ad-hoc technical evaluation committee (CTE), coordination of the public participation processes, and the provision of recommendations to the MEF on the deliverance of environmental permits. ONE also has the mandated responsibility to coordinate monitoring of the environmental impacts of approved projects. Between 1997 and October 2011, ONE issued 454 environmental permits; the vast majority (43 percent) related to mining projects, with industry, energy and tourism projects also benefiting from relatively large numbers of permits. The agency is also charged with management of environmental information, environmental monitoring and state of the environment reporting. With 36 professional staff to cover the national territory, ONE is clearly understaffed.

ONE was historically financed predominantly by external assistance through the Environment Program and has not achieved financial autonomy or sustainability despite its vital role on Madagascar's environment sector. With the onset of the political crisis in 2008, the last sources of Environment Program funding for ONE were suspended. Currently the only source of funding for ONE are the fees levied through the processing of environmental permits; initially intended only to cover the costs of evaluation of EIEs and follow-up monitoring, these fees are now also used to cover staffing and administrative costs of the organization. Moreover, in reality, the fees levied are generally insufficient even to cover the costs of evaluating EIE documents, and the follow-up compliance. The fees were set in 2004, and do not fully take into account the complex nature of certain projects – for example in the mining sector – that ONE is required to evaluate and monitor over very long periods. Section 3.III provides further analysis of the financial and budgetary situation of ONE.

[155] This is the instrument used for projects that do not require a full environmental impact assessment under the national legislation. A PEE is essentially a mitigation plan for project with minor impact on the environment.

The legal status of ONE is not entirely in harmony with the nature of its environmental assessment review and compliance monitoring mission. Since 2009, ONE has had a status as an independent legal entity (an EPIC or 'Etablissement Public à Caractère Industriel et Commercial'[156]) and has financial and administrative autonomy[157]. This legal status allows it to generate profits and act as a service provider. An environmental regulation mission, such as the one that has been assigned to ONE, should typically be exercised by a regulator driven by objectives of compliance and not by the need to generate financial receipts to pay staff and other administrative costs, which is becoming the case with ONE.

Madagascar National Parks (MNP) was established in 1990 as a non-profit association to manage the national network of protected areas on behalf of the State. Madagascar National Parks is responsible for ensuring the protection of ecosystems and species, promotion of research and environmental education and management of ecotourism activities in national parks. Madagascar National Parks is also responsible for management of community development activities in the vicinity of protected areas, for which fifty percent of visitor entry fees are earmarked. With responsibility for 44 national parks covering 2.8 million hectares, the main issue facing Madagascar National Parks is its financial autonomy and sustainability. Despite over twenty years of existence, Madagascar National Parks remains strongly dependent on external assistance to meet its operating budget. In recent years, the Government has provided no financing for Madagascar National Parks from its internal budget, and tourism generated revenues represent only a small proportion of its budgetary needs. The remaining budget is provided by external donors – notably IDA / GEF through the Third Environment Support Program Project (EP3), and to a lesser extent through a grant from KfW, the European Union and revenues from the Foundation for Protected Areas and Biodiversity. This issue is discussed in more detail in Section 3.III below.

Reorganization of Madagascar National Parks took place in 2011 to allocate increased responsibility to protected area managers, and an institutional audit is being carried out as part of the EP3 to develop recommendations to streamline the organization's structure and functioning. Its technical capacity and available resources are generally relatively strong for issues linked to conservation and protected area management but the skills-base is weaker in terms of issues related to conservation financing, community and social issues related to protected area creation and management, and protected area tourism; despite the increasing importance of such issues for Madagascar National Parks. Madagascar National Parks treads a thin line between its legal status as an independent association, and an organization effectively seen as a parastatal agency with strong links to the Government. While created as an independent entity, the statutes of Madagascar National Parks state that the Minister for Environment is the President of the Board, and that the Ministry selects a majority of other Board members.

Two trust funds operate in the environment sector – the Foundation for Protected Areas and Biodiversity and the Foundation Tavy Meva. The Foundation for Protected Areas and Biodiversity (FAPBM) was created in 2005 by the Government and two international conservation NGOs – WWF and Conservation International. FAPBM's mission is to provide a secure and sustainable source of financing to the existing protected area network and to support the creation of new protected areas. To date contributors to the Foundation's capital include AfD, FFEM, WWF, Conservation International, GEF and the World Bank. A total of US$17.5 million in combined contributions from IDA/GEF have been injected into the FAPBM through the EP3. A series of technical assistance activities have been financed by donors, including IDA through the EP3, KfW, and the French Government. In 2011, FAPBM disbursed US$0.5 million to six protected areas; in 2012 this increased to US$1.0 million for fifteen protected areas covering a surface of 1.6 million hectares. In addition, the Foundation supports five protected areas with US$0.5 million per year from a sinking fund created by KfW. The challenge for FAPBM, which has now met its self-imposed target of a US$50 million capital by 2012, will be strengthen its strategic planning activities and the functioning of its Board to allow it to clearly define its vision and mission as a financier of protected areas, to target new sources of financing to supplement traditional donor contributions, and to secure and maximize revenues from its capital.

The Foundation Tany Meva was created in 1996 with the support of USAID. The mission of Tany Meva is to support environmental activities at the local community level. The current capital of Tany Meva is in the order

[156] Decree No 2008.600 of 23rd June 2008
[157] It is, however, placed under the guardianship of the Minister in charge of environment.

of US$18 million, including US$12.6 million in an endowment fund and the remaining value in sinking and revolving funds. Tany Meva generates US$0.4 to 0.5 million per year which are disbursed as small grants (on average less than US$10,000 per grant) to community groups. Since 1996, 1170 projects for a total value of US$9.3 million have been funded. Projects related to climate change, urban environmental management, forest co-management initiatives and environmental education are amongst those that have been financed. To date Tany Meva has been less effective than the FAPBM in terms of its visibility and its ability to secure large sources of financing from traditional donors.

3. Legislative and Regulatory Framework

Principle 3: Good governance is characterized by the rule of law.

The legal framework governing environmental protection in Madagascar is characterized by its rapid evolution and its current largely reactive approach to the development of legislation. The adoption of the Malagasy Environment Charter in 1990 and the development of the National Environmental Action Plan, in the early 1990s marked the beginning of an era of development and adoption of new laws and regulations to address the wide variety of environmental problems facing the country. While initially focusing on forest management and biodiversity conservation, over the last twenty years domestic environmental law has evolved to address most aspects of modern environmental and natural resources management.

Environmental issues are accorded high-level recognition in the Malagasy Constitution and through the legislation implementing the national Environment Charter. The Constitution states that all persons are obliged to respect the environment. The existing Environment Charter was adopted in 1990 and subsequently updated in 1997 and 2004 (Law No. 90-033 of 21 December 1990 modified by Law No. 97-012 of 6 June 1997 and Law No. 2004-015 of 19 August 2004). The Charter provides the legal framework for the implementation of the national environmental policy and has for its objective the harmonization of the population and the environment in a context of sustainable development. With the development of a new national environmental policy in 2010, a new Environment Charter has been drafted to reflect the current national environmental priorities and is currently being discussed with stakeholders.

Madagascar is party to numerous international environmental conventions, treaties and agreements (refer Table 3.3); however, integration of the obligations conferred upon Madagascar by these treaties into the legislative framework has not been fully achieved.

Table 3.3: Madagascar's International Environmental Agreements

Name of Agreement	Year entered into Force
Convention on Fishing and Conservation of Living Resources of the High Seas	1966
Conservation of Wetlands of International Importance (Ramsar Convention)	1975
Conservation on the International Trade in Endangered Species of Wild Flora and Fauna (CITES)	1975
Vienna Convention for the Protection of the Ozone Layer	1988
Montreal Protocol on Substances that Deplete the Ozone Layer	1989
Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal	1992
Convention on Biological Diversity	1993
United Nations Convention on the Law of the Sea	1994
United Nations Framework Convention on Climate Change (UNFCCC)	1994
United Nations Convention to Combat Desertification	1996
Kyoto Protocol to the UNFCCC	2005

Source: CIA World Factbook, 2012

An important characteristic of the Malagasy environment legal framework is that it co-exists with a system of traditional or customary laws, embodied by the system of *Dina*, that apply to natural resources management. *Dina* are written or oral laws that form the basis of a social contract for a group of persons, typically at the level of a village. *Dina* date from pre-colonial times and address issues including resource management and sharing, prohibited and allowed uses of land and resources, and penalties for infractions. *Dina* are recognized in the overall Malagasy legal framework, which has the ambitious goal of using *Dina* as a

means of integrating modern legislation with traditional customs, thus rendering legal agreements culturally acceptable. However as most modern Malagasy legislation focuses on prescriptions and prohibitions the prevailing 'command and control' approach has often resulted in conflicts with traditional approaches.

Issues based legislation exists for a range of topics but its effectiveness is variable. An extremely large number of laws, decrees and orders form the regulatory framework for the environment sector. A small number of key pieces of legislation are listed in Table 3.4, however in total, hundreds of pieces of legislation exist. In the forestry sector alone, a recent inventory identified at least 59 individual pieces of legislation[158]. Notable exceptions to the range of issues addressed in the regulatory framework are climate change adaptation and mitigation, and urban pollution and waste management; these latter issues are addressed solely through the very general mandate of local government to provide for sanitation and a 'clean and healthy' environment.

Table 3.4: Selected Elements of the Environment Legislative Framework in Madagascar

Sector	Selected Legislative Instruments
General Instruments	Constitution of the Republic of Madagascar (2007-001) Constitution of the Fourth Republic of Madagascar of 11 December 2010 Law 90-003 on the Charter of the Environment[159] Ordinance 82-029 related to the safe-keeping, conservation and protection of national heritage Inter-ministerial Order 4355/97 regarding the designation of sensitive zones and definition of their boundaries as further amended and completed by Order No 18/732 of 27th September 2004 setting out the definition and delimitation of sensitive forest areas Inter-ministerial Order 52005/2010 modifying the Inter-ministerial Order 18633/2008 relative to the temporary global protection of sites identified in Order 17914/2006 and lifting the suspension for delivery of mining and forestry permit in certain sites
Environmental Assessment	Decree 99-954 dated December 15, 1999 related to the compatibility of investments with the environment, as amended to date, notably through Decree No 2004-167 (referred to as the MECIE) Order 6830/2001 setting out the procedures and modalities of public participation in the EIA process
Protected Areas	Law 2001/05 related to the Code for Protected Areas as amended to date (referred to as the COAP)[160] Decree 2005-013 related to the implementation of Law 2001-005 related to COAP
Community Based Natural Resources Management	Law 96-025 related to local management of renewable natural resources (referred to as the GELOSE) Decrees 2000-27 and 2000-28 relative to communities and environmental mediators respectively Decree 2001-122 fixing the conditions for implementation of contracted management of State forests (referred to as the GCF)
Forestry	Law 97-017 on modification of the forest legislation Law 97-1200 adopting the Forest Policy of Madagascar Numerous Orders, Decrees and Ordinances referring to exploitation and exportation of precious timber
Mining Sector	Law 99-022 on the Mining Code Law 2001-031 establishing a special regime for large investments in the Malagasy mining sector Inter-ministerial Order 12032/2000 regarding the regulation of the mining sector and matters of environmental protection.
Fisheries and Coastal Resources	Ordinance 93-022 relative to the regulation of fishing and aquaculture activities Decree 94-112 relative to the general organization of maritime fishing activities Decree 2010-137 relative to integrated coastal zone management
Industrial Pollution	Law 99-021 related to the management policy and control of industrial pollution

[158] Rambinintsaotra & Andrianantenaina, 2010

[159] The Environment Charter - Charte de l'Environnement Malgache - is currently being updated following the adoption of a new national environmental policy document in 2010.

[160] A new Code for Protected Areas was drafted in 2008, but it has not yet been presented to the Government for adoption due to the ongoing political crisis.

Sector	Selected Legislative Instruments
	Decree 2003-021 on industrial pollution control policy
Water Resources	Law 98-029 of January 20, 1999 related to the Water Code Decree 2003-191 creating and organizing water basin agencies Decree 2003-192 related to the organization, mandate and functioning of the National Authority of Water and Sanitation, Decree 2003-464 related to the classification of surface water and governing industrial emissions Decree 2003-941 relating to monitoring of water, control of water for human use and priorities for access to water

Source: World Bank study team; ONE, 2010

The MECIE, the national environmental assessment legislation, is a cornerstone of the legislative framework. Initially developed in the 1990s as part of the NEAP, it was last updated in 2004. This legislation requires revision and benchmarking to international standards to allow it to address new environmental challenges in Madagascar and to bring it in line with international best practice on environmental assessment (refer Box 3.2).

An ad-hoc approach is typically adopted to the development of new legislation. When a perceived problem or gap arises, rather than revisiting the legislative and policy framework as a whole, the tendency has been to adopt a new legislative instrument. This 'band-aid' approach has led to a large number of instruments that have a very narrow focus. The situation has been exacerbated by the fact that there is generally weak technical capacity in the drafting of legislation. For example, ministerial advisors rather than lawyers or legal experts have drafted key pieces of forestry legislation. Those drafting legislation often do not have a clear understanding of the place within the overall legislative framework, nor access to relevant legal instruments that are often difficult to obtain.

The existing legislative framework is highly fragmented and incoherent, both within and across legislative instruments. Nominally, the Constitution is the highest level of the legislative framework, followed by international conventions to which Madagascar is party, followed by laws, ordinances, decrees, inter-ministerial orders, orders and notes/memorandums. There is a lack of harmonization in the vertical hierarchy of Malagasy environmental legislation, with certain lower level instruments designed (intentionally or unintentionally) to override the provisions of higher-level instruments. There is also a high degree of horizontal inconsistency with ambiguity, conflict and duplication between different pieces of legislation, and in the responsibility for their enforcement. This situation leads to redundancy in the framework and general confusion in its implementation. It also creates loopholes that can be exploited by parties wishing to operate outside the regulatory framework.

4. Rights of Access and the Role of Civil Society

Principle 4: Good governance is characterized by transparent processes, and a strong civil society that participates in public affairs.

The need for a strong, independent civil society that can actively participate in public affairs is never more apparent than during periods of political turmoil. During these periods when existing, already fragile 'supply-side' governance systems are overturned, the 'demand-side' of governance provided by civil society is called upon to play a dual role. Firstly by increasing its vigilance of Government and private sector activities and drawing the spotlight onto irregularities caused by a desire to profit from a power vacuum, and secondly by stepping into roles that would typically be reserved for, or shared with, Government in a functional political environment.

Civil society in the form of international and national NGOs, is a highly visible presence in the environment sector. At least eight international conservation NGOs and a number of Malagasy conservation NGOs are active in Madagascar. Conservation NGOs tend to focus their activities on protected area creation and management (either as promoters or delegated managers for NAPs or through technical assistance to Madagascar National Parks), community based natural resource management, environmental education, and/or livelihoods development activities with local communities. Outside of the conservation NGOs, there are few environmentally focused NGOs.

Several internal characteristics of Malagasy civil society organizations affect their ability to play a genuine lobbying or advocacy role[161,162]. While environment and natural resources sector civil society organizations are arguably more mature and robust than organizations in other sectors, they share many of the same characteristics. There is considerable overlap between political leadership and civil society, which means that some organizations are driven by political rather than community representation agendas. Many civil society organizations play predominantly or partially a role of service provider – often in the form of quasi-consultancy organizations. Such associations are not representative of communities and do not play a lobbying or advocacy role. The advisory role of certain NGOs in contentious projects, for example in the mining sector, also arguably limits their ability to simultaneously play a role of environmental watchdog. Financial sustainability is a major problem for numerous civil society organizations; across all sectors, nearly half of all organizations surveyed in 2010 had an operating budget of less than US$100/year. Finally, limited geographical coverage limits the ability of civil society organizations to be fully representative of rural populations.

In recent years issues such as illegal exploitation of precious timber have galvanized civil society organizations that have increasingly made their common voice heard and national civil society in particular has started playing a more prominent role. There are now numerous examples of civil society's strength in drawing national and international attention to problems and issues such as exploitation of critically endangered tortoise species or precious timber. The Alliance Voahary Gasy, a national platform of conservation and environment NGOs, has played a pivotal role in coordinating the harmonized communication by civil society organizations and is an increasingly visible player in the environmental and natural resources sector.

External influences on the ability of civil society to participate in public affairs have been analyzed in terms of the 'rights of access' of civil society; an evaluation that looks at the degree to which governance is transparent, participative and responsible. The Access Initiative (TAI), an international network of civil society organizations, has developed a standardized methodology to evaluate how effectively civil society is able to play a role in 'demand-side' environmental governance. The evaluation is performed by using a series of case studies to examine the current situation in the environment sector across three 'rights of access', namely: (i) access to information on government decisions; (ii) public participation in decision-making; and (iii) access to justice. The results of the investigations are used to identify gaps in existing legislation, institutions and practices in the environment sector, and to develop recommendations that can be used in awareness raising and policy dialogue with Government, development partners and civil society to improve environmental governance. The evaluation focuses predominantly on the relationship between governance systems and civil society, but also raises issues in relation to community and private sector roles in governance as relevant.

The Malagasy national coalition of TAI, which was established in early 2011, carried out an evaluation that involved twelve case studies across a range of sectors and locations in Madagascar (refer Table 3.5). The case studies - three of which are summarized in Boxes 3.3 to 3.5 below - were selected in a participative manner to reflect recent and current environmental issues that have generated interest or concern within civil society or within the general public. The case studies present a qualitative evaluation undertaken by the TAI coalition of a range of situations and aim to illustrate key points in the overall picture of rights of access in Madagascar. The following sections discuss the key findings of the TAI evaluation that are relevant to the issues treated in the CEA[163].

Table 3.5: Case studies selected for TAI evaluation of Madagascar's environment sector

Access to Information about Government Decisions	Public Participation in Decision Making	Access to Justice
• Mineral exploitation in Anosy Region by QMM/Rio Tinto • Measures to respond to cricket invasions in southern Madagascar • Sedimentation of Lac Alaotra	• Protected Areas Code (COAP) development • Petrol Code development • National Program of Action on Adaptation for Climate Change	• Poaching and smuggling of *angonoka* tortoises in the Baly Bay National Park • Exploitation of precious timber in northeast Madagascar

[161] USAID, 2010
[162] World Bank, 2010
[163] The full TAI evaluation for Madagascar is available at http://www.accessinitiative.org

Access to Information about Government Decisions	Public Participation in Decision Making	Access to Justice
• Mineral exploitation by the Ambatovy project in eastern Madagascar	(NAPA) development • Development of legislative text for Integrated Coastal Zone Management (ICZM) • Construction of a hotel complex on Nosy Hao Island, site of a new marine protected area	• Application of the management plan in the COFAV NAP

Source: TAI, 2012

In the context of the TAI evaluation, 'access to information' is defined as the ability of citizens to obtain environmental information in the possession of public authorities or the private sector. The analyses considered information related to project, policy or strategy planning, implementation or monitoring. The key findings of the evaluation are documented below.

The first challenge in terms of access to information is the scarcity of publically available data. Government does not generate nor share regular, robust datasets on environmental and natural resource issues. The private sector is not bound by regulation to share all data and can invoke principles of intellectual property for data it deems sensitive. There is a lack of real-time information available; this is a particularly significant failing where the provision of such up to date information could influence behavior or responses to environmental issues (for example in the case of response to an environmental pollution incident). There is a strong reliance by information providers on the Internet as a means of communicating information; the cost advantages of this means of communication are strongly outweighed by the restrictions that are generated in terms of accessibility by stakeholders without the resources or capacity to use the internet. There is generally poor awareness on the part of stakeholders as to their rights and obligations in terms of accessing information. Finally, information distribution mechanisms are typically not sustainable as they often rely on external financing sources.

There is an unequal balance in resources available to Government and private sector entities to generate and disseminate information. A typical example of this situation is in the case of development projects that are subject to Government environment approval. While information requirements for reporting by the private sector to Government are fairly well spelt out in regulations – for example through the approval conditions (*cahiers de charge*) of projects – the Government often appears unwilling or unable to enforce these requirements. The private sector tends to dictate the timing and content of information that it shares leading to perceptions or incidences of impartiality in terms of the content and timing of information sharing. Government is not facilitated to play its role as the regulator of environmental information. Evidence has shown that the private sector in the past has invoked intellectual property concerns to avoid releasing environmental data that it deems sensitive. There is currently little guidance provided in the legislation as to the definition of information that can be considered confidential.

The situation in terms of information flow to communities, civil society and lower level Government technical agents is even more difficult as there are few effective regulatory mechanisms whereby Government or private sector entities are obliged to respond to data requests from communities or civil society; and there are few legal requirements for the content, timing or type of information that is shared. These parties are generally subject to a one-way flow of data that has been selected, treated and presented in a form and at a time chosen by the party that has generated the data.

The evaluation concluded that despite the panoply of legal instruments that make high-level reference to the principle of access to information, in reality, there is little translation into regulatory obligations. Where they do exist, the application and enforcement of such mechanisms is weak. The evaluation concluded that access to information in the environment sector requires improvement through the development and enforcement of regulatory mechanisms that ensure equal and timely access to relevant information in a form that is suitable for the receiving audience. Mechanisms are equally required to ensure that information flow can be a two-way process with stakeholders provided with the mechanisms, support and follow-up in their requests for information from Government and private sector.

Box 3.3: Principle No. 1 - Access to Information: The case of mineral exploitation by QMM/Rio Tinto

This case study examined the mineral exploitation activities of QMM/Rio Tinto in the Anosy region of southern Madagascar and focused on the following questions: (i) whether the Government and/or the private sector mining company had put mechanisms in place to allow public access to information about the project; and (ii) if so, what the effect of such mechanisms has been. The case study concluded that while efforts have been made on the part of the Government and the mining company to diffuse environmental information, the overall success of these efforts has been mitigated. The timing and content of the information flow is dictated primarily by the mining company, and to a lesser extent the Government, and there is no clear mechanism to allow the community to request environmental information that may be of interest. The case study noted that such rights exist under the auspices of the National Environment Charter but are not embodied in regulations or procedures. The case study results also indicated that neither the affected communities, nor the local or regional authorities, are typically aware of their legal rights to demand such information.

The case study concluded that the type of information that is available to communities is limited to information on the ambient environment, and the activities and environmental obligations of the mining company. Information on actual environmental performance via publication of monitoring results is not available. Interviews with stakeholders revealed that these content limitations are exacerbated by accessibility and language constraints as many documents are only available on websites and in French / English language effectively putting them out of reach of the majority of the local population. The case study recognized that positive efforts that have been made to present information in a form and language accessible to the larger public (i.e. through radio, theatre or magazines) but such interventions are limited in their effectiveness to achieve full transparency of information flow as they are not frequent and thus present information that can date back several months, and they provide information in a form developed and treated by the mining company, rather than as raw data. Furthermore, such interventions are not considered as sustainable as they rely on external financing. Finally, the case study identified that the company has restricted access to certain environmental information that it has deemed sensitive or confidential.

In the context of the TAI evaluation 'public participation' is defined as informed, timely and meaningful input and influence in decisions on general policies, strategies, and plans at various levels and on individual projects that have environmental impacts. The case studies evaluated public participation in relation to the environmental aspects both of development projects through requirements for participation in the environmental assessment process, and in terms of public participation in policy and strategy development. The key findings of the evaluation are documented below.

Public participation requirements for the environmental aspects of project development are outlined in Order No. 6830/2001 fixing the procedures and requirements for public participation in environmental assessment. This Order requires public participation for projects subject to the highest form of environmental assessment – an EIE – in the form of consultation of documents, a public inquiry or a public audience. No requirements for exist in the case where no EIE is required even though such developments are not necessarily benign in terms of their potential environmental or social impacts, particularly when there are a large number in a concentrated zone. ONE determines the form of consultation and advises the proponent. ONE can also develop project-specific arrangements with the proponent for public consultation. In such a case, no guidance is provided on legal minimum requirements for participation and while such a provision in the Order may be designed to impose stricter requirements on proponents, it also represents an effective loophole to reduce consultation requirements. While the results of public consultation are required to be made public, interested parties must pay for access to relevant documents. Requirements for post-EIE public participation are outlined in the environmental management plan and approval conditions for projects. Such requirements typically take the form of dissemination of information on environmental monitoring, and not participation in the true sense.

Despite the relatively sound legislative framework for involvement in the environmental assessment process, public participation activities that actually occur for an individual development can vary depending on a range of factors. The case study for a tourism development in the south of Madagascar carried out as part of the TAI evaluation (refer Box 3.4) concluded that opportunities for consultation and participation on this particular development had been very limited, and not in keeping with legislative requirements. Generalizations cannot be drawn based on a single case study but it appears that distance from major centers, lack of visibility of the project within civil society and the general public outside of the study area, and a lack of understanding of requirements and obligations on the part of regional Government agencies, proponents and communities were central to the failure to fully apply the requirements at least in this case.

Legal requirements for public participation in legislative, policy or strategy development do not exist in Madagascar. Although the case studies revealed that in some cases limited participation did occur at the discretion of the Government, it was extremely narrow in terms of the participants. Line ministries and powerful groups (such as large international NGOs or the private sector) were generally the only invited participants. This is a weakness in public participation requirements as many of these upstream processes have a fundamental influence on land use and economic development for instance by determining strategic development priorities for certain sectors or setting out requirements for participation in latter stages of policy implementation. Interviews with Government indicated that the highly technical nature of the issues addressed in these policies were the main reason for limiting participation however, the role of the Government in such a scenario is arguably to find appropriate means to communicate and seek feedback on important issues.

In the context of the TAI evaluation, 'access to justice' is defined as the ability of citizens to turn to impartial and independent arbiters to resolve disputes over access to information and participation in decisions that affect the environment, or to correct environmental harm. The case studies focused on natural resources exploitation issues that are the subject of current judicial proceedings. The results of the evaluation are documented below.

A key cause of limited access to justice for communities and civil society in rural areas is the physical distance that exists between plaintiffs and the nearest court. District or commune level courts tend not to be operational, and 'travelling courts' have proved unsustainable or too infrequent. As a result most cases are heard in regional courts located at significant distances from rural communities. For plaintiffs located in rural settings the costs and lost time incurred with travelling to regional courts is significant, and numerous interviewees in the case studies noted that there is increased difficulty and pressure in presenting before a court in a large unfamiliar setting.

The procedures of the court system in Madagascar are complex and unclear; lawyers are mandatory for the certain steps in the process, which incurs additional costs, and plaintiffs and witnesses are often unaware of their rights and obligations. Communities, civil society and technical agents involved in the preparation of witness statements, depositions and evidence do not typically have a good mastery of the steps required. Relatively simple errors, such as lack of signatures or dates on key documents, can result in cases being delayed or even overturned. Access to information on procedures, status of cases before the courts and decisions is difficult and costly to obtain – particularly for third parties.

The role of civil society in cases brought before the justice system is often unclear. For example, under the provisions of the Protected Areas Code, civil society cannot be a plaintiff in cases involving illegal exploitation of species in protected areas. Yet simultaneously because of their presence on the ground and their involvement with communities they are often forced to act as de facto arbiters in situations involving natural resource exploitations or in addressing grievances brought by the communities in relation to the actions of Government or private sector. This unclear legal status is exacerbated by the low technical capacity of many environmental civil society organizations in legal and judicial matters.

Corruption, and lack of independence, in Madagascar's justice system is a well-recognized problem and one that has a particular relevance for actions related to environmental issues. Natural resource exploitation – such as logging of precious timber or poaching of critically endangered tortoise species – is controlled and organized by powerful networks of poachers, traffickers and re-sellers with strong links into various elements of Malagasy society and Government. There is strong suspicion that lobbying of judges by these networks has resulted in cases being overturned or favorable verdicts for defendants being returned. Community and civil society plaintiffs are completely powerless in the face of such a scenario. There are no protection schemes for witnesses or plaintiffs and this adds to the fear of involvement in cases involving these powerful networks.

Officials in the courts system often have low awareness of environmental issues and even of the requirements of environmental legislation. Their task is rendered more difficult by the state of environmental legislation, which as previously noted is by turns complicated, contradictory, ambiguous or redundant. Such flaws in the legislative framework open loopholes for defendants and allow creative interpretation of legal requirements on the part of corrupt judges.

Box 3.4: Principle No. 2 - Public Participation: The case of tourism development on Nosy Hao Island

The Velondriake Marine Protected Area (MPA) is a community-managed site included in the IMO 52005/2010 that is under the stewardship of the Velondriake Committee. The construction of a hotel complex in early 2010 by a private sector entity on the largest island within the MPA, Nosy Hao, has the potential to affect future ecotourism activities and the fisheries based livelihoods of the local community. The TAI case study examined whether there had been an effective public participation process during the planning and construction of the hotel complex in order to ensure that environmental and socio-economic values of the MPA were protected.

The case study concluded that despite the legal requirements for public participation in the development of the hotel complex, notably through *Order No. 6830/2001 fixing the procedures and requirements for public participation in environmental assessment*, the process was flawed. Not only was there very little public participation, but the participation that did take place had no apparent effect on the evolution of the project. According to the case study findings, the majority of decisions were taken between the hotel developer and the regional authorities with no involvement of local community representatives nor of technical agents from regional Government services. Interviews with community representatives indicated a lack of transparence in the details of agreements reached between these parties. Civil society attempted to aid community representatives to become involved in the project development process but was effectively sidelined, as the legislative framework does not define a role for third parties. The case study findings also highlighted the negative influence of the site's isolation, the lack of awareness on the part of the community as to their rights and obligations and the lack of technical capacity on the part of the local community to fully engage with regional authorities and the developer on an equal footing. There was no visible monitoring on the part of Government of the implementation of the public participation requirements of the legislation.

Box 3.5: Principle No. 3 - Access to Justice: The case of exploitation of *angonoka* tortoises

The *angonoka* or Ploughshare Tortoise (*Astrochelys yniphora*) is considered to be the world's rarest tortoise species. Endemic to Madagascar, only several hundred individuals remain in the wild in the Baly Bay National Park on Madagascar's west coast. Due to their large size and rarity they are highly sought after in the international pet trade, especially in Asia, and have been increasingly targeted by illegal poaching and smuggling activities. The purpose of this case study was to examine if environmental justice has been effectively applied in response to poaching activities and if the actors involved in the conservation of the angonoka have access to the justice system.

Poaching of this species is illegal under Malagasy law and in line with international conventions to which the State is party such as the Convention on International Trade in Endangered Species (CITES). Since 2002, 24 cases of poaching have been brought before the court system; however, the case study indicated that for a variety of reasons, the treatment of the cases has resulted in very low levels satisfaction for stakeholders involved in the conservation of this species. The case study found that there is only one forum for arbitration of suspected cases of poaching – the Majunga Tribunal. The physical isolation between the National Park and the nearest urban center of Majunga where the tribunal is located is a major influence on the ability for stakeholders to access justice. In normal conditions it can take two days to travel between the National Park and Majunga, and community representatives of the protected area management committee incur heavy costs and loss of time traveling of Majunga. Once there they reported feeling intimidated and pressured because of their relatively low ability to express themselves before the courts. The justice system has also failed to undertake simple measures – such as avoiding the transport of suspected poachers in the same vehicles as plaintiffs – that would reduce pressure on community representatives and minimize feelings of fear to be involved in court actions.

According to the case study neither the courts, nor the Government, nor the technical agents of regional Government services necessarily have access to or seem to fully understand the specific legal framework that applies to poaching cases. In addition, ambiguity and lack of harmonization in the laws themselves and deficiencies in the marking of the National Park boundaries complicate the task as incidents inside and outside of the National Park boundaries are treated differently. The case study concluded that direct access to justice for civil society is limited as only Madagascar National Parks can act as the plaintiff in cases before the courts; civil society cannot be formally represented in a judicial hearing. Decisions from the tribunal are often not communicated or made available to outside parties. The case study noted that because Madagascar National Parks does not act as the civil party for every case, often cases are heard in the absence of a plaintiff, which is detrimental to their success. Based on interviews with stakeholders, the case study concluded that corruption of high level officials and magistrates and lobbying of judges in the courts continuously undermines the effectiveness of the justice system. Finally, the case study found that the conservation actors, while informally grouped into a platform, do not have the strength or the coordination to fight against the strong and highly organized network of traffickers.

Examination of the case studies concluded that access to justice for environmental issues in Madagascar is weak and requires significant improvement. The reasons for the weak performance of the justice system in relation to environmental issues range from relatively simple logistic issues to complex questions of corruption within the justice system and the power imbalance between the State and highly organized networks of traffickers of natural resources.

II. Examples of Applied Environmental Governance in Madagascar

This section draws on the definition of good governance introduced at the beginning of the chapter and applies it to two highly topical issues: (i) governance challenges related to Madagascar's involvement in a future REDD+ performance payment mechanism for forest carbon credits; and (iii) governance challenges related to the management of exploitation of precious timber. The purpose of this section is to provide the reader with two examples of how the different elements of the prevailing governance framework interact to cause situations that not only threaten the integrity of Madagascar's natural resources, but deprive the Government and community of much-needed financial resources.

1. Governance challenges related to Madagascar's involvement in a future REDD+ performance payment mechanism

REDD+ in Madagascar: a history and current status of activities

1.

Like most developing countries with extensive forest cover, Madagascar has been quick to see the potential for its forest resources to generate significant financing through a potential future international performance payment mechanism known as REDD+ (reducing emissions from deforestation and forest degradation and promoting conservation of forest carbon stocks, sustainable management of forest, and enhancement of forest carbon stocks in developing countries). The framework that will guide REDD+ is still under negotiation in international forums, but the mechanism is based on the premise that countries can be rewarded for reducing greenhouse gas emissions from deforestation and forest degradation, increasing carbon stocks and sustainably managing and conserving their forests. The sources of financing for REDD+ are also still under discussion internationally, but could include regulated and voluntary markets, as well as international funds, such as the World Bank managed US$300 million Forest Carbon Partnership Facility (FCPF) Carbon Fund and bilateral agreements, such as the USD1 billion Amazon Fund managed by Brazil.

Madagascar started readying itself for entry into a future REDD+ forest carbon market in 2008 with the establishment of a large and engaged multi-sectoral and multi-agency committee known as the Technical Committee for REDD+ (CT-REDD). The primary role of the CT-REDD was the preparation of a REDD+ Readiness Preparation Proposal (R-PP), a necessary step to obtain financing from the World Bank managed FCPF[164]. Completed in final draft form in 2010, Madagascar's R-PP received high-praise for being a well-prepared, locally specific and comprehensive document. The R-PP establishes the key elements for the country to build technical and institutional capacity for REDD+ including the frameworks for: (i) a national REDD+ strategy addressing the main drivers of deforestation and forest degradation; (ii) a national legal and institutional framework for REDD+ (benefit sharing rules, mechanisms for managing REDD funds, carbon ownership rules); (iii) a national reference emission level of emissions from deforestation and degradation (based on analysis of past and future emissions); and (iv) a national-level mechanism to monitor and report on emissions from deforestation and forest degradation, combining remote sensing analysis and field observation.

In a parallel but closely related process, NGOs in Madagascar have been active in promoting REDD+ at the project level and have targeted the voluntary market for eventual carbon sales. Three sub-national projects aimed at selling credits at the voluntary carbon markets are being implemented in three large NAPs in the eastern humid forest ecosystems – Makira, Corridor Ankeniheny-Zahamena (CAZ) and Corridor Fandriana-Vondrozo (COFAV). These projects are led by large international NGOs (Conservation International and Wildlife

[164] The Forest Carbon Partnership Facility (FCPF), which became operational in June 2008, is a global partnership focused on reducing emissions from deforestation and forest degradation, forest carbon stock conservation, sustainable management of forests and enhancement of forest carbon stocks (REDD+). The FCPF assists tropical and subtropical forest countries develop the systems and policies for REDD+ and provides them with performance-based payments for emission reductions. Through its Readiness Fund, the FCPF provides around USD3.5 million for countries to implement their roadmaps for achieving "REDD+ readiness", whereas through its Carbon Fund, the FCPF will pilot performance-based payments in a few countries.

Conservation Society) and they all follow a similar model, namely reduction of emissions through the creation of large protected areas made up of a core protected area, user controlled areas and buffer area, support for community management of forest resources, and implementation of alternative activities to deforestation, including agriculture intensification, agro-forestry and bushfire control.

These projects are using methodologies approved by the VCS (Verified Carbon Standard) to calculate the emission reductions being generated by their activities, and to issue these credits through an internationally credible standard. The World Bank's BioCarbon Fund purchases credits from one of these projects (the CAZ project led by Conservation International). Two other large REDD+ initiatives in Madagascar – the GoodPlanet-WWF led Holistic Conservation Program for Forests (PHCF) whose second phase (2012-2015) aims at generating voluntary carbon credits as well; and the Swiss Inter-cooperation led FORECA project - are testing tools and methodologies to build reference emission levels and monitoring and reporting systems of emissions. Together these five activities cover 16 sites and an area of 1.76 million hectares across five major habitat types.

These NGO led activities have provided a strong technical understanding of the country's forest carbon stocks and have allowed testing of approaches to tackle deforestation. Different projects have adopted different methodologies and approaches for technical and governance activities including measurement of carbon stocks, mechanisms for involving communities and benefit sharing, and mechanisms for negotiating agreements with Government. This diverse array of experience initially allowed Madagascar to become a leading laboratory in the African region and globally for implementing REDD+ activities on the ground and also influenced Madagascar to adopt a nested or bottom-up approach whereby experience from sub-national projects has informed national level strategic and institutional musings of the CT-REDD.

However, the onset of the political crisis in 2009 amplified underlying and unresolved governance challenges related to forest carbon finance with the result that Madagascar has changed from being perceived as a frontrunner in forest carbon finance to an 'also-ran'. The immediate effect of the crisis was to stall the FCPF R-PP validation process due to lack of international recognition of the *de-facto* government. This in turn led to nascent discussions, negotiations and progress on forest carbon stock governance issues in Madagascar being effectively blocked at a critical juncture without resolution of numerous important elements. Simultaneously inter-agency conflicts for control of forest carbon have intensified as Government agencies search for additional sources of financing to replace decreasing Government budgetary allocations and reduced external assistance. The political crisis has also affected the evolution of NGO projects, particularly for those projects that aim to sell carbon in the short term on the voluntary carbon market, thereby stymieing the potential to test different approaches to important elements of forest carbon governance such as benefit sharing and community based monitoring approaches. Lack of clarity on the institutional framework for REDD+ has meant that initial pre-sales (in the form of advanced payments on future carbon credits) that took place on the voluntary market before 2008 have not been repeated in the intervening four years.

Overview of current institutional structure

Given the financial stakes potentially involved in future sales of forest carbon credits, and the current budgetary constraints within Government agencies, there has naturally been a degree of jockeying for position within different Government departments. The situation has not been aided by historic conflicts between key agencies. The DGF, DCC and ONE are the key players in forest carbon. The DGF is broadly charged with management of forest resources, including the transfer of management of these resources to NGOs and communities. The DCC is charged with climate change adaptation and mitigation activities, leading the participation of Madagascar in international negotiations. The ONE seeks to play a leading role in forest carbon specifically as the institutional home of the MRV system. The roles that these organizations play in forest carbon activities are largely self-assigned and there is no overall vision to set out clear and complementary mandates. The CT-REDD has been instrumental in moving forward on R-PP development and trying to design future governance arrangements, but it has no formal status and its members are technicians rather than decision makers. A clear leadership and political will to move this rather complex issue forward has never emerged.

The resulting situation is a Governmental institutional structure that is ambiguous at best and chaotic at worst. It is a fluid and changeable structure both in terms of the roles of different organizations and in terms of turnover of key staff, including at the most senior levels. There is little inter-sectoral coordination or involvement of agencies responsible for related land-use or resource management decisions in the current institutional structure. There is no single agency within Government responsible for coordination of activities and liaison with external stakeholders. This lack of clarity discredits Madagascar in the eyes of foreign investors as it greatly increases the risk for investors, and reduces the likelihood of Madagascar's becoming REDD+ 'ready' in the near future.

The current institutional structure for forest carbon management in Madagascar is furthermore characterized by strong international NGOs and a weak Government administration. On a positive note, the strong NGO presence has ensured that the operational and technical aspects of forest carbon finance have progressed, as noted above. However, the current ambiguity has meant that NGOs have not been able to reach solid agreement with the Government on revenue sharing and in some cases have resorted to working independently of Government on forest carbon pre-sales. This has led to lost opportunities for financing of the national forestry and natural resource sector through the development of equitable revenue sharing agreements between Government and NGOs as least in terms of pre-sales. However, given the emerging international discussions on forest carbon credits, it is likely that these assets issued in the voluntary market will only realize their financial potential if they are fully embedded in the national legal and institutional framework.

Legislative framework for carbon rights and benefit sharing

Sequestered carbon is not explicitly defined in the current Malagasy legal framework leaving questions on its ownership and the associated rights of use open to legal interpretation. Sequestered carbon is not automatically State property in Madagascar, as it is not defined as a 'natural resource' that would make it the exclusive property of the Government[165]. Two options could be explored to define the legal status of REDD+ credits under Malagasy Law. The choice of which option to pursue could be determined by criteria related to funding of REDD+ activities, equity in terms of revenue-sharing, and sustainability of expected REDD+ outputs (increase of removals / reduction of emissions). The first of these options would involve the definition of REDD+ credits as a "natural resource". Such a definition would mean that such credits are part of the holdings of the State and must be used for the country's best interests. Under this option, the State would have the full and complete ownership of carbon credits and would be the only legally able authority to transfer the legal title to third parties. REDD+ credits would thus not likely be privately acquired upon delivery, but only when transferred to third parties - including to private investors interested by sustainable forestry management in Madagascar - by the Malagasy government.

The second option would involve the definition of REDD+ credits as "intangible movable assets". In this case the removed/sequestered carbon is considered an "industrial commodity", or "natural commodity", depending on the level of human intervention. Carbon credits are therefore linked to a title proving the result of an action (removed/avoided carbon). The title can be freely sold and transferred and its value depends on potential use (determined by required regulatory compliance or compensation on the voluntary market). The property is subject to private acquisition (including for the benefit of public law entities, including the State, to manage their private holdings) and ownership of carbon credits will be granted to the entity able to prove ownership. Under this option, private acquisition would be possible, but the Malagasy government should be guaranteed an important proportion of REDD+ credits, given its status as landowner and its predominant role in sustainable forestry management. Owner(s) of carbon credits under this option would not be directly identified by law, but on the basis of several criteria or guidelines potentially specified by law, including: (i) tenure rights, including recognized and registered customary rights; (ii) resource use rights, including by logging concession operators contributing to increase of removals or reduction of emissions; (iii) use rights within the activity perimeter; or (iv) capital or business inputs contributing to increase of removals or reduction of emissions.

[165] Wemaere & Rajaonson, 2006

At an operational level, forest carbon rights are not explicitly integrated into community based natural resource management legislation such as GELOSE and GCF. Because the land subject to these contracts rests under State ownership, the legal ability of communities to be able to sell forest carbon stocks is questionable and would need to be subject to revision of the legal framework or be the subject of a separate agreement. The long experience of application of the GELOSE and GCF mechanisms shows how complicated it can be to effectively develop, implement and enforce legislation that allows for community involvement in natural resource management. Such complexity is likely to be exacerbated in the case of carbon stocks not only because of the inherent technical complexities in the sales of forest carbon, but also because the opportunity costs to communities and the economic benefits occur on different timescales.

The contracts accompanying the recent Government ordinances[166] that delegate transfer of management of new protected areas that are under creation (NAPs) from the State to NGOs state that the carbon credits in the NAPs belong to the Government. The contracts state that specific conventions will be developed to define the terms of agreements between the Government and the NGOs managing the NAPs. The contracts further state that the delegated managers will assist the Government to develop projects to sell carbon credits from the NAPs.

There is no national guidance or legislation on benefit sharing frameworks or mechanisms and progress to date on this issue has been led by NGOs. The Makira project, which is being managed by Wildlife Conservation Society (WCS), is arguably the most advanced of the projects underway in Madagascar. In July 2008, WCS signed a MOU with the Government for the creation of the Makira Carbon Company (MCC). The MOU agreed that WCS would act as an agent for sale of carbon credits from Makira, with the revenue to be divided amongst the local community (50 percent), protected area management (20 percent), the Government, with funds theoretically earmarked for development of forestry activities (20 percent) and marketing and administration expenses (10 percent). However, certain fundamental aspects of the benefit sharing mechanism remain to be determined and a consistent and consensual nationwide approach for benefit sharing that integrates principles of transparency and participation is required.

Impacts of governance failures

In returning to the definition of 'good governance' identified at the outset of this chapter, the preceding discussion identifies the many levels on which the current governance structure for forest carbon has substantial weaknesses. There is no single, coherent policy on forest carbon sales; the institutional arrangements are vague and weak in terms of capacity and resources; legislation does not treat issues associated with forest carbon in a robust manner; and there is little transparency in revenue sharing or in the agreements that the Government has reached with NGOs wishing to exploit forest carbon. There is a strong and active civil society, but in terms of REDD+ activities, their focus to date has been operational and revenue generation activities, rather than engagement with Government on governance issues related to carbon finance – a situation caused by the ongoing political instability.

The impacts of the governance failures described above have been real and significant for Madagascar and can be measured in terms of lost opportunities for financing, either to support the REDD+ preparation process or for sales on the voluntary carbon market. Forest carbon sales operate in a market environment and Madagascar is one of many players in this market. Undeniably, Madagascar is potentially a highly attractive candidate to attract buyers. Sales here have the advantage of generating significant biodiversity and social and poverty reduction co-benefits and there is a strong and active civil society presence to attract buyers. In addition the country is generally perceived as being free of high levels of systemic corruption, illegal commercial logging on the geographical scales seen in certain Southeast Asian and African countries, and other disincentives that are present in many other countries. However as in all markets, risk plays a crucial factor in investment decisions. The lack of a clear institutional and legislative framework translates into a lack of certainty for investors; and with the current global interest in generating financing through forest carbon sales there are enough other competitors in the market to translate this lack of certainty into a concrete loss

[166] Arrêté 45.328/2011 portant délégation de gestion de la Nouvelle Aire Protégée en création dénommé « Corridor Ankeniheny-Zahamena »; Arrêté 45.329/2011 portant délégation de gestion de la Nouvelle Aire Protégée en création dénommé « Corridor Forestier Ambositra-Vondrozo »; and Arrêté 45.330/2011 portant délégation de gestion de la Nouvelle Aire Protégée en création dénommé « Makira »;

of investment for Madagascar. This applies both to funding from multi-donor funds such as the FCPF Carbon Fund for which Madagascar was initially identified as a priority country, and transactions on the voluntary market, which are undeniably even more risk-sensitive.

Not only do governance failures affect relations with external stakeholders, but internal stakeholder support for REDD+ also suffers. The political economy characteristics of Madagascar mean that there is a long history of natural resource rent capture by elites. This has been demonstrated in the mining sector and more recently in the exploitation and exportation of precious timber[167]. With forest carbon stocks representing another significant potential source of financing, there is a strong likelihood that unless a clear and consensual governance structure is put in place, this financing is also at risk of capture by political elites. Such a scenario would cause community dissatisfaction and potentially undermine the whole process as local communities charged with guardianship of forest resources would not see any economic benefit to avoiding deforestation.

Suggestions for Improvements to the Governance Framework

Failure to participate effectively in forest carbon transactions means that the country will potentially miss out on opportunities to transform natural capital in the form of forest carbon into other productive forms of capital that can facilitate sustainable development. Forest carbon can be viewed as a renewable resource and governance structures should aim to maximize revenues generated from the transformation of this resource and allow for the effective and equitable use of the revenues generated. Natural capital transformation centered around forest carbon has the advantage of being less destructive that other forms of natural capital transformation and could, depending on the evolution of future REDD+ mechanisms, play an important role in assuring future sustainable economic development in Madagascar.

However, without short-term and convincing improvements to the governance framework for forest carbon finance, Madagascar runs the risk of lost financing opportunities and increased damage to its international reputation. A comprehensive review of the current institutional arrangements will be a necessary pre-cursor to the development of a clear and comprehensible institutional structure. Inter-agency conflicts require resolution through the unambiguous allocation of roles and responsibilities to different organizations, and the establishment of formal and informal communication mechanisms. The role of other concerned Ministries, Madagascar National Parks, and sub-national entities (such as the DREFs and CIREFs) also needs to be clarified. Collaboration with local and international NGOs should also be strengthened through formal and informal exchanges to capitalize on the technical capacities and lesson learnt during project implementation. Consistent approaches to negotiation of agreements between Government and NGOs need to be adopted to create a level playing field and encourage NGOs to work with Government. A national inter-sectoral multi-stakeholder body to steer the design of the national REDD+ strategy with a clear and formalized mandate is a condition for REDD readiness and should be implemented as early as possible in the REDD+ readiness process.

Inter-sector coordination and consensus will be important to achieving a sound governance platform for forest carbon sales and to effectively addressing the drivers of deforestation and forest degradation. The Ministries responsible for agriculture, mining, land use, public works, water, and finance are amongst those that will need to ensure that a sound, cross-cutting enabling policy and legislative framework exists and that their strategies and activities are aligned with the vision for development of national forest carbon initiatives. The policy, governance and operational activities of these Ministries are also crucial for effective emission reductions to take place. There needs to be a clear link between REDD+ activities and sector-wide forest governance issues. In short, unless deforestation is effectively reduced, no performance-based payments will be made and opportunities for revenue generation and sustainable development will thus be lost.

Review and improvement of the legislative framework relating to carbon rights and benefit sharing will also be a necessity. REDD+ offers the possibility to compensate local communities for the positive externalities they generate by sustainably managing their forests; however, there is a need to define the legal status of carbon credits and to integrate the question of carbon rights into existing natural resource management legislation (i.e. GELOSE and GCF legislation) to provide surety for communities, avoid inconsistencies in the treatment of different types of natural resources and avoid complex and potentially redundant legislative frameworks. The rights of local communities in the vicinity of NAPs to the benefits generated by carbon credits

[167] World Bank, 2010

needs to be determined in the same way that their access rights to natural resources within the NAPs have been defined.

A key notion of benefit sharing, and one that is likely to be insisted on by local and international partners, is that revenue generated for the Government by carbon sales, should be targeted at those that produce the asset, including the communities that incur opportunities costs for conserving forest resources; for example, conservation use, community development around protected areas, natural resources management or to further the development of the forest carbon markets development process. In general, Madagascar will need to put in place legislation and a national-level mechanism that allows REDD+ funds to be allocated in an efficient manner to those actors that effectively contribute to reducing emissions, thus creating the assets being paid for. Once a full-fledged REDD+ system at the national level is in place, as opposed to multiple fragmented projects, the funds management mechanism will have to allocate resources from the national to the local level.

An additional aspect of benefits sharing that should be considered in the review of the legislative framework will be the benefits and costs of earmarking of revenues allocated to Government for forest management or conservation activities. The current lack of earmarking in Madagascar in the environment sector means that revenues generated by the environment sector are not guaranteed, even partially, to be reinvested in the sector. In times of political upheaval when Government priorities often change in favor of other sectors, financing for the management and protection of natural resources can thus be adversely affected leaving the door open for their exploitation with a resulting decrease in the economic benefits that the sector generates and the potential to cause irreversible damage to natural resource stocks. The National Forestry Fund (FFN) is a dedicated account funded by revenues from forestry management activities (e.g. fees for permits and authorizations) and used in regulatory activities in the forestry sector; the FFN may be one solution for the management of REDD+ generated revenues. Regardless of the structure implemented, funds need to be managed in a transparent and logical manner and focused on activities that generate measurable benefits in the sector.

2. Governance challenges associated with the management of products of illegal exploitation of precious timber

Background to Illegal Logging in Madagascar

Over the last 20 years, illegal logging of precious timber has been a recurrent trend in Madagascar with peaks in activities mirroring successive periods of political and social unrest. Since at least the 1990s, illegal logging has followed a cyclical pattern with timber harvested on a continual basis and stockpiled (often in highly imaginative locations) until a natural disaster or political situation creates an enforcement vacuum that facilitates exportation of collected products. In recent years, exploitation of rosewood and ebony from the forests in the northeast of the country threatens biodiversity and the country's reputation as it has gained substantial coverage in international media and attention from environmental activists and civil society who have been particularly vocal in its condemnation of the illegal activities[168]. Following the onset of the political crisis, in 2009, approximately 100,000 trees (representing 52,000 tons of timber) were logged. Of this more than 36,000 tons was exported, 95 percent of it to China. Most of this timber was felled during a six to eight week period in February and March when the central Government was effectively non-operational. The political crisis also marked the beginning of a northwards movement of illegal logging activities into previously unaffected protected areas that are classified as world natural heritage sites[169].

The unauthorized logging of rosewood trees is a criminal offence in Madagascar, although the legislative framework remains complex. Inter-ministerial Order 16030/2006 and Order 12704/2000, prohibit all extraction of wood resources in "sensitive zones, including protected areas" and their peripheral zones. However, at least twelve decrees, ordinances and orders deal with the question of precious timber exploitation and exportation and there is a high degree of ambiguity in the legal framework with

[168] "Lemur Forests Pillaged by "Gangs" as Madagascar Reels", National Geographic News, March 24, 2009, http://news.nationalgeographic.com/news/2009/03/090324-lemurs-looting-madagascar.html; "Million-dollar beds fuel Madagascar timber crisis", BBC News, 26 October 2010, http://www.bbc.co.uk/news/science-environment-11626412

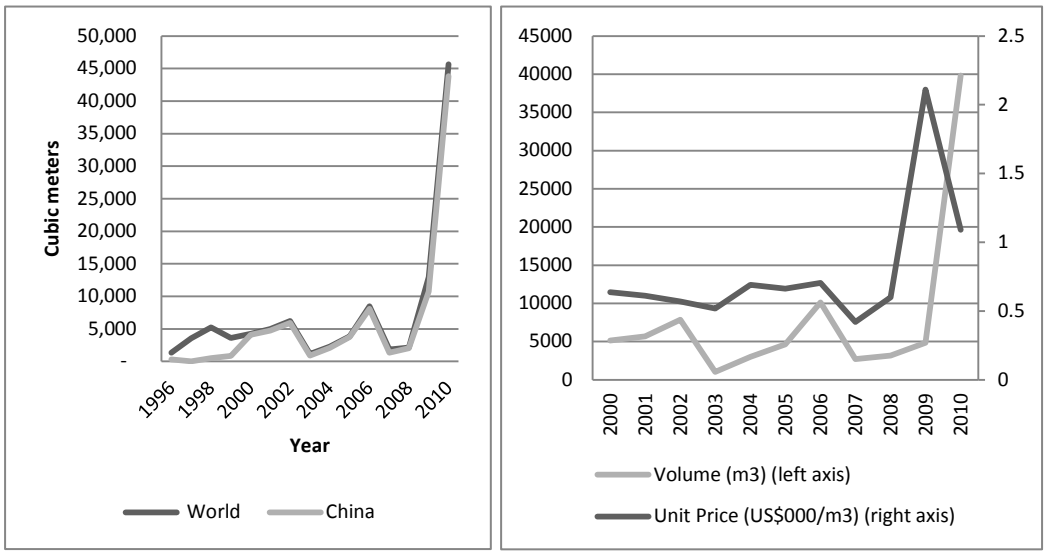
[169] World Heritage Rainforests in Madagascar threatened by illegal logging and trafficking of precious wood, Friday, April 3, 2009, UNESCO, http://whc.unesco.org/en/news/500

contradictions, duplication and redundancy between texts[170].

The Malagasy transitional Government has sent conflicting messages on the issue of precious timber exploitation and exportation. The DGF, with the support of technical and financial partners, undertook to develop a series of tools for the sustainable management of the country's forests This collection of tools was part of the Kolo Ala approach and their development was financed by different partners through the Environment Program. In the order of US$15 million was invested in these activities between 2005 and 2010 (US$10 million from IDA and US$5 million from USAID). While these tools were being developed and operationalized the Government aimed to ensure that forests would be managed in a sustainable manner, without loss of stock and in a manner that would generate economic benefits for the country. To this end, negotiated exploitation contracts were suspended by the forestry administration as of 2005 and the exportation of precious timber (i.e. rosewood, ebony and pallisander) in raw form (logs) or semi-worked was prohibited since 2004. This "moratorium" proved unstable as "exceptional" authorizations for exportation were regularly granted in 2007 and at the beginning and in September of 2009. The official justifications were that these authorizations allowed trees that were felled during cyclones or old stocks to be disposed of. In reality, these exceptional permits caused waves of illegal cutting of trees in primary forests and protected areas.

Such exceptions also served to create the impression that all harvested wood will eventually be allowed to be exported and implicitly encourages ongoing stockpiling. In March 2010 the Minister for Forests signed Decree 2010-141 prohibiting the cutting, extraction and export of rosewood and ebony which signaled at least a temporary end to Government issued exportation permits. In early 2012, the Minister for Environment issued Ministerial Order 0741/2012, which has come under strong attack from civil society and observers as serving to potentially re-open the exploitation and exportation of illegally exploited timber stocks.

Figure 3.1: Evolution of Precious Timber Exports from Madagascar



Source: World Bank, 2010

Impacts of Illegal Logging Activities in Madagascar

Illegal logging not only threatens Madagascar's ecosystems and unique biodiversity - an irreplaceable public good, but also robs Malagasy people of development opportunities as it prevents natural capital from being converted efficiently into productive and human capital. Rosewood is extremely valuable and can sell for US$5,000 per cubic meter, more than double the price of mahogany. However, a small proportion of the logged timber's final value rests in Madagascar and that this money is concentrated amongst a very small group of individuals. The timber logged in 2009 was estimated to have generated revenue in the order of US$220 million for 20 or so individuals, US$9.6 million for local communities through the role of individuals as loggers and transporters, and revenue of US$21.7 million for the Government[171]. While this is a not

[170] Rambinintsaotra & Andrianantenaina, 2010
[171] Ballet & Rahaga, 2009

insignificant amount for a cash-strapped Government in a full political crisis, it is overshadowed by the half a billion dollar value of the predominantly nature based tourism industry that is suffering from the reputational damage caused by logging activities. Thus, in addition to destroying a world heritage sites and plundering the country's natural resources, illegal logging deprives the Government, and the population, of millions of dollars of taxable revenues.

Illegal logging harms tourism in northeastern Madagascar, tarnishes the country's reputation in international forest carbon finance markets, which are highly susceptible to such risks and destroys biodiversity. In economic terms, it is estimated that the illegal logging activities in 2009 caused US$13.1 million in lost tourism and watershed benefits in affected protected areas[172]. In physical terms, the 2009 logging activities disturbed an area of 4,000 to 10,000 hectares in protected areas[173]. Up to 500,000 additional trees and countless vines were also cut to make rafts to transport the timber and additional damage was caused by logging camps, depots, tracks, and associated hunting activities that targeted threatened lemur species.

Governance Context of Illegal Logging Activities

Before attempting to address questions of governance related to the management of remaining timber stockpiles, it is useful to examine the governance failings that led to the recurrent episodes of precious timber exploitation. Table 3.6 draws on a number of sources[174] to summarize the key characteristics of the current governance situation against the characteristics of good governance identified at the outset of this chapter.

Table 3.6: Characteristics of Governance Situation related to Precious Timber Exploitation

Characteristics of Good Governance	Characteristics of the Current Governance Situation
Predictable, open and enlightened policy-making and transparent processes	Opacity is the leitmotif of the governance situation related to precious timber exploitation. Decisions related to policy and legislation have typically been made in isolation by a limited group of political elites. The relationship between the small number of well-known, highly influential, timber barons who control the trade and regional and national politicians is muddy with frequent claims of corruption. Only a small proportion of revenue from timber exploitation finds its way into the State's coffers; while hard to prove, there is little doubt in the view of most observers that political elites have reaped significant private financial benefit from the illegal activities. The recent announcement by the Government to seize and sell stockpiled timber and its apparent willingness to engage in discussions with technical and financial partners had signaled a positive change to this trend but the recent adoption of Ministerial Order 0741/2012 has raised questions on the part of observers as to the real will of the Government to engage on this issue.
A bureaucracy imbued with a professional ethos acting in furtherance of the public good	Responsibility for management of the forests where illegal logging has taken place is split between the Ministry of Environment and Forests, notably through the Direction-General of Forests (DGF) and Madagascar National Parks (MNP). The DGF is responsible for management of non-protected forest areas and enforcement within Madagascar National Parks managed national parks. The local Forestry Administration, consisting of the Regional Director of the Environment and Forests (DREF) and the District Head of Environment and Forests, is in charge of the management of state forests, and controls all forestry-related operations; a role that it is poorly equipped and poorly resourced to undertake. Suspicions of collusion (or at least of agents turning a blind eye) between these agencies and timber barons have been raised by independent observers, who note the massive inequalities in political power and resources that exist between these two groups. Madagascar National Parks has better resources and trained staff and is responsible for management of its national parks, but does not have the power to arrest or prosecute those engaged in illegal activities and must rely on the forestry administration to make arrests and follow up with prosecution; a situation that has been described by some as the 'Achilles heel' of Madagascar National Parks in its fight to protect the national parks from logging activities.
The rule of law	The legislative framework regulating precious timber logging and exports has been highly changeable over the last decade, oscillating between prohibitions and exceptions (refer Figure 3.2). This 'complex and self-contradictory legal environment' has hindered

[172] Ballet & Rahaga, 2009
[173] Randriamalala & Liu, 2009
[174] TAI, 2012; World Bank, 2010; EIA & Global Witness, 2009

Characteristics of Good Governance	Characteristics of the Current Governance Situation
	enforcement and provided loopholes for exploiters. Few of the cases that have been brought before the courts have resulted in guilty verdicts. Representatives of the judiciary have cited both legal flaws in cases prepared by forestry agents and the contradictory nature of the legal framework as being responsible for this situation. The independence of the judiciary in Antalaha, where most cases are tried, is however perceived by some as highly vulnerable, given the power exerted by the timber barons and observers have found that potential witnesses have expressed fear of intimidation and physical violence by the traders in retaliation for providing information.
Strong civil society participating in public affairs	International support for biodiversity conservation in Madagascar appears to be the major counterbalancing force that contains illegal logging activities. Civil society has, from the outset of the spike in illegal logging activities in 2009, been highly vocal in its condemnation of the situation. It has drawn significant national and international attention to the issue and has been almost single-handedly responsible for the regular media coverage and interest on the part of the international observers. However, as important as this lobbying role has been, civil society does not have a clear role that allows it to provide input or feedback to Government decisions or policy with its involvement at the discretion of Government, nor a legally defined role in the sense that it cannot act as a plaintiff in legal cases against timber barons for illegal activities carried out in protected areas (refer also Box 3.5).

The genesis of the current period of illegal logging has been in large-scale governance failings that have occurred since the onset of the political instability. However in looking to solutions to the future, it must be recognized that while the current political crisis may have exacerbated the situation, governance issues related to illegal timber exploitation in the country's northeast date back at least a decade. A recent in-depth analysis of the forest governance sector in Madagascar found that illegal logging of precious timber and corruption amongst forestry administrations are inherent vulnerabilities of governance frameworks in developing countries[175]. Public benefits from forests are realized when forests are preserved, but significant short-term private benefits can be gained through exploitation. This leads to a situation where a high level of Government enforcement is required, but incentives and mechanisms for effective enforcement are limited because of the value of the exploited products, the discretionary powers of officials and the dispersed nature of forests. Thus to achieve long-term solutions, the persistent and underlying causes of governance failures must be addressed.

The Government of Madagascar, in line with the recommendations of several international organizations recently indicated that it had made a sovereign decision to seize all illegally harvested logs in order to send a strong deterrence signal to illegal operators. It committed to inventory all precious woods in bulk and in containers, stored in the country's ports, and hidden in private properties throughout the country, and to sell the seized wood[176]. As of the end of the January 2012, the Government had reportedly seized 30,000 logs but believed many more remain to be seized, amounting up to 100,000 logs. Their sale could generate potential revenues estimated at between US$50 million and US$100 million.

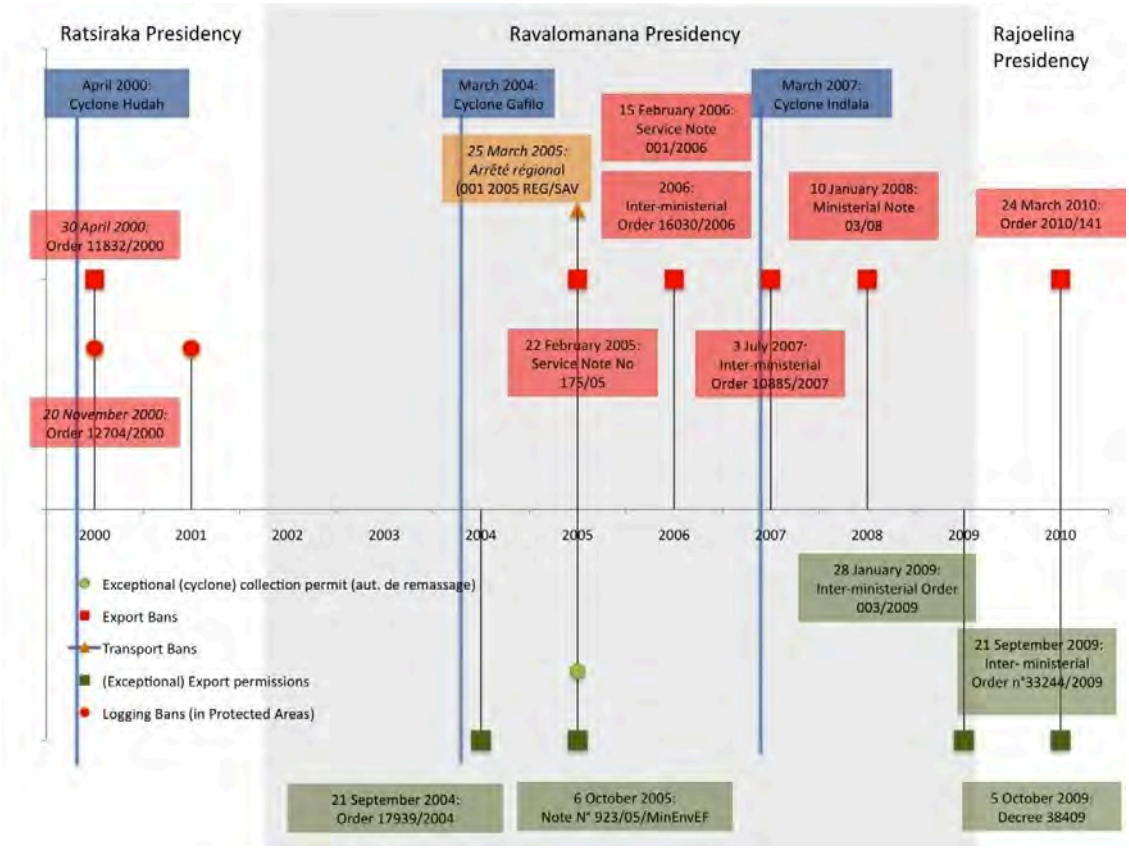
However, following this statement, in what was seen as a back-flip by many observers, the Minister for Environment adopted a Ministerial Order 0741/2012 which seemingly allowed exportation of some timber stockpiles. While the Order has been roundly criticized for its legal deficiencies, as well as its implication for illegal exploitation of other forestry products, at the time of writing it was still in force and its effect on a future sale process is not clear. A large number of governance questions therefore remain in terms of precious timber exploitation and exportation.

Suggested Modifications to Future Short-Term and Long-Term Governance Framework

With regards to stock disposal, three general options are available: (i) confiscation and storage for the time being; (ii) destruction; (iii) sale in an international auction and /or carving into small pieces for use in local handicrafts.

[175] World Bank, 2010
[176] EIA & Global Witness, 2009

Figure 3.2: Regulation regarding precious timber exports and extraction 2000 – 2010



Source: World Bank, 2010

The sale of seized stockpiles of timber will only result in positive impacts if certain conditions are met; otherwise, the sale could do more harm than good as it could send a signal to timber exploiters they will eventually be allowed to sell timber stocks and profit from the sales. Two equally important challenges exist. The first is to ensure a successful auction process and efficient, accountable and transparent use of recovered revenues, targeting sectors that have the potential to benefit the most vulnerable segments of the population. The second is to ensure that the process will prevent any future illegal logging activities.

Putting aside broader questions related to the advantages and disadvantages of a sale compared to storage or destruction of the seized products, three key questions exist: (i) What is the best governance framework for such a sale? (ii) What governance framework should apply to the use of proceeds from the sale? (iii) What governance framework should be put in place to ensure that the sales do not act as a catalyst for future illegal exploitation? The Government has not yet defined how it will respond to these questions; the following section contains a number of suggestions that provide the perspective of the World Bank based on its experience in similar situations in other countries, and that aim to catalyze discussion amongst stakeholders.

Overall, the governance framework to be put in place for the sale process should be transparent, robust and allow for involvement by civil society, communities and independent observers throughout the process. There are four steps in the sale process: (i) certification; (ii) auction of products; (iii) management of revenues generated; and (iv) allocation of revenues generated.

A certification system is an essential pre-cursor to the sale itself. The certification system is required to avoid the laundering of non-seized products, the re-commencement of illegal exploitation directly following the sale and to allow tracking of sold products through the various stages of production until they enter the marketplace in their final form. Different options exist for certification systems. The most sophisticated and the most reliable involves DNA marking of logs; a process that requires the removal of DNA samples from each

log and the creation of a genetic database that buyers at each stage of the process can use to assure that their purchases are from seized logs.

The sale of seized products should be through an open auction process. A third party should be engaged to manage the auction and the Government should not sell the products directly. The third party – typically an international auction house that specializes in such types of sales – would announce the auction and the conditions in advance in national and international forums, and should be joined by an independent observer throughout the process.

The framework for managing and allocating the revenues generated by the sale should be discussed and fixed at the outset of the sale process. Given the nature of the products being sold and the current political context, the revenues should be placed in a special account that is managed and audited by an independent committee. The revenues represent a significant yet out of the ordinary source of income for the country. The revenues should not be used to cover day-to-day costs of the administration but should be reinvested in the sustainable development of the country, particularly focused on those locations where the logging took place. While a limited part of the revenues could be allocated to the State treasury to compensate for the lost taxes due to the illegal nature of the activity, caution will be required to avoid the perception that the Government is undertaking the sale as a means of generating financial revenues.

The final use of the generated revenues should be determined in a participative manner with a range of stakeholders – including civil society, communities in affected areas, and the private sector. One means of achieving this would be to hold national, regional and local debates on the use of the revenues that establish the criteria for the types of activities that could be financed by the revenues – for example, investment in social infrastructure, development of alternative sources of revenue for affected communities, and surveillance activities for protected areas that were looted – as well as the distribution and timing of investments.

In the longer term, the ability to avoid a re-commencement of the current, persistent cycle of illegal exploitation, storage, followed by sanctioned or non-sanctioned exportation of precious timber will require reform of the forest sector governance as a whole. While the objectives for the long-term governance of the sector seem clear, the path to achieve them is harder to define and the ability to meet objectives will be primarily determined by the political will of the Government to address this issue in a transparent and coherent manner. The following analysis presents some elements of a response in terms of the different options that could be considered, and the components of a governance framework that may be needed to achieve these options. Sector governance reform should aim to increase the accountability, transparency and capacity of the administrative and legislative framework, as well as allowing a greater role for civil society and the community. Different options exist that should be examined and discussed in a transparent and participative manner with a wide range of stakeholders. These options should be discussed and examined in a manner that draws on international experience (for example the experience in Kenya with the trade in ivory) and that is underpinned by technical analyses. To this end, a detailed sector-specific analysis would be required to underpin any future intervention by the World Bank in the sector.

The first broad option is the 'prohibitive approach' whereby all logging of precious timber would be prohibited. Under this approach, following the currently envisaged sale of seized stocks, no further exploitation or exportation of precious timber would be allowed, thus protecting the integrity of the remaining timber and the forests within which they are found. Achievement of this ambitious option would require a comprehensive review of the legislative framework to strengthen prohibitions and close existing loopholes, significant monitoring and enforcement activities (including provision of resources and capacity building for field based forestry agents to carry out such activities), and perhaps most importantly a strong political will to not cede to timber barons by granting 'exceptional' exportation permits in the future. Given the importance of natural capital to underpin the future economic development of Madagascar, it is unlikely that this option would be the most beneficial to the country as a whole. In addition, experience over the last two decades has shown how difficult prohibition of precious timber exploitation is in Madagascar; attempts to implement a complete nationwide ban may effectively lead to a continuation of the status quo where cycles of illegal exploitation terminate in exportation of banned products with or without the complicity of the Government.

The second broad option is the 'resource valorization approach' whereby limited exploitation of precious timber, and other forest products, would be allowed based on scientific quotas. Under this approach, precious timber and other forest products would be viewed as an important component of the country's natural capital; i.e. a natural resource that has an economic value that can be sustainably exploited for the benefit of the country. The vision underpinning this option would be a national forestry sector that is sustainably managed, based on scientific evidence and in line with formally adopted governance tools, to optimize the resource rents from timber exploitation, to ensure equitable and effective use of revenues generated by the sector, and to ensure the ongoing productivity of forests, in terms of both timber and related ecosystem services.

This option would also require significant reform of the entire national forest sector governance framework to place the future management of precious timber in the context of overall sector management, and avoid creation of a parallel legislative and policy framework for precious timber. If attempts were made to implement this option under prevailing governance structures it could cause more harm than good as there are inadequate checks and balances in place to avoid rorting of the system. A forest value chain analysis would provide essential information that would allow the completion and operationalization of a range of governance elements (locally known as Kolo Ala tools) that the DGF started preparing in 2005 - including inventories, forestry zoning, development of quotas and detailed management plans, a system of competitive public tendering for exploitation licenses and the implementation of a system of tracking and certification of timber (for example certification by the Forest Stewardship Council - FSC). This option would need to be supported by fiduciary reform including revision of fiscal policy in the forestry sector and promotion of a strictly controlled and certified economic chain of activity in precious timber to minimize corruption and avoid this process being used for illegal exploiters to gain a foot in the door.

Policy on the distribution and investment of revenues from the forestry sector would need to be developed in a transparent and participative manner; much along lines as proposed above for the management and use of revenues from the international auction of seized products. Continued support to protected area managers would be required to strengthen enforcement activities within national parks that have to date been the target of illegal logging activities; until 2014, such activities are programmed as part of the current World Bank financed additional financing for the Third Environmental Support Program Project (EP3).

Under this second option too, the revision of the legislative framework and the strengthening of the forestry administration will be vital. A complete inventory and analysis of existing legislation is required as the basis for an updated, coherent framework that operationalizes the chosen policy direction. The development of a national Forest Code (such as that exists for the mining sector, protected areas and the water sector in Madagascar) would be a means of consolidating and updating the existing instruments in a single legal instrument for the forestry sector. Issues such as the definition of different forest products and the use-rights attached to them under different management regimes (i.e. in protected areas and buffer zones, in non-protected zones, and in land subject to community based natural management contracts) would need to be confirmed. Links to ongoing land tenure reform processes would need to be taken into account. Ensuring that the forestry administration has adequate and well-trained staff, sufficient equipment and political and judicial support at both the central and decentralized levels would be an essential pre-cursor to the development of a future governance framework.

Strengthening of the role of the criminal justice system in terms of investigation, prosecution, and conviction, as well as the confiscation of proceeds of illegal activities will be an essential complementary activity[177]. In Madagascar, as in other countries suffering from illegal forest exploitation, criminal justice systems have generally been weak in fighting illegal logging. The justice system is rarely used to combat illegal logging and in the few cases where it has been used, it has tended to target low-level criminals whose involvement in illegal logging is due to poverty. As such, it has created no real deterrent for large-scale illegal operations that are carried out by sophisticated criminal networks. Criminal justice thus needs to focus on these networks, and the high-level corrupt officials who enable and protect them.

[177] For a more detailed discussion of the role that the criminal justice system can play in combating illegal logging refer to Goncalves et al, 2012.

Finally, the role of civil society and the benefits and support that it can bring to an under-resourced administration need to be recognized. The weakness and lack of accountability of the existing institutional structure that has been overwhelmed by the strength of private sector timber barons, and the failure to allow civil society and communities to have a real voice in the management of this problem need to be redressed in the proposed governance framework. The legislative framework requires revision to ensure that there is a recognized place in the governance framework for third parties – be they technical or advocacy based stakeholders – to have a tangible influence in policy dialogue and outcomes, and a legally recognized role in judiciary proceedings.

III. Public Environmental Expenditure Review

This section presents an analysis of environment sector revenues and expenditure[178]. The analysis focuses on the revenues and expenditures in key sectors – including forestry, fisheries, mining and protected areas, and on the budgets and expenditures of the main institutions that are discussed in the CEA, namely the Ministry of Environment and Forests, the regional DREFs, ONE and Madagascar National Parks. The data collection exercise that underpins these analyses was carried out during a period of political upheaval in December 2011 with the country three years into a political crisis and immediately following a major rotation of high-level staff in key ministries, and the evaluation is thus marked by limitations in data availability.

1. Environment Sector Revenues

Environmental revenues are fiscal and non-fiscal revenues, and international grants and credits for activities related to environmental and natural resource management. For the purposes of the CEA, revenues generated from the forestry and fishing sectors and visitor entry fees to Madagascar National Parks managed protected areas (known as DEAPs) have been included in the analyses of environmental revenues. While representing a subset of the full range of environmental revenues, these datasets were selected for inclusion due to the relative completeness of the data, their level of influence on overall revenue trends, and their links to the environmental-development priorities identified in the CEA. Revenues from the mining sector have not been included as they are not managed by environment sector agencies (i.e. MEF, ONE or Madagascar National Parks).

Fiscal revenues generated by the environment sector totaled US$21.6 million between 2003 and 2011, an average of US$2.4 million per year. Fiscal revenues are derived predominantly from value-added tax, income tax for personnel, tax on revenues and tax registration fees. The fisheries sector, and in particular industrial shrimp fishing, contributed the largest proportion of fiscal revenues in this period with over 80 percent of total fiscal revenues. The forestry sector – timber and non-timber forest products – contributed the remaining fiscal revenues over this period.

In the environment sector, non-fiscal revenues remain generally low, and peaked between 2008 and 2010 due to fees generated by the exploitation of precious timber. Between 2008 and 2010, during the concentrated period of precious timber exploitation and exportation, nearly US$41 million in royalties for precious timber exploitation were collected by the Government, whereas prior to 2008 such revenues were in the order of US$200,000 per year. In comparison, the fisheries sector contributed in the order of US$4 million per year between 2003 and 2011 in non-fiscal revenues, with a peak of US$9 million in 2008.

Non-fiscal revenues generated by Madagascar National Parks in the form of protected area entry fees (DEAPs) have generated an average of US$900,000 per year since 2003, of which half is injected into the overall budget of Madagascar National Parks and half is distributed to communities around protected areas for development projects. The amount of DEAPs generated has been strongly influenced by the political situation, which has affected overall tourism entries to Madagascar. In 2008 before the political crisis, DEAPs reached a peak of US$1.5 million, a figure that dipped to US$550,000 in 2009 before increasing in 2010 and 2011 to reach US$1.1 million.

ONE generates non-fiscal revenues through evaluation fees for environmental permit applications. These fees, which are stipulated in Annex III of the MECIE, remain modest and between 2003 and 2011 have

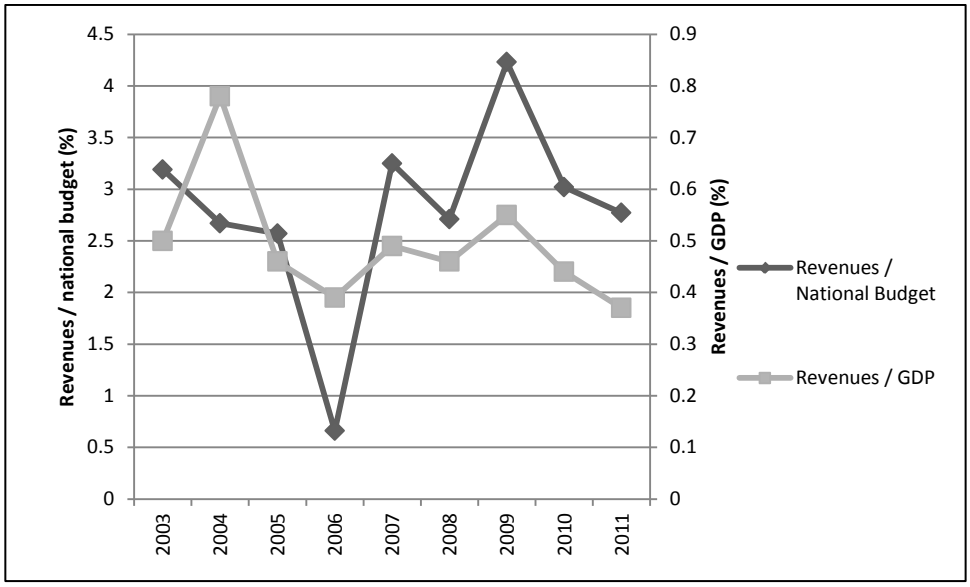
[178] The analysis presented in this section is drawn from: Andriamarozaka I. 2012. *Rapport finale de la revue des depenses publiques sur l'environnement.* Report prepared for the World Bank, Antananarivo.

generated an average of US$70,000 per year. These fees are deposited into a 'Special Evaluation Account (CSE)' that, in theory, is used solely for activities associated with evaluation of EIE applications and monitoring of approved projects.

External assistance to the environment sector has traditionally accounted for an important proportion of total environment sector revenues. With a peak of US$42 million in 2007, external assistance to the sector totaled US$75 million between 2004 and 2011. An 84 percent reduction in external assistance to the sector was experienced between 2010 and 2011 as a result of the ongoing political crisis. The Bank's support to the environment sector through the EP3 has been a significant contributor to the environment sector budget contributing 64 percent of external assistance between 2003 and 2011. The additional financing of the EP3 that became effective in early 2012 has a total budget of US$52 million, and in the short-term this financing will represent the largest external financial contribution to the sector.

Between 2003 and 2011, revenues from the environment sector contributed an average of 2.8 percent of the national budget annually. Peaks were experienced in 2007 and 2010 due to fiscal revenues from QMM/Rio Tinto and royalties from WISCO. Revenues from the environment sector during this period averaged approximately 0.5 percent of GDP.

Figure 3.3: Evolution of environment sector revenues against GDP and national budget



Source: MFB / World Bank study team

2. Environment Sector Expenditure

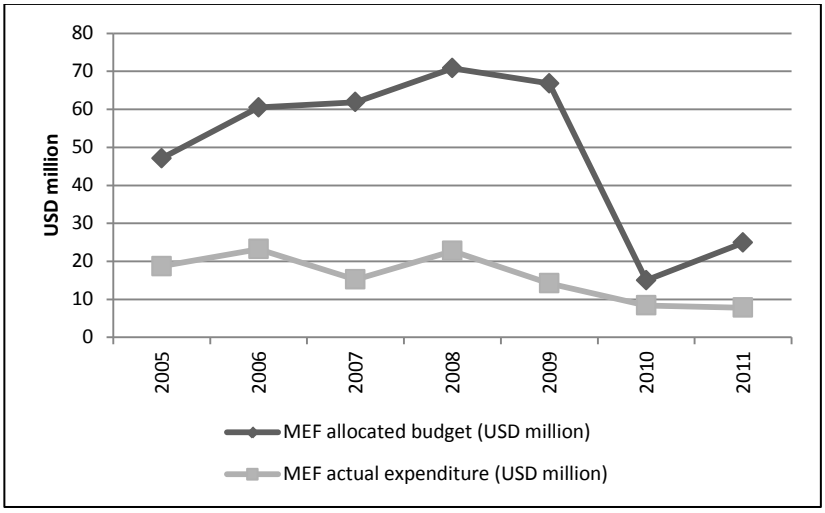
Environment sector expenditure has been considered in terms of amounts and defining traits of expenditure of the key organizations operating in the sector, and through comparison with the national budget and GDP. The organizations that have been included in the analysis are the Ministry of Environment and Forests (MEF), the Regional Directions of Environment and Forests (DREF), Madagascar National Parks (MNP), and the National Environmental Office (ONE).

The budget and expenditure of the Ministry of Environment and Forests (MEF) has been highly variable over the last decade. The budget of the MEF, as for all Government ministries, is voted in the Initial Finance Law (adopted at the end of each year for the following year), and the modified in a Rectified Finance Law to reflect more accurate projections of spending (adopted in April of the budget year). Data on actual expenditure is collected at the end of each year[179]. The peak that was observed in 2008, following the merger of the then

[179] The difference between the allocated, rectified and actual budgets can be explained both by the availability of funds throughout the year and the spending priorities of the Government and the individual Ministries. The political crisis has seen increased political influence in spending decisions and increased allocation of national budget in favor of 'political' ministries such as the Office of the President and the security forces. (Source: World Bank, 2011)

Ministry of Forests and Water and the Ministry of Environment, in both allocated budget and expenditure was quickly followed in 2009 by a significant drop in both allocated and expended budget with the onset of the political crisis (refer Figure 3.4). This downwards trend continued until 2011 for actual expenditure, despite an increased budget allocation.

Figure 3.4: Evolution of allocated and expended budget for MEF 2005 - 2011



Source: MFB / World Bank study team

Expenditure of MEF is characterized by a relatively low rate of budgetary engagement. Between 2005 and 2011, approximately 35 percent of the allocated budget was expended. Both before and after the political crisis the rate of engagement for salary related expenditure has been higher than that for investments. Between 2005 and 2008, 74 percent of allocated budget for salaries was expended, while only 33 percent of the allocated budget for investments was expended. Between 2009 and 2011, the respective engagement rates were 84 percent for salaries and 16 percent for investments.

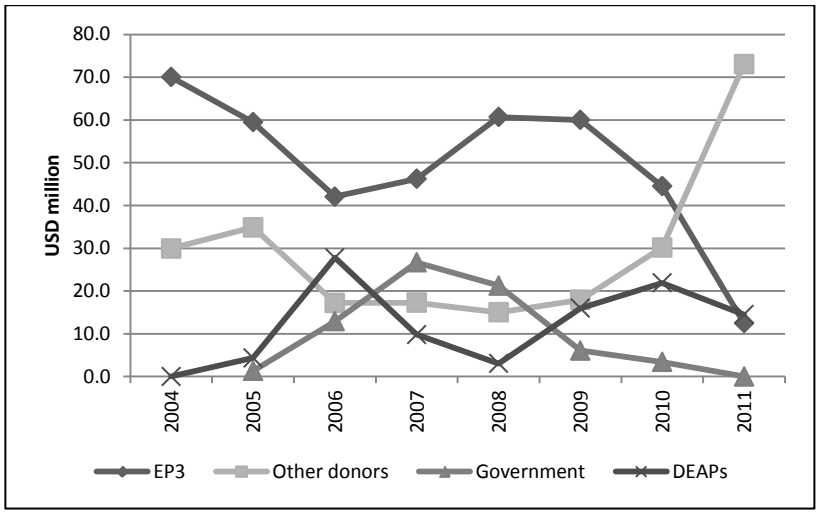
Before the political crisis, investments represented the largest expenditure of MEF; after the onset of the crisis the trend was reversed and salaries represented the largest expenditure. Between 2003 and 2009, investment represented 80 percent of the budget, while salaries represented 20 percent. As of 2010, investments accounted for 35 percent of expended budget and in 2011, 29 percent. This trend can be explained at least in part by the withdrawal of donors from the sector that were the main source of funding for investments before the political crisis. The proportion of budget expended on salaries increased during this period to 44 percent in 2010, and 52 percent in 2011. In absolute terms, the budget expended on salaries remained relatively stable between 2008 and 2011.

Little information is available on the budgets of the DREFs at the regional level. Data on the DREF budgets are not included in national budget statistics but are held at the regional level. Revenue sharing between central and regional agencies remains unbalanced with regional budgets representing on average 6 percent of central budgets in the period 2008 to 2010.

Madagascar National Parks is highly dependent on external assistance to make up its budget needs. Between 2004 and 2011, on average, half of the expended budget of Madagascar National Parks originated in financing from the EP3, 83 percent of which as used for operational costs, including staff salaries. Madagascar National Parks was the main beneficiary of the EP3 between 2004 and 2011, accounting for 56 percent of project expenditure. Other donors contributed around 30 percent of the total expended budget. Visitor entry fees and Government financing from internal resources contributed on average 12 percent and 10 percent annually, although since 2009, the Government has virtually ceased financing Madagascar National Parks from its internal budget.

Madagascar National Parks has had disproportionate expenditure on operational costs, including staff salaries. Between 2003 and 2011, an average of 83 percent of overall expenditure related to operating costs. In this period, salaries are the highest expenditure category with an average of 47 percent of the total budget. Investment and capital expenditure represents on average 16 percent of the total budget in the same period (refer Table 3.7).

Figure 3.5: Source of expended budget for MNP 2003 - 2011



Source: MNP / World Bank study team

Table 3.7: Breakdown of MNP expenditure (as percentage of total budget) 2003 - 2011

	2003	2004	2005	2006	2007	2008	2009	2010	2011
Operating Expenses	85.8	94.6	87.7	91.7	76.6	77.7	86.4	81.3	97.1
- Salaries	*52.8*	*54.9*	*45.3*	*49.7*	*37.7*	*42.8*	*53.2*	*35.7*	*69.0*
- Goods & services	*33.1*	*39.7*	*42.4*	*42.0*	*38.8*	*34.9*	*33.2*	*45.6*	*28.1*
Capital Expenses	14.2	5.4	12.3	8.3	23.4	22.3	13.6	18.7	2.9

Source: MNP / World Bank study team

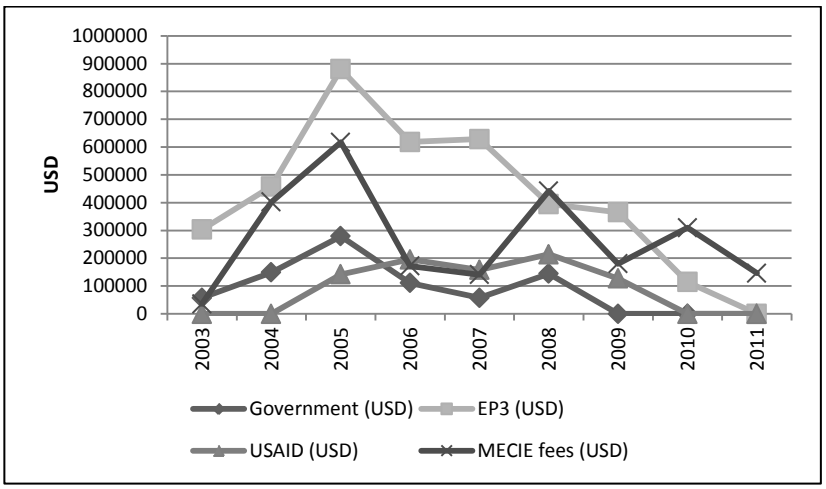
ONE's budget has been significantly affected by the withdrawal of donors from the environment sector. Historically, EP3 contributed 47 percent of ONE's budget, followed by other donors (23 percent), non-fiscal revenues from environmental permit evaluation fees (20 percent) and Government financing (10 percent) (refer Figure 3.6). With the change of status of ONE to an EPIC in 2009, and the onset of the political crisis that saw the suspension of those components of EP3 that financed ONE and the withdrawal of other donors, the sole source of financing is now the fees charged for evaluation of environmental permit applications (refer Figure 3.7). The expenditure of ONE is focused on recurrent costs, with 92 percent of the budget during the period 2003 – 2011 used for salaries and goods and services. ONE now suffers from an operational financing gap that in 2010 was estimated at US$275,000[180].

Overall, the proportion of environmental expenditure compared to the national budget rests modest, averaging 1.3 percent annually between 2003 and 2011 (refer Figure 3.8). In terms of the categorization of expenditure by environmental theme, a 2001 analysis of distribution of expenditure by environmental theme revealed that biodiversity received the largest share of the budget (55 percent) followed by regulation / environmental assessment (22 percent), water and forest resources (14 percent) and soil and water management (9 percent). No comparative data is available for recent years, although biodiversity (protected areas) and forestry remain the main expenditure targets and the main use of external financing from donors as

[180] ONE, 2010

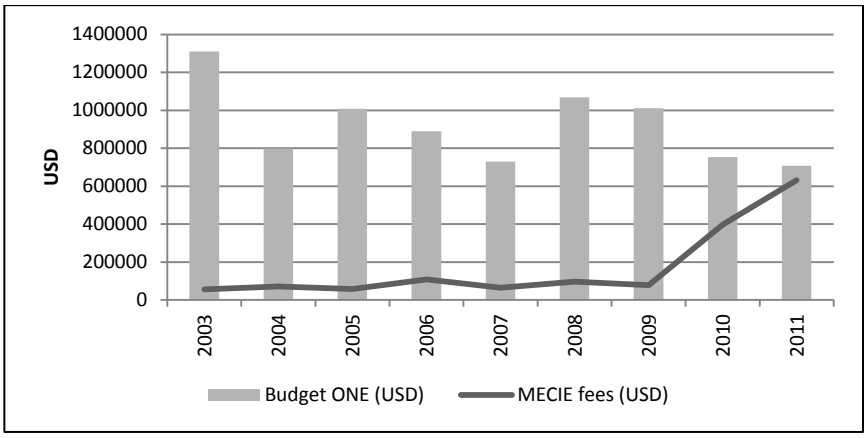
evidenced by the dominance of Madagascar National Parks' budget in the sector and its majority share of external assistance to the sector.

Figure 3.6: Evolution of ONE financing sources 2003 - 2011



Source: ONE / World Bank study team

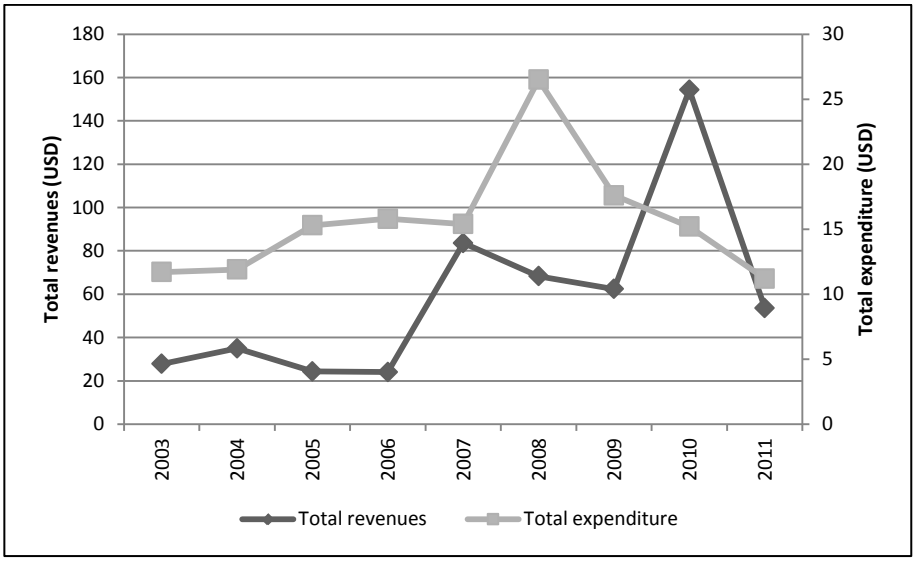
Figure 3.7: Relationship between ONE budget and MECIE fees 2003 - 2011



Source: ONE / World Bank study team

Environment expenditure as a percentage of GDP provides an indication of the share of income the country is willing to devote to environmental purposes. It reflects the priority assigned to the environment in a country's economy subject to what it can afford. In Madagascar, environmental spending as a proportion of GDP has decreased from a peak of 0.9 percent in 1999, to an average of 0.25 percent in the period between 2005 and 2008. Following the commencement of the political crisis, environmental spending dropped to just 0.1 percent of GDP in 2011, well below the internationally recommended ratio of spending as a proportion of GDP of 1 percent. By way of comparison a conservative estimate puts the costs of environmental degradation at 9 to 10 percent of GDP. While global figures are patchy, some estimates cite a range of 0.5 to 1.5 percent for the proportion of environmental spending as a function of GDP in developing countries; values that are significantly higher than in Madagascar despite the global importance of the country's natural resources and in particular its biodiversity.

Figure 3.8: Evolution of environment sector expenditure against GDP and national budget



Source: MFB / World Bank study team

IV. Suggestions for Improved Governance in the Environment Sector

This section summarizes the main pillars for future environmental governance reform derived from the preceding analyses, and is structured around the elements of good governance introduced at the beginning of the chapter. It also contains conclusions relating to the management and use of environment sector revenues and expenditure to support good governance in the environment sector. The discussion contained in this section can be used to inform debate and dialogue between Government, civil society and development partners in relation to future reform efforts.

Reform Pillar 1 - Audit of policy, institutional and legal frameworks for key issues and technical support for improvement: Detailed analyses of the governance frameworks of key issues in the sector will allow concrete recommendations to be made and options presented to Government during future policy dialogue to underpin future governance support. Key issues for more detailed consideration include forestry and forest product exploitation, climate change adaptation, carbon finance, protected area management and environmental regulation (specifically the implementation of the MECIE). Central, sectoral and decentralized agencies would be included in the audits. The results of these audits could be used as a basis for discussion with the Government to find opportunities to: (i) better harmonize the existing capacities and resources through improved coordination of actions, programs, and projects that would enhance the overall environmental management system of Madagascar; and (ii) identify targeted areas for additional support.

Reform Pillar 2 - Technical support for transparent international auction process for seized illegally logged precious timber: The Government has committed to disposal of seized timber stocks that were illegally exploited. As discussed above, the benefits of such a disposal will only be realized if it is carried out in accordance with certain conditions. The World Bank is currently providing technical support to inform the Government of Madagascar's decision making on viable options for disposing of accumulated stocks of illegally harvested rosewood, as well as the preparation of a framework to minimize the re-occurrence of this situation in the future.

Reform Pillar 3 - Capacity building of judiciary, administration and civil society in relation to the enforcement of environment sector legislation and the roles, rights and responsibilities of these parties: Improvements to the legislative framework will only be effective if efforts are made to improve the means of enforcement. Strengthening of the capacity of all parties involved in the application of environmental legislation is required ranging from the judiciary to technical field agents. In addition, environmental justice and information needs to be taken to the people; physical distances and complex procedures mean that access to justice and the 'rule of law' is effectively limited to a subset of society. Procedures need to be less complex and in line with the

capacity of local communities to become meaningfully involved in environmental action and mechanisms such as traveling courts and/or reopening of local courts need to be supported. Efforts are particularly needed to clearly define and strengthen the role of civil society in the legal system.

Reform Pillar 4 - Policy dialogue with Government on change of legal status of ONE and future sources of financing: The legal status of ONE should be reconsidered in light of the incongruity between its current status as an EPIC and its mandate to enforce a regulatory function. As an EPIC, ONE does not generate adequate revenues to cover its costs and experiences recurrent financing gaps; between 2003 and 2011, the budget of ONE accounted for an average of 6 percent of annual spending in the environment sector. There is thus also a need for dialogue with Government to identify sustainable sources of financing to be developed for this organization.

Reform Pillar 5 - Policy dialogue with Government on functioning of MNP and future sources of financing: The budget of Madagascar National Parks represents a significant proportion of the environment sector budget - an average of 37 percent of the annual expenditure between 2003 and 2011 - and is met primarily through external assistance. Out of all the organizations in the sector, Madagascar National Parks accounts for the largest proportion of expenses; the budget of Madagascar National Park is financed predominantly by the World Bank that contributed in the order of 50 percent of operational costs before the political crisis, and approximately 80 percent following the onset of the crisis, and the subsequent withdrawal of other financial partners. Dialogue is required with the Government to investigate the feasibility of a change in the statutes of Madagascar National Parks that: (i) allow continued financial and administrative autonomy of Madagascar National Parks and fulfillment of its role as protected area manager; (ii) facilitate clearly defined relationships with the Government as the owner of the national parks assets; and (iii) ensure that Madagascar National Parks continues to enjoy the required flexibility to manage its own financial and human resources without undue or unwanted interference from government bodies.

Reform Pillar 6 - Support to benchmarking of MECIE legislation to international best-practice: The revision of the MECIE legislation is required to bring it up to date in terms of the types of developments that are underway in Madagascar, and advances in international best practice in environmental assessment over the last decade. Box 3.2 provides specific recommendations for issues to be addressed in such a revision.

Reform Pillar 6 - Support to Government for the generation of robust environment datasets that are widely and freely available to interested parties. Development of standardized indicators and data collection methodologies, as well as technical resources to collect and share data would aid Government to generate and disseminate information in relation to key environmental issues. Development of a national environmental monitoring network and collaboration with civil society would be important elements of such an approach.

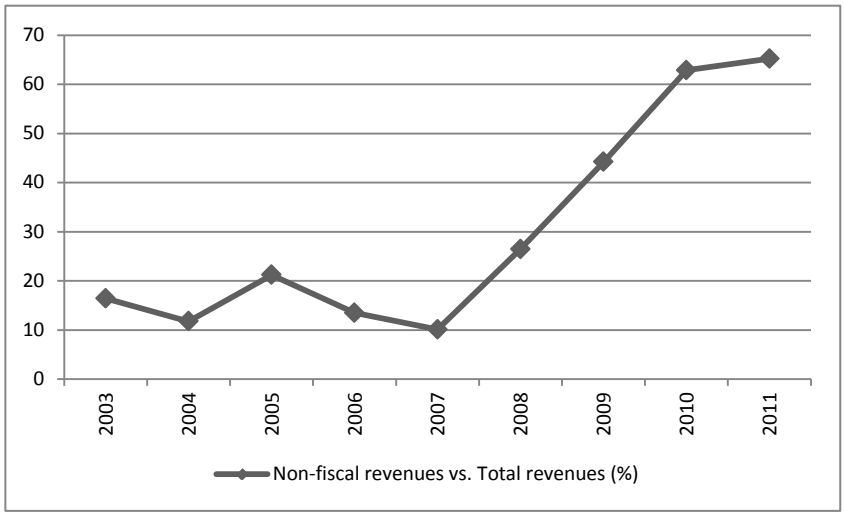
Reform Pillar 8 - Support to civil society that builds on improving access to and dissemination of information and mechanisms for benchmarking Government performance: Mechanisms are required to support civil support and increase its role as an independent voice within the sector[181]. Key principles of such support should include: (i) a focus on support that is 'organic' i.e. that helps domestic actors learn by doing and which builds on existing political and civil society structures; and (ii) a focus on support that is 'experimental' i.e. that is structured for careful monitoring and assessment of impact. Examples of the type of support for which there is evidence of success, and that may be suitable for consideration in the Malagasy context, include support for information related initiatives, including support to local organizations to access, process and disseminate information, and support for benchmarking of Government performance.

Reform Pillar 9 – Support to development of policy mechanisms to better capture non-fiscal revenues and to earmark environment and natural resource revenues for use in the sector: Once external development assistance is removed from the calculation, environmental revenues generated by the sector are outstripped by environmental expenditure. Between 2003 and 2011, total revenues of approximately US$40 million were generated, compared to total expenditure of US$140 million. Earmarking of environmental revenues for use in the sector is limited and occurs only through non-fiscal revenues that are generated by Madagascar National Parks and ONE that are re-injected into the budgets of these organizations. The contribution of non-fiscal revenues to the overall revenues has traditionally low but the ratio has increased in recent years due to the

[181] This discussion is drawn from Devarajan et al, 2011.

revenues generated by exploitation of precious timber in recent years. The contribution of non-fiscal revenues has historically not been consistent and is heavily influenced by exceptional circumstances, meaning that budgetary planning cannot assume a constant contribution from these revenues; a situation that is true for many other sectors in Madagascar. The low contribution of non-fiscal revenues in the environment sector to the national budget belies the presence and rate of exploitation of the country's significant natural resources. Proper capture of non-fiscal natural resource revenues would allow the environment sector to contribute a greater share to the national budget.

Figure 3.9: Evolution of contribution of non-fiscal revenues to total revenues



Source: MFB / World Bank study team

Finally, the adage 'what is not measured cannot be monitored' applies to the economic and financial functioning of the environment sector. The problems encountered in terms of data availability due to the current political situation add to inherent and long-term problems in data collection and treatment in the sector. For example, regional budgets, EPIC organization budgets and budgets of independent but closely linked organizations such as Madagascar National Parks, are not included in the overall budgetary database. Accessing these data requires significant efforts and consultations with a number of different organizations and there are inconsistencies in the resulting datasets. If monitoring of economic and financial data in the sector is not carried out in a transparent and coherent manner, then there is no means of ensuring that spending aligns with national sector priorities, and the accountability of decision makers who allocate budgets is greatly reduced. The challenges of lack of data and poor data management are compounded by limited capacity of personnel in the sector in financial management and reporting.

Chapter 4: Analysis of Selected Environment Sector Public Policies

Chapter 4 of the CEA presents a detailed analysis of the four priority environment-development issues identified at the end of Chapter 2: (i) sustainable financing of the protected area network; (ii) planning for climate resilient development and institutions; (iii) environmental regulation of the mining sector; and (iv) implementing improved cookstoves for improved indoor air pollution. At the end of each discussion, suggested directions for improvement are presented and are revisited in Chapter 5 as part of the process of identification of future interventions for the World Bank in the environment and natural resources sector.

I. Sustainable Financing of the Protected Area Network

Protected areas have long been the conservation tool of choice for Government and NGOs to preserve Madagascar's unique natural heritage. A large national protected area network has been established, but its financial needs are significant. Despite past investments by a number of external partners, the future sustainable financial management of the protected area network is not yet guaranteed. The IUCN defines protected area financial sustainability as "the ability to secure sufficient, stable and long-term financial resources, and to allocate them in a timely manner and in an appropriate form…to ensure that protected areas are managed effectively and efficiently with respect to conservation and other objectives"[182], and identifies a number of elements that contribute to successful sustainable financing of protected areas including development of a diverse funding portfolio, consideration of indirect and opportunity costs, and ensuring the protected management systems are structured to operate in a cost-efficient manner that allows for long term planning and financial security. This section of the CEA analyses the existing and future situation of Madagascar's protected area network and suggestions for priority actions to improve sustainable financing of the network.

1. Description of Madagascar's Protected Area Network[183]

Following the announcement of the Presidential 'Durban Vision' in 2003, which committed the country to a tripling of the protected area surface in the following decade, the expansion of the protected area network has been rapid and impressive. The network has increased from 46 protected areas covering less than 3 percent of the national territory in 2003 to 144 protected areas covering 12 percent of the country's surface today (refer Figure 4.1). With nearly 6.9 million hectares now covered by protected areas, Madagascar ranks above global and regional averages for the proportion of national territory covered by protected areas[184].

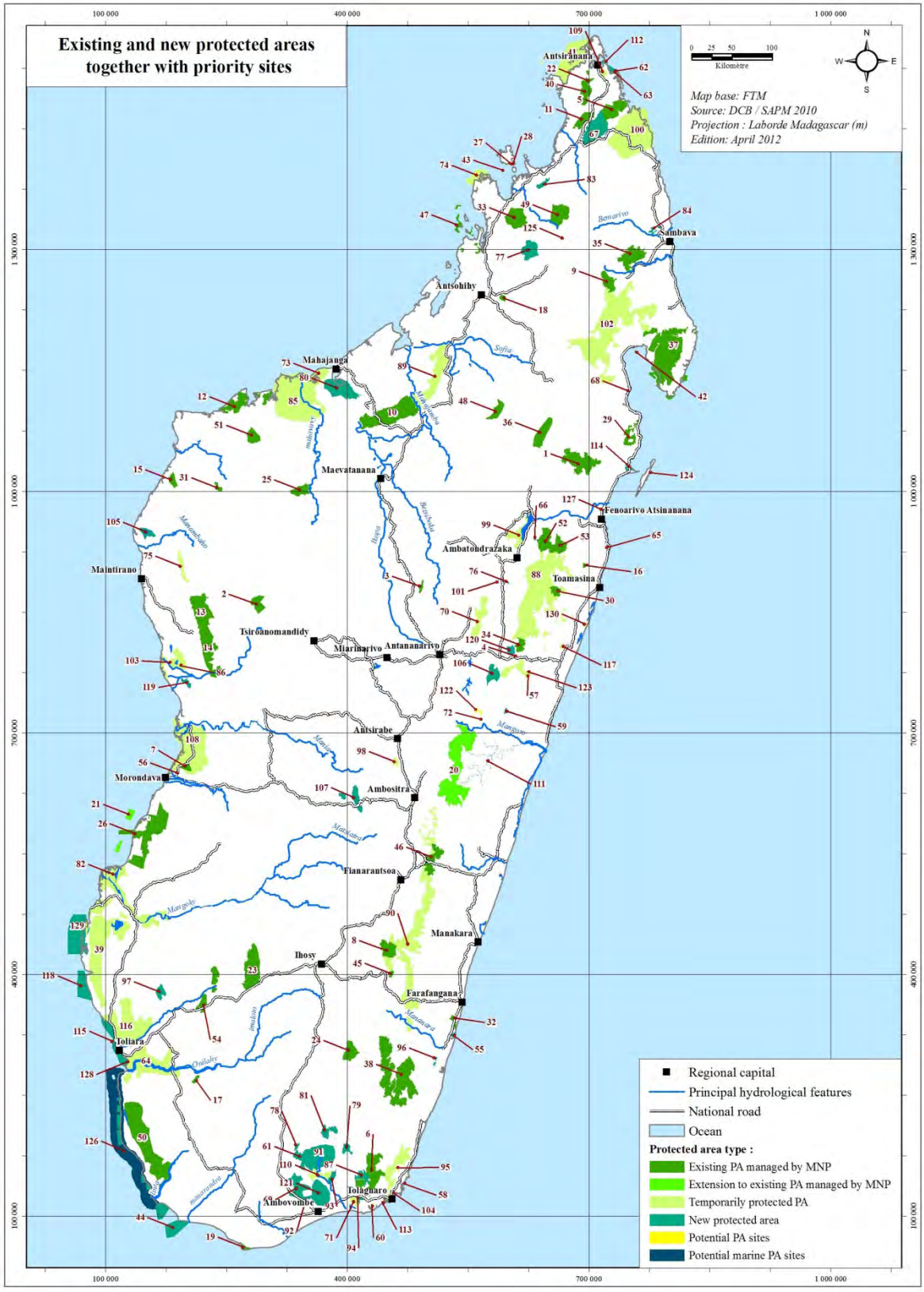
In addition to these protected areas, a biodiversity modeling and prioritization exercise in 2008 identified an additional 12.2 million hectares that have potential to become protected areas in the future. This includes 4.5 million hectares of potential terrestrial protected areas and 5.3 million hectares of potential marine protected areas. These additional areas are included in the official statistics and in Inter-ministerial Order 52005/2010 that affords them protection from a range of activities, but they are true 'paper parks' as there is no physical protection or enforcement of their boundaries and as such, these sites are not included in the analyses described below.

[182] Emerton et al, 2006

[183] The statistics on the national protected area network presented below are taken from the Inter-Ministerial Order 52005/2010. A comparison of data contained in this Order with a national protected area database (REBIOMA) indicate that the Order may underestimate the surface of the protected area by roughly 14,000 hectares due to inaccuracies in the GIS database and inconsistencies in naming of protected areas. For the purposes of this discussion the data contained in the official Order are used, and it is noted that the difference between the two datasets is less than 1 percent of the total network surface and is thus insignificant for the purposes of the current discussion.

[184] The global average and regional average for Sub-Saharan Africa are both 9.42 percent of national territory; the average across all developing regions is 10.36 percent (UNEP-WCMC, 2011)

Figure 4.1: Madagascar's Protected Area Network (SAPM)



Source: Agreco, 2012
Note: Refer Annex 4 for key providing protected area names

The national protected area network is comprised of several different types of protected areas. The 144 protected areas in the national network can be categorized as shown in Table 4.1. These include 44 protected areas managed by Madagascar National Parks, five extensions of Madagascar National Parks protected areas[185], 24 protected areas with temporary protection status under the provisions of the COAP that are awaiting granting of permanent protection status, and 71 new protected areas (NAPs) that are in the process of creation and that have not yet obtained temporary protection status under the COAP. Apart from four protected areas that are being created by Madagascar National Parks[186], protected areas in the latter two categories are being developed and managed by NGOs on behalf of the Government. No temporary or permanent protection status permits have been granted by the Government since the onset of the political crisis in 2009.

Table 4.1: Overview of Protected Areas Types and Surfaces from Decree 52005/2010

Protected Area Category	Description	No. of PAs	Surface Covered (million ha)
MNP managed protected area	Established protected area with permanent protection status under the COAP	44	2.11
Extension of MNP managed PA	Proposed extension of MNP managed protected area, without permanent protection status at the time of writing.	5	0.28
Protected area with temporary protection status	Protected areas, the majority of which are managed by NGOs, that have temporary protection status under the COAP and are awaiting granting of permanent protection status	24	2.57
New protected area (NAP)	Protected areas, that are being developed by Madagascar National Parks (4 protected areas) or NGOs, and are in the process of applying for or awaiting temporary protection status under the COAP.	71	1.95
TOTAL		144	6.91

Source: Agreco, 2012

In terms of IUCN categories, there are distinct differences between the protected areas managed by Madagascar National Parks and those managed by other organizations. All Madagascar National Parks-managed protected areas are categorized as IUCN categories I, II and IV, and since the late 1990s no new category IV protected areas have been created. Non-Madagascar National Parks managed protected areas are most commonly categorized as IUCN categories V and VI, with lesser numbers of categories II and III (refer Box 4.1 for a description of IUCN categories).

A range of organizations are involved in protected area management and creation: these include the Ministry of Environment and Forests (MEF), Madagascar National Parks and a number of conservation NGOs. While the State, through MEF, has ultimate control over the protected area network, the Government has set in motion a process whereby non-State entities (including NGOs and the private sector) can receive a delegated authority to manage a protected area on behalf of the Government. This process was established in recognition of the fact that it would be impossible for the State alone to manage the full network. Madagascar National Parks currently has delegated management of 44 protected areas, and two conservation NGOs - WCS and Conservation International - have recently received delegated management authority for three large protected areas: Makira, CAZ and COFAV respectively.

A key characteristic of the national protected area network is the important role that local communities play in terms of natural resource management and in co-management of the protected area. As noted, recently created protected areas have commonly applied IUCN Protected Area Categories V and VI that promote ongoing resource use by local communities. The establishment of community based natural resource

[185] Extensions of MNP managed protected areas are counted in a separate category as they do not yet have the same formal protection status as the original protected areas.
[186] These are Sahamalaza National Park, Mikea National Park, Nosy Hara National Park and Nosy Ve National Park.

management contracts in the buffer zone of protected areas and the establishment of different models of community co-management are commonly applied tools. All non-Madagascar National Parks protected areas include a community development / resource use zone in their management plans, the majority of these protected area include this zone within the protected area boundaries[187]. The current network thus represents an evolution away from traditional notions of externally managed National Parks that formed effective islands within the larger socio-economic landscape to an increased focus on local community management and use of protected areas.

Box 4.1: Overview of IUCN Categories for Protected Areas

Category & Description

Ia Strict Nature Reserve: strictly protected areas set aside to protect biodiversity and also possibly geological features, where human visitation, use and impacts are strictly controlled and limited.
Ib Wilderness Area: usually large unmodified or slightly modified areas, retaining their natural character and influence without permanent or significant human habitation, and managed so as to preserve their natural condition.
II National Park: large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area; provide environmentally and culturally compatible, spiritual, scientific, educational, recreational, and visitor opportunities.
III Natural Monument or Feature: set aside to protect a specific natural monument, generally quite small protected areas and often have high visitor value.
IV Habitat/Species Management Area: aim to protect particular species or habitats and management reflects this priority.
V Protected Landscape/ Seascape: the interaction of people and nature over time has produced an area of distinct character with significant, ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values.
VI Protected area with sustainable use of natural resources: conserve ecosystems and habitats together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in a natural condition, where a proportion is under sustainable natural resource management and where low-level non-industrial use of natural resources compatible with nature conservation is seen as one of the main aims of the area.

Source: Adapted from http://www.iucn.org/about/work/programmes/pa/pa_products/wcpa_categories/

2. Current Costs and Financing Sources of the Protected Area Network

The overall management cost of the network – including both protected areas managed by Madagascar National Parks and those managed by other organizations – in 2011 was US$18.9 million. This equates to an average per hectare cost of US$2.74 per hectare per year for a network size of 6.9 million hectares. Comparison with international experience shows that the costs of protected area management in Madagascar are comparable with those in other countries (refer Table 4.2).

Table 4.2: Comparison of Protected Area Management Costs in Madagascar and Globally

Location	Average Existing Cost of Protected Area Management (US$/ha/year in 2011)
Madagascar – MNP protected areas	3.00
Madagascar – non-MNP protected areas	2.57
Madagascar - average	2.74
Developing countries – global average	1.5
Developing countries – Central and Western Africa	1.38 to 3.36

Source: Adapted from Agreco, 2012

The portion of the network managed by Madagascar National Parks had a total cost of US$8.4 million in 2011, or an average cost of US$3.00 per hectare per year, based on a surface of 2.82 million hectares. The actual costs engaged by Madagascar National Parks varied in the period 2004 to 2010 and were considered to be largely inferior to the budget required for effective management of the network. The budget of 2011, which

[187] Agreco, 2012

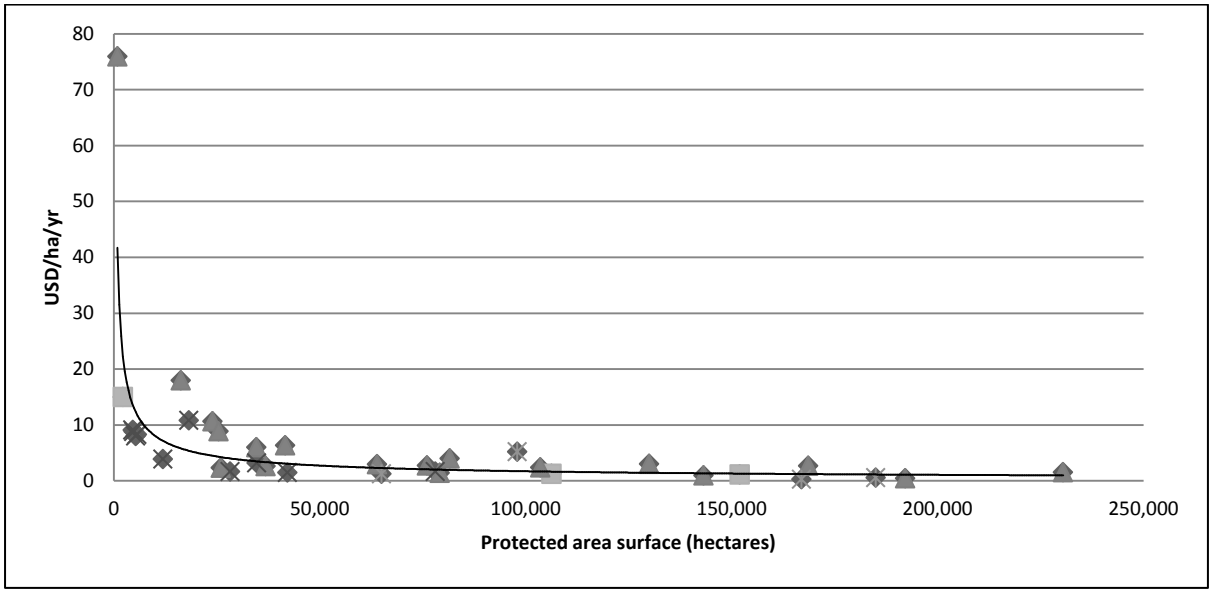
is considered to be more in line with the real needs of the network, was thus adopted as the basis for the analysis of existing costs.

Protected areas managed by organizations other than Madagascar National Parks had a total cost of approximately US$10.5 million in 2011, based on a network size of 4.09 million hectares, which represents an average cost of US$2.57 per hectare per year. Costs for management of protected areas outside of the Madagascar National Parks part of the network vary significantly depending on the stage of creation of the protected area with costs increasing throughout the creation process; the above analysis reflects the fact that the majority of non-Madagascar National Parks managed protected areas are in the early stages of creation.

The costs of the protected areas in Madagascar are not homogenous across the network. A 2003 study found that, globally, the largest influence on variation in protected area management costs was the protected area size[188]. This trend holds true in Madagascar where the surface of the protected area is the most important influence on management cost for all types of protected areas[189]: Smaller protected areas cost more to manage on a per hectare basis than larger protected areas (refer Figure 4.2). Tourism is another important influence on the cost of protected area management; protected areas that attract higher numbers of tourists have a higher management cost per hectare than those with low or no tourism visitation: Madagascar National Parks protected areas that do not have tourism have an average management cost of US$1.89 per hectare per year which is nearly 40 percent lower than the average per hectare management cost[190]. The type of ecosystem and the level of threat to the protected area do not change the management costs in a significant way[191].

The existing sources of financing for the protected area network can be categorized as (i) direct or indirect external assistance; and (ii) capture of network generated economic benefits. Direct and indirect external assistance includes Government, donor and NGO financing to the protected area network and contributions to the FAPBM, a national conservation trust fund. Capture of network generated economic benefits has focused to date on tourism and carbon stocks.

Figure 4.2: MNP Protected Area Managements Costs in relation to Protected Area Surface



Source: Agreco, 2012

Direct external assistance is currently the most important source of financing for the protected area network contributing approximately 92 percent of network costs. Madagascar National Park is financed

[188] Bruner et al, 2004
[189] Agreco, 2012
[190] Agreco, 2012
[191] Agreco, 2012

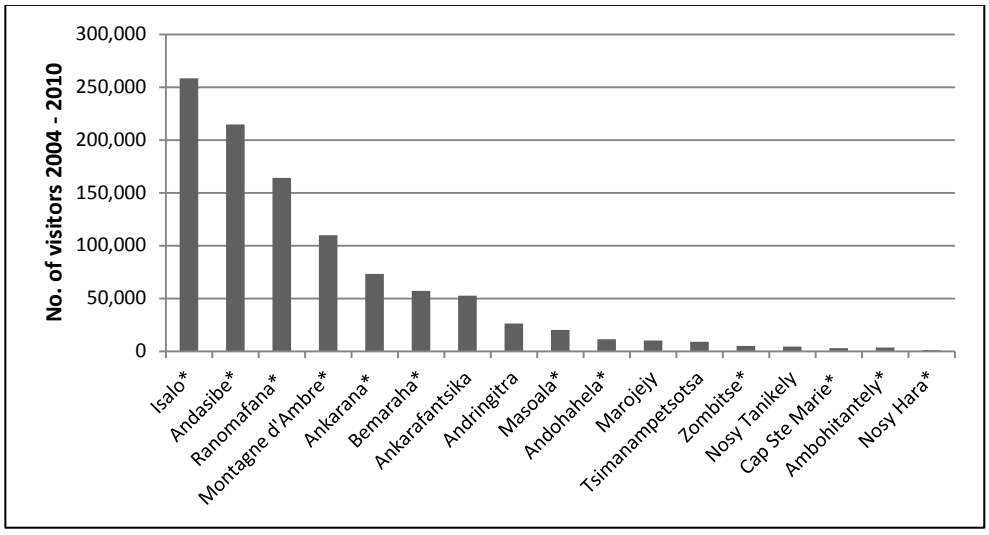
predominantly through the EP3; between 2012 and 2015, the EP3 will contribute approximately $US4.8 million per year to Madagascar National Parks for protected area management costs, representing approximately 64 percent of its management costs[192]. For protected areas outside the Madagascar National Parks network, NGOs, other donors, and private Foundations are the mains sources of funding.

Indirect external assistance is generated through the Madagascar Foundation for Protected Areas and Biodiversity (FAPBM), an autonomous conservation trust fund created in 2005, which is a central component of the country's strategy for sustainable financing of the protected area network. In 2011 the Foundation supported the partial recurrent costs of six protected areas from its endowment fund. The mandate of the Foundation states that it is a co-financer of protected areas with a focus on supporting recurrent management costs. The Foundation has a prioritization procedure in place that considers the biodiversity value as well as the financing gap experienced by various protected areas in selecting those protected areas that it will support. The 2012 disbursements of the Foundation increased to approximately US$1.0 million per year and provide partial support to 15 protected areas covering 1.6 million hectares.

Efforts have been made to establish sustainable financing mechanisms based on a sub-set of the economic benefits generated by protected areas, namely tourism and sales of carbon credits on the voluntary market. Tourism to Madagascar's protected areas generated direct revenues of US$1.05 million in 2010, and indirect revenues in the forms of salaries of guides and induced employment opportunities of over US$5 million, although repeated cycles of political instability have had significant negative impacts on tourism sector growth. Nature based tourism, and in particular tourism associated with protected areas, is the leading sub-sector of tourism activity in Madagascar: Over half of visitors in a 2000 visitor survey had chosen their travel in function of the ability to take part in ecotourism activities. In 2010, in the order of 110,000 tourists visited Madagascar's protected area network; despite the ongoing political crisis this figure was near the maximum visitation level of 130,000 recorded in 2008. The country has a high rate of return of visitors and relative long average stay duration – both factors which contribute to the potential economic benefits of the sector.

Tourism activities in protected areas are concentrated in a small number of zones; between 2004 and 2010, six protected areas attracted more than 90 percent of visitors. Across the network, there are 13 protected areas that attracted more than 500 visitors and within this group there are distinct sub-groups; a small number of well-established and highly visited protected areas that between 2004 and 2010 attracted more than 100,000 visitors each; a group of protected areas with average visitation – roughly 20,000 to 70,000 between 2004 and 2010; and a group with low visitation ranging from several hundred to 10,000 visitors over the seven year period.

Figure 4.3: Tourist Numbers in Madagascar's Protected Areas from 2004 to 2010



* Indicates a protected area supported by the World Bank funded EP3
Source: Madagascar National Parks

[192] World Bank, 2011c

Economic rents generated by ecotourism in Madagascar are potentially high compared to other tourism rents because of the unique nature of the tourism experience. Rents from tourism in Madagascar are captured through entry fees to protected areas and in the form of visa fees and hotel taxes; the revenues generated by these latter sources are not earmarked for conservation purposes (refer below). Fifty percent of visitor entry fees are earmarked for protected area management and the remainder is distributed to local communities for development projects.

Sales of carbon are a less well-developed source of revenue for protected areas than tourism in large part because of governance issues. In 2008, US$600,000 was generated for the Makira Carbon Company[193] from the pre-sale of carbon credits generated by the Makira NAP. Other agreements that have allowed promoters of new protected areas to receive 'donations' from the private sector in exchange for future carbon sales have been reached; but the extent and nature of these agreements is not known. The current political crisis in Madagascar has proved a significant obstacle to advancement of sales of carbon credits on the international market as discussed in Section 3.II.1.

The financing gap experienced in Madagascar is typical of developing countries: A 2004 analysis estimated a funding shortfall of US$1 – US$1.7 billion per year across the developing world for assuring the management of protected areas[194]. Average current spending on protected areas in developing countries ranges from US$0.05 to US$3.00 per hectare, while actual needs range from US$0.90 to US$9.00 per hectare[195]. Examples in other countries with similar protected area coverage to Madagascar, in Congo, Cameroon and Ghana available protected area financing is between 20 and 45 percent of actual needs[196]. This analysis highlighted the fact that it is not enough to simply declare new protected areas, but equally important is the need to ensure that sustainable and long-term sources of financing are available to assure their management, a task that falls into the mandate of a range of Government, donor and civil society organizations[197].

At a global level, the type of funding available to protected areas has also changed and is not necessarily always appropriate to the needs of protected areas. Much protected area finance is structured around short-term project life cycles and targeted towards capital investment; financing ongoing management costs is a much less attractive use of funds for many donors – the World Bank being a notable exception through the EP3 project. In addition, funding is increasingly tied to a focus on poverty reduction and economic development rather than strict biodiversity conservation activities, thus constraining the uses to which it can be put[198]. This trend highlights the need for future Bank assistance to strike a balance between conservation and development objectives, and adopt solutions to support local communities that maintain at their core biodiversity conservation objectives.

3. Future Costs and Financing Sources for the Protected Area Network

By 2013, the costs of the protected area network are expected to increase by 55 percent to US$23.0 million per year. The Madagascar National Parks portion of the protected area network is expected to increase in cost from US$8.4 million per year to US$9.6 million per year (or US$3.36 per hectare per year). The non-Madagascar National Parks managed portion from US$10.5 million per year to US$13.4 million per year (or US$3.36 per hectare per year) as protected areas pass through the stages of creation to become operational protected areas with a higher cost per hectare (refer Table 4.3).

[193] A joint venture between the Government of Madagascar and the Wildlife Conservation Society
[194] Bruner et al, 2004
[195] Bruner et al, 2004
[196] Congo: 9.7 percent coverage, Cameroon: 9 percent coverage and Ghana: 14 percent coverage in 2010 (UNEP-WCMC, 2011)
[197] Hockings et al, 2000
[198] Emerton et al, 2006

Table 4.3: Future Costs of Madagascar's Protected Area Network

Year	MNP Protected Areas		Non-MNP Protected Areas		Total Network	
	Total Cost / Year (US$)	*Cost / ha / Year (US$)*	*Total Cost / Year (US$)*	*Cost / ha / Year (US$)*	*Total Cost / Year (US$)*	*Cost / ha / Year (US$)*
2015	9.6 million	3.36	13.4 million	3.36	23 million	3.36

Source: Agreco, 2012

Tourism will be an important part of the future financing strategy for the protected area network; the network has the potential to generate over US$30 million per year as a result of tourism activities[199]. Activities that increase the attractiveness of the protected area network to tourists will assist in not only increasing tourist numbers, but will render an increase in tourist entry fees feasible. Once fundamental improvements to infrastructure are made in protected areas (for example ecolodge development, improved hiking circuits, and park access), the outstanding nature of the tourism attractions means that current visitor entry fees are be inferior to the willingness-to-pay of (particularly foreign) tourists[200]. Collaboration with the private sector to finance the required improvements to tourism infrastructure will be an essential ingredient to the success of this approach. The EP3 is assisting the Government in this regard by supporting infrastructure improvements in selected protected areas, and facilitating dialogue between Madagascar National Parks and private sector tourism operators in relation to public-private investments.

The FAPBM has significant potential to contribute to the sustainable financing of the protected area network, particularly in light of recent contributions to the endowment fund that have significantly increased the Foundation's capital. To optimize the potential of the Foundation and build investor trust there is a need to ensure transparent and consistent procedures for the allocation of funds both for the protected areas selected and the types of activities that are financed, regardless of the source of the contribution to the Foundation. There is also a need to increase the capacity of the Foundation in terms of fundraising and funds management; the EP3 is contributing to such capacity building.

There is much hope that sales of forest carbon credits will finance protected areas in Madagascar in the future; to date governance issues in Madagascar and the immaturity of the international market have resulted in limited tangible financial returns. Carbon stocks vary greatly by different ecosystem types in Madagascar with recent estimates of 90tC/ha for humid forests and 17tC/ha for dry forests[201]. While there is strong interest in the voluntary market, international negotiations on a formal carbon finance market are proceeding slowly and some commentators do not expect to see a functioning market before 2020. Estimates of the potential benefits to Madagascar from forest carbon transactions should therefore be undertaken in a prudent manner.

The future financial gains from bioprospecting should be more conservatively estimated. Financial returns from bioprospecting are often exaggerated and as more countries enter the market with unique combinations of biological and technical resources for sale, market niches may become smaller, leading to declining profits and conservation incentives. The funds available for bioprospecting are not often used to make direct payments to conservation and private industry and research institutes are unlikely to provide funds for conservation efforts without receiving tangible benefits in return[202]. To date Madagascar has struggled to develop the governance framework necessary to promote and regulate bioprospecting. A number of previous attempts at legislation development have failed and there has been a failure to fully capture economic benefits from bioprospecting activities that have been undertaken by foreign companies within the national territory. The Government is currently developing a national bio-prospecting policy in line with its commitments under the Nagoya Protocol of the Convention on Biological Diversity, and will require support to translate this into legislation and activities.

[199] Adapted from Carret & Loyer, 2003 for the current size of the protected area network and taking inflation since 2003 into account.
[200] For example, foreign tourist entry fees to protected areas are set at US$10 – US$25 per day; a rate well below that of protected areas in comparable countries and below foreign tourists' willingness to pay.
[201] A note of caution must be applied in the interpretation of these figure with respect to the following issues: (i) the calculation is based on broad assumptions about average carbon stocks in different forest types; (ii) only a relatively small proportion of the carbon stocked in Madagascar's protected areas will meet the requirements of the carbon market and be available for sale through carbon credits; and (iii) the process of establishing an international avoided deforestation carbon market will be time consuming, with no guarantee that consensus will be reached even in the medium term on the regulatory framework for such a market.
[202] Emerton et al, 2006

In addition to market mechanisms, additional fiscal policy mechanisms may prove fruitful sources of financing for the protected area network, but further analyses of their feasibility in the Malagasy context is required. Visa fees and a nightly hotel tax are charged for visitors; in 2010 these instruments generated returns of US$2.4 million but there is no earmarking of these funds towards conservation purposes, despite the fact that the vast majority of visitors to Madagascar travel to partake in nature based tourism in the protected areas. Examples of the types of instruments include those that target reinvestment of revenues generated by the sale of protected areas-related products or services (such as tourism) in conservation, or earmarking of a proportion of taxes unrelated to biodiversity or protected areas for conservation (for example use of mining sector revenues for protected area support). Advantages of fiscal policy instruments is the ability to target specific groups or products and the fact that relatively low rates of tax can generate large flows, due to the size of the tax base. Obstacles to their use to date that would need to be overcome include lack of awareness of their potential benefits among protected area managers, lack of data on the economic benefits of protected areas, and the fact that financial and economic planners have not traditionally included environmental goals when they design and implement fiscal systems.

4. Mechanisms for Offsetting Opportunity Costs of Protected Area Network Creation

As well as direct costs of protected area creation and management incurred by protected area management organizations and the Government, local communities have borne opportunity costs through the establishment of protected areas. In economic terms, an opportunity cost is the cost of an alternative that must be forgone in order to pursue a certain action. In the context of Madagascar's protected area network, opportunity costs are most often incurred by poor, rural communities that lose access to land and natural resources upon creation of a protected area. Several investigations, focusing on protected areas in the eastern humid forests of Madagascar, have attempted to quantify the opportunity costs incurred by local communities and identified a range of opportunity cost values of US$353 to US$1400 per household[203]. This amount is significant when viewed in the context of average annual household incomes, which in rural, eastern Madagascar where poverty rates exceed 80 percent are less than US$200 per household[204]. Creation of a protected area thus costs a household, on average, between two and seven years' income. A secondary but important conclusion of these studies was the uneven distribution of opportunity costs for affected households with degree of reliance on natural resources and the value of resources exploited the key factors in determining the degree of impact.

In recognition of the burden placed on local households by protected area creation a range of approaches have been trialed to offset opportunity costs as part of efforts to increase the overall sustainability of the protected area network. The most common approaches that have been used (either separately or in combination) in Madagascar include: (i) community based natural resource management contracts (known locally as '*transfert de gestion*' - TDG); (ii) the compensatory 'social safeguards' approach that was originally developed to fulfill the World Bank's safeguards policies and which is now embodied in national guidelines on protected area creation[205]; and (iii) a livelihoods improvement approach. The costs to protected area managers of implementing these approaches represent, both for Madagascar National Parks and NGOs, the most significant cost in protected area creation[206] and there is thus a need to evaluate these approaches to ensure that they are providing not only benefits for local communities, but value for money for protected area managers[207].

The creation of community based natural resource management (TDG) contracts in Madagascar commenced in earnest in 1999 and since that time in the order of 700 contracts have been created. The majority of these contracts apply to forest resources, although increasingly contracts governing the use of marine and coastal resources are being developed. TDG contracts have been used by NGOs and donors to create 'green belts'

[203] Ferraro, 2002; Hockley & Razafandrilambo, 2006; Shyamsunder & Kramer, 1996; Shyamsunder & Kramer, 1997

[204] Based on average annual income (consumption) for Atsinanana, Analanjirofo and Alaotra Mangoro regions in eastern Madagascar (Instat, 2011).

[205] ONE, 2008

[206] Agreco, 2012

[207] There exists a comprehensive and complex literature on the means of integrating conservation and development objectives through activities undertaken in the vicinity of protected areas, as well as numerous analyses of the benefits and failings of different approaches both in Madagascar and elsewhere. The goal of the following discussion is not to revisit this debate but to describe the approaches that are commonly used in Madagascar and the identification of certain principles that could improve these approaches.

around established and new protected areas with the dual objectives of improving enforcement of protected area boundaries, and delivering benefits to communities through sustainable use of natural resources, alternatives to destructive livelihood practices such as *tavy*, and in some cases, commercialization of natural resources. While seen as landmark legislation both nationally and internationally, more than ten years of experience shows that success rates with TDG contracts have been variable and that a number of principle factors are responsible for this[208].

TDG contracts are initially established for three years, at which time a review is carried out with the aim of developing a ten-year contract. To date, no reviews have been carried out putting the contracts and the resources that are managed under the contracts in a state of limbo; this lack of long term certainty is not conducive to sustainable and forward looking management of resources on the part of communities. Areas that are transferred to communities are zoned to include conservation zones, sustainable use zones and commercial zones. In reality, the importance given to each of these zones varies with some TDG contracts containing no or very small areas of production zones; this limits the ability for communities to generate economic benefits under the contract and thus ultimately the sustainability of the contract. Enforcement of regulations established under a TDG contract is an ongoing problem. Parties to the contract not have formal enforcement powers and Government agents on the ground are far and few between. This limits the ability to enforce regulations in the face of intrusions both by parties from outside the TDG zone, but also villagers that may live inside the zone but not be party to the TDG contract. The policy framework that applied to community based management of coastal and marine resources remains particularly problematic because of lack of consensus on the zones and resources that should be eligible for community management.

The communities that engage in TDG contracts require extensive and ongoing support to enable them to enforce the terms of the contracts, set sustainable quotas for extraction and commercialize products. To date such support has been lacking and some critics have accused the Government and NGOs of looking for a low-cost solution to protected area management that does not generate adequate mutual benefits for communities[209]. While there remains clear potential for TDG contracts to deliver conservation and social benefits, communities need long-term surety in contracts and evidence of tangible economic benefits to ensure that they remain active and engaged partners in the TDG process. Criticisms have been leveled at both Government – for providing inadequate monitoring and enforcement and not carrying out periodic reviews – and NGOs / donors – for jumping on the "TDG bandwagon" and putting in place too many TDG contracts too quickly with appropriate ongoing support. There is extensive literature available on the lessons learnt from TDG implementation in Madagascar and new projects that intend using TDGs as a means of enhancing protected area management while providing community support need to draw on past experiences.

The social safeguards approach of the World Bank had its genesis in the application of the Bank's environmental assessment operating procedures to protected areas created during the EP3. To date this approach, which is based on the identification of households directly affected by protected area creation and the development of micro-projects to compensate for lost income, has been applied by the World Bank to over 25,000 households in the vicinity of eleven protected areas. The social safeguards approach differs from the other approaches described here as it is based on the systematic targeting of directly affected households, rather than being aimed at the village or community level. The approach has only been implemented since 2009 and as such, benefits have not yet been fully realized. Experience to date indicates that in order to optimize the efficiency of this approach, additional efforts need to be made in the identification of micro-projects to ensure their relevance to local conditions, livelihoods and markets, and the scale and duration of accompaniment that is provided to beneficiary households.

The livelihoods improvement approach is a broad term that applies to income generation, economic, health, or other social projects implemented in communities in the vicinity of the protected area network as a means of achieving the conservation objectives of the protected area network. This approach is centered on the assumption that by improving the wellbeing of local communities that are traditionally reliant on natural resources contained in protected areas, they will be induced to reduce their reliance on these resources. Experience in numerous countries, including Madagascar, is that unless such projects are developed with a clear targeting of beneficiaries, are closely monitored and are integrated with enforcement efforts, they have

[208] PGM-E, 2009
[209] Hockley & Andrianmarovololona, 2007

low success rates or even generate effects that are contradictory to the desired outcome. During the EP1 this approach was implemented in the form of 'Integrated Conservation and Development Projects' or the now infamous ICDPs. The effectiveness of ICDPs as a conservation tool in Madagascar (as elsewhere) was roundly judged as inadequate[210]. To prove successful as a means of improving protected area sustainability, the new generation of livelihoods improvements activities, including those to be supported by the World Bank as part of the EP3, will need to build on the substantial experience from previous attempts at integrating community development and conservation objectives to develop and test new operational models and thereby avoid a return to past errors.

II. Planning for Climate Resilient Institutions and Development in Madagascar

One quarter of Madagascar's population, representing 5 million persons, lives in zones at risk of natural disasters and the country has been identified as the second most exposed country in Africa to multi-disaster risks[211]. The country's geographic position and low adaptive capacity – which itself is influenced by high poverty rates, rapid population growth, high dependence on natural resources, and weak institutional capacity - exacerbate the country's vulnerability. A degraded hydro-meteorological monitoring network and poor historic datasets mean that projections of future climate conditions under different climate change scenarios are limited for Madagascar. However the modeling that does exist – including new modeling presented below on future drought conditions – indicates that: (i) the impacts of climate change are likely to be severe; (ii) the impacts are likely to be unevenly distributed; and (iii) the potential for climate change to increase the frequency and/or intensity of extreme climate events – droughts, cyclones and storm surge, is likely to be of significant concern. This section of the CEA presents the available knowledge on climate change impacts in Madagascar, describes the current institutional structure that has been established to manage climate change and the obstacles that this structure will need to overcome to meet the substantial challenges that lie ahead, and identifies a wide range of future directions for reform, including actions that could be supported by the World Bank.

1. Overview of Madagascar's Climate Characteristics and Historic Climate Trends

Madagascar exhibits a high degree of climatic diversity and harbors a large number of microclimates across its territory; characteristics that renders analysis of past and future climate trends complex. The climatic characteristics of Madagascar are influenced by four key factors: the country's geographic position, its topography, the maritime influence, and the prevailing wind patterns. Average annual rainfall varies from 350 mm/year in the semi-arid deep-south, to more than 4000 mm/year in the northeast. In the west and on the central highlands, 90 to 95 percent of annual rainfall falls during the wet season (October to April), while on the east coast there is no clear wet season, but a reduction in rainfall in the period September to October. In the deep-south rainfall is highly erratic from one year to the next, and although precipitation is typically constrained to the wet season between October and April, heavy falls representing nearly all the year's rainfall can fall outside this period. The west coast where average annual temperatures reach 27.5°C is hotter than the east coast with annual average temperatures of 23°C. In the highlands, the climate is temperate and temperature decreases with altitude. Minimum temperatures are observed in July throughout the country and maximum temperatures are observed in January and February for most regions, except the northwest and certain parts of the highlands. On average, three to four cyclones affect Madagascar each year in the period November to April; the northeast, northwest, central-east and west coast are most commonly affected by cyclones.

There is a lack of historic climate data in Madagascar due to an incomplete and degraded meteorological monitoring network, which limits the ability to identify past climate trends. There are only twenty-one functioning synoptic weather stations throughout the country representing on average one station every 18,000 square kilometers. Other types of weather stations - predominantly pluviometers - are located in a non-uniform manner throughout the country and their functionality varies, as does their integration with the national meteorological database. Historic climate data is lacking throughout the country, particularly for the

[210] For example see USAID, 2010
[211] United Nations, 2009

period from the 1990s onwards and particularly in the deep-south where data is practically non-existent[212]. Notwithstanding these limitations, analysis of available data has led to development of a series of conclusions on past climate trends in Madagascar over the last four decades in all regions except the deep-south.

Recent warming trends in Madagascar are in line with global observations; they have manifested predominantly through an increase in the incidence of extreme temperatures[213]. A warming trend has been observed in the south of the country since the 1950s and in the north since the 1970s. Warming in the south has been more intense than warming in the north of the country. Night time temperatures have increased by 0.02°C to 0.04°C per year between 1961 and 2005 throughout the country, except in the west in the vicinity of Majunga where a slight decrease in annual average night time temperatures has been observed. Daytime temperatures increased on average by 0.02°C per year in the north and 0.04°C per year in the south in the period between 1961 and 2005.

The volume of annual precipitation across Madagascar has been highly variable throughout the last century and clear trends in precipitation patterns are harder to define[214]. In the southern zone of Madagascar, but excluding the deep-south for which data is unavailable, trends indicate that an increase in temperature has led to an increase in precipitation, while in the north of the country, the volume of precipitation has tended to increase when temperatures have decreased. During the last forty years, on the East Coast and Central Highlands precipitation in the winter months (June to August) and in the period before summer (September to November) has tended to decrease and the duration of dry periods has increased. Across most of the western part of the country, the intensity of rainfall as measured in terms of millimeters of rainfall per day and per year has tended to increase, while it has decreased in the southeast and northwest.

Over the last twenty-five years the average number of cyclones that have affected Madagascar each year has not changed significantly, but the number of intense cyclones has increased[215]. From 1975 to 1989, 23 cyclones (representing 18 percent of the 127 cyclones during this period) were Category 4 or 5 cyclones[216]; in the period 1990 to 2004, 50 cyclones (representing 34 percent of the 147 cyclones during this period) were Category 4 or 5. Between 1980 and 1993, cyclones affected predominantly the center-east, the center-west and a part of the central highlands and had winds of average speed of 120 kph. Since 1994, cyclones have affected a larger part of Madagascar and the most affected zones are further to the north, with the northeast being particularly severely affected.

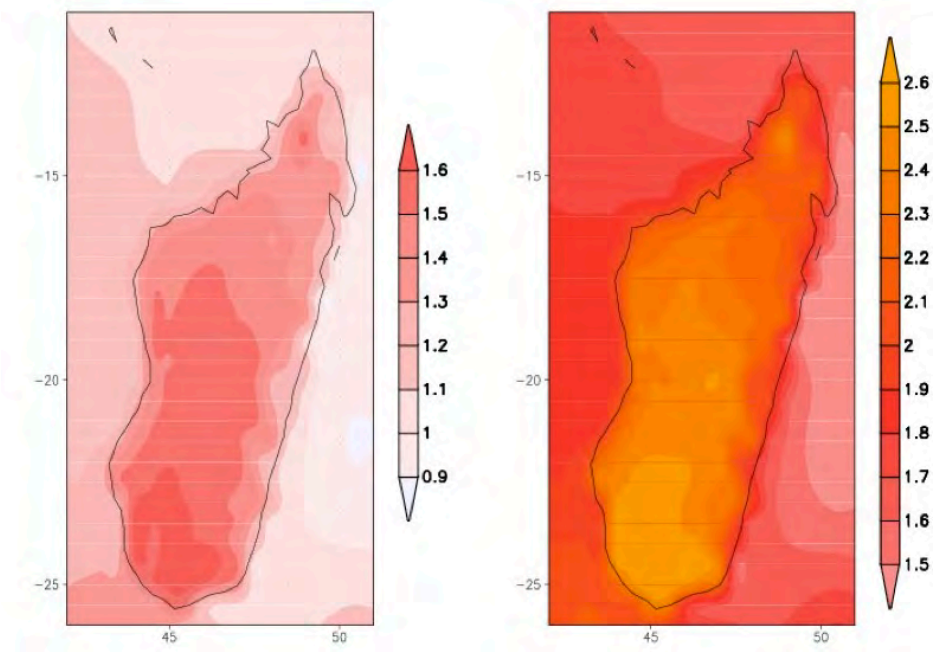
2. Projected Changes in Average Climate and Extreme Events in Madagascar

Temperature and Precipitation

Modeling of future temperature in Madagascar indicates that by 2055 the entire country is expected to experience increasing temperatures when compared to the reference period of 1961 to 1990[217] (refer Figure 4.4). Modeling indicates that the most substantial increases will be in the interior of the country where annual average daytime temperatures are projected to increase by 2 to 3°C. Temperature increases are projected to be less in coastal regions: This lesser increase is most likely explained by higher humidity and cloud cover in these zones that tempers temperature increases. Increases are projected to be higher in winter and early spring than in the summer and autumn seasons.

[212] The deep-south zone refers to the semi-arid zone of the regions of Anosy, Androy and Atsimo-Andrefana, generally between Amboasary-Sud and Toliara.
[213] DGM, 2008
[214] Ibid
[215] Ibid
[216] Category 4 or 5 cyclones are the most intense cyclones and are defined as those with sustained winds of 210 – 249 kph or ≥ 250 kph respectively.
[217] DGM, 2008; IEc, 2012

Figure 4.4: Projected Changes in Annual Average Temperature in 2055 (Scenario A2, 13 GCMs)



(i) Annual average minimum (nighttime) T°C (ii) Annual average maximum (daytime) T°C

Source: Direction Generale de la Meteorologie, 2008

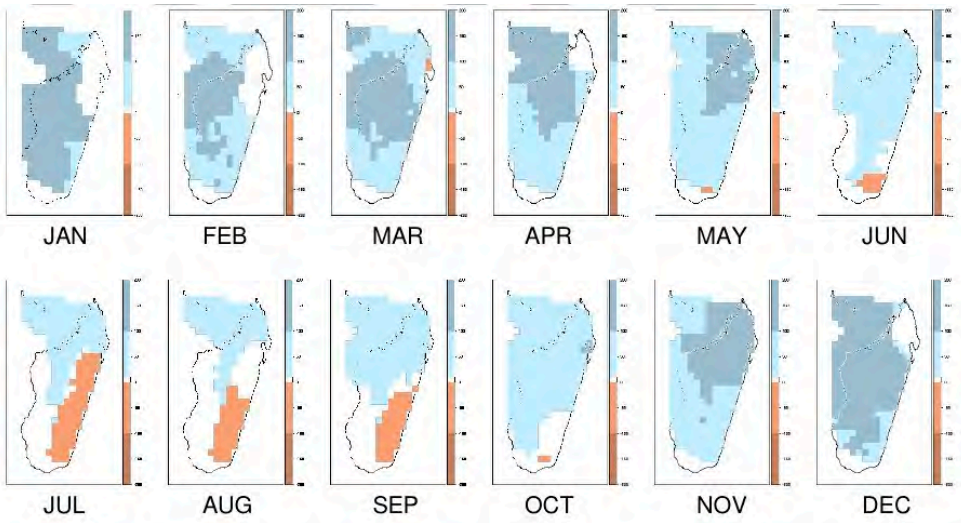
Modeling for future precipitation patterns in Madagascar is less conclusive[218] (refer Figure 4.5). The 2008 data indicate that: (i) between January and April, and in November and December an increase in precipitation is expected across the country; (ii) between May and June, and in October a decrease in the south-east zone is expected and an increase across the rest of the country; (iii) between July and September an increase is projected in the north, northwest and highlands and a decrease in the east and southeast. The 2008 data should be interpreted with caution as they are based on limited historic data and do not allow conclusions on changes in intra-annual or inter-annual precipitation patterns to be reached; an understanding of such patterns is fundamental to the evaluation of the impacts of changes in precipitation. Updated modeling in 2012 generated similar results for most of the country with increased precipitation projected in many high elevation areas and reduced precipitation in many lower elevation areas, and indicated a somewhat more severe drying trend in southern Madagascar than previously forecast[219].

Droughts

Future drought conditions in Madagascar have been modeled across a grid size of 50km x 50km in terms of two drought indices: (i) the Standardized Precipitation Index (SPI); and (ii) the Palmer Drought Severity Index (PDSI) for three, thirty year time periods: 2011 to 2040; 2041 to 2070; and 2071 to 2100[220]. The SPI is a probability index that considers only precipitation and which measures precipitation deviations from the baseline on a monthly basis. A negative SPI indicates drought conditions, while a positive SPI indicates wet conditions. Droughts as measured by the SPI are classified both in terms of their duration (i.e. 1 month, 3 month, 6 month or 12 month droughts) and their severity (i.e. mild, moderate, severe and extreme droughts[221]). SPI droughts are most relevant for rainfall dependent activities such as rain-fed agriculture or municipal supply in certain regions. The PSDI is a drought indicator that is calculated on a monthly scale and uses soil characteristics, precipitation and potential evapotranspiration (based on temperature) data to determine the water balance of a particular region. The index has proven most effective in determining long-term drought over several months rather than in determining conditions over a matter of weeks. It uses a 0 as normal, and drought is shown in terms of negative numbers.

[218] Ibid
[219] IEc, 2012
[220] Data in this section is adapted from IEc, 2012.
[221] Mild drought: SPI = -1.0 to -1.99; moderate drought: SPI = -2.0 to -2.99; severe drought: -3.0 to -3.99; and extreme drought: SPI < -4.0

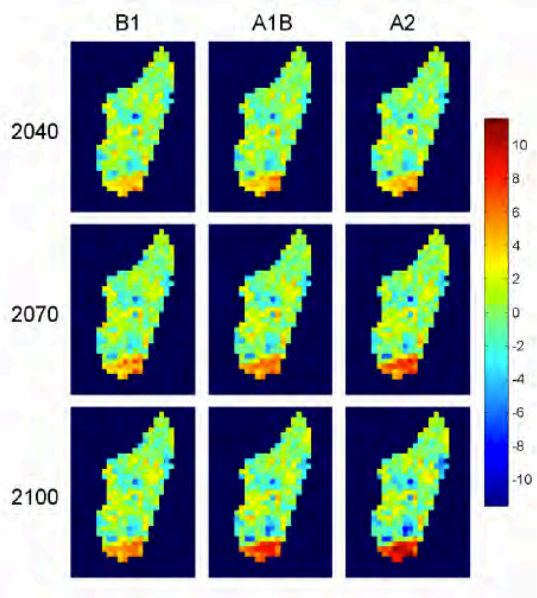
Figure 4.5: Projected Changes in Precipitation in 2055 (Scenario A2, 6 GCMs)



Note: Figure illustrates median changes in monthly precipitation (mm per month) based on the results of six GCMs. Blue areas indicate an increase in precipitation and brown areas indicate a decrease. The white areas indicate those zones where there was inadequate concurrence between the different models to draw conclusive results on future precipitation.
Source: Direction Generale de la Meteorologie, 2008

The combined effects of increased temperature and reduced precipitation in southern Madagascar are projected to result in increased drought severity in this region[222]. Both the SPI and PDSI indices reveal a worsening trend in drought severity in the southern region of the country in coming decades, an area that is already subject to recurrent droughts that are linked to crop failure and food insecurity (refer Figure 4.6). The SPI results also indicate that medium-term (i.e. 3 month) extreme droughts could increase in duration in the west of the country by 2100, an area that to date has not suffered the same degree of drought conditions experienced in the south. In other areas the drought signal is not as clear – for some scenarios and some future time periods worsening drought is projected, while for other scenarios and time periods, drought is projected to decline (refer Annex 6).

Figure 4.6: PSDI Results for Severe Drought



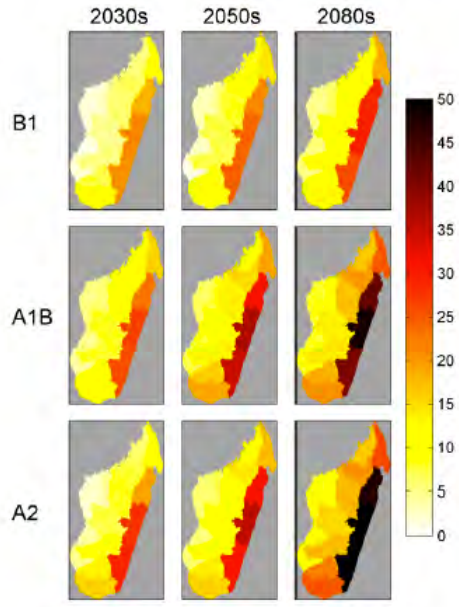
[222] Refer Annex 6 for detailed results of drought projections.

Note: The scale on the right-hand y-axis indicates the increase or decrease in the number of months of drought conditions over the 30-year period in question. On the left-hand y-axis, 2040 represents the period 2011 – 2040, 2070 represents the period 2041 to 2070, and 2100 represents the period 2071 – 2100.

Source: IEc, 2012

A third method of considering future drying and drought trends due to climate change involved analysis of reference crop water deficit, which is defined as the potential evapotranspiration minus rainfall. According to this indicator, areas with zero or low deficits are more likely to support rainfed agriculture. The analysis revealed that the largest increases in reference crop water deficit – i.e. the declines in water available relative to plant demands – are projected to occur in eastern Madagascar where rainfall is currently abundant and which supports large areas of rainfed agriculture (refer Figure 4.7). This drying trend is projected to worsen over time and is more severe for higher emissions scenarios.

Figure 4.7: Percent Change in Reference Crop Water Deficit due to Climate Change



Note: The scale on the right-hand y-axis indicates the percent increase in reference crop water deficit for the three scenarios indicated on the left-hand y-axis, 2040.

Source: IEc, 2012

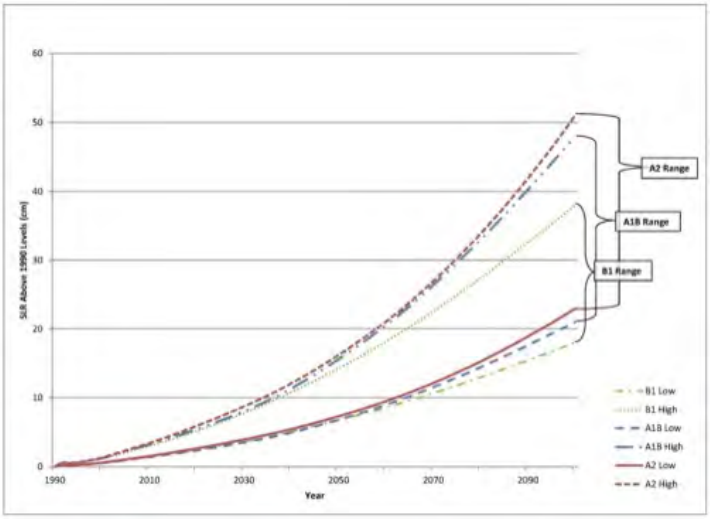
Sea Level Rise

Current research suggests that climate change will accelerate the rate of sea-level rise (SLR) along much of the world's coastlines[223], resulting in flood damages, erosion, wetland inundation, and other ecological losses[224]. In addition, SLR may exacerbate the effects of cyclones and storm surges. As an island nation, Madagascar is vulnerable to both the direct effects of SLR and interactive effects of SLR with other coastal stressors, such as development and pollution. Climate change affects global SLR through the thermal expansion of seawater, melting of land-based ice, and changing ocean dynamics. Calculation of relative SLR also accounts for non-climate changes, such as land uplift and subsidence that vary by location[225]. These types of land movements may occur as the result of tectonic, glacial, or human activity, and they vary significantly with geologic and soil characteristics.

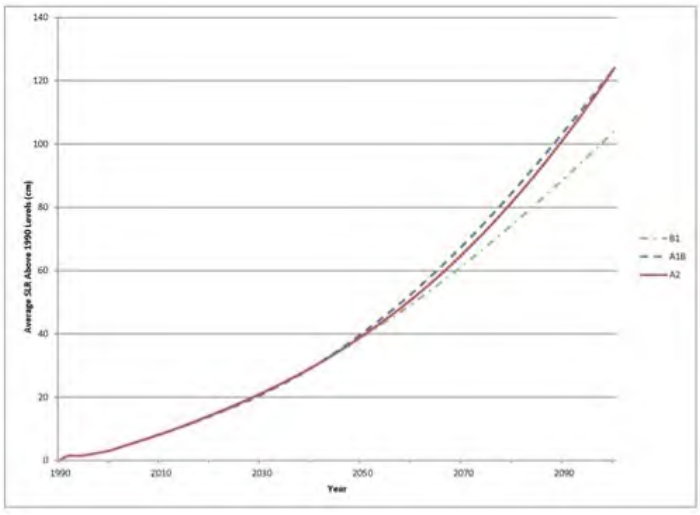
[223] Meehl et al, 2007
[224] CCSP, 2009
[225] Mitchum et al, 2010

Maximum global projections of SLR of between roughly 50 and 120 cm by 2100 have been generated but inadequate data exists to refine these for the specific characteristics of Madagascar (refer Figure 4.8)[226]. Ideally, these global projections would be modified for specific coastlines within Madagascar using tide-gauge data on uplift and subsidence. However, Madagascar has one tide-gauge station in Nosy-Be, and complete annual data for this site are only available for eight years between 1958 and 1972. Thus due to the significant data quality limitations, this trend has not been able to be exploited to generate relative SLR projections. Although publicly available data on relative SLR in Madagascar are poor, additional tide-gauge data may exist in the records of Madagascar's ports or local organizations. If such data exist, land subsidence trends could be estimated and incorporated into relative SLR projections.

Figure 4.8: Preliminary Estimates of SLR using IPCC & Vermeer and Rahmstorf (2009)



(i) Estimates based on IPCC SLR scenarios



(ii) Estimates based on Vermeer & Rahmstorf (2009) scenarios

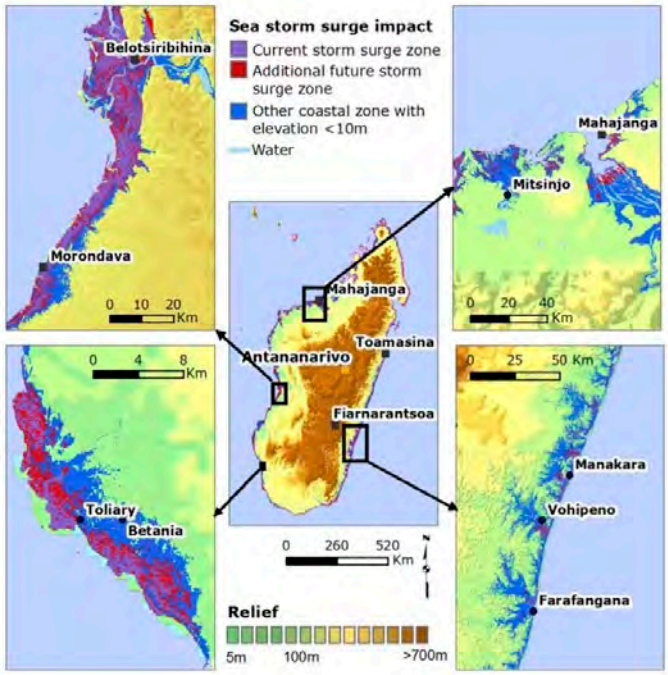
Source: IEc, 2012

To better understand potential impacts of SLR in Madagascar, the effects of a homogenous 1.0m SLR and 10 percent increase in storm surge have been analyzed[227]**.** This analysis indicates that nearly one quarter of Madagascar's coastal urban areas could be exposed to climate change induced sea level rise and

[226] This data is adapted from IEc, 2012. Refer Annex 5 for a discussion of the methodology used.
[227] The IPCC defines storm surge as a temporary increase at a particular locality in the height of the sea due to extreme meteorological conditions: low atmospheric pressure and/or strong winds.

intensification of storm surges. This would place the country in the top ten developing countries worldwide in terms of the proportion of coastal urban extent affected[228]. It is furthermore estimated that Madagascar, along with three other countries (Mozambique, Nigeria and Mauritania) could account for more than half of the total increase in storm surge zones in the Sub-Saharan Africa. Within Madagascar, coastal towns that are the most likely to be affected are Toliara, Morondava, and to a lesser extent, Majunga (all located on the west coast) which together house approximately 730,000 persons representing 3.6 percent of the national population (refer Figure 4.9). Areas on the east coast may be less vulnerable, but include Vohipeno and Manakara. Additional areas at risk may be identified is economic risks are more systematically reviewed or if analyses are conducted to identify the joint risks of SLR and storm surge.

Figure 4.9: Impact of Homogenous 1.0m SLR and 10 percent Storm Surge Increase



Source: Dasgupta et al, 2011

Cyclones

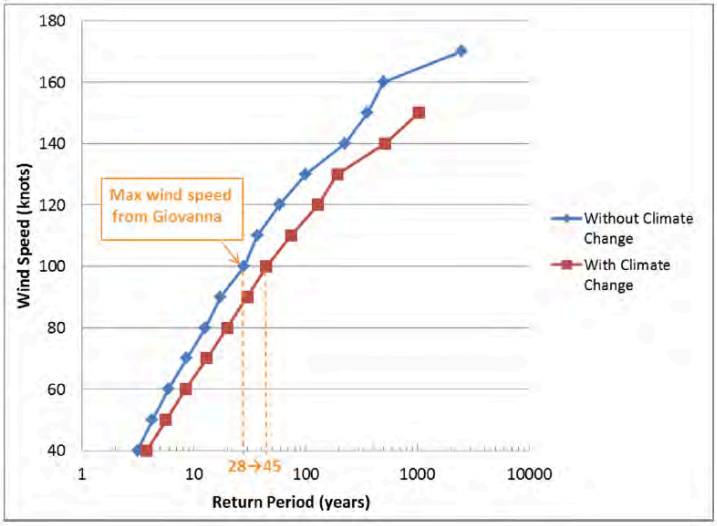
Modeling undertaken in 2008 projected that the total number of cyclones affecting Madagascar is not expected to change significantly by 2100, but in keeping with observations of past trends, the number of intense cyclones is expected to increase[229]. Modeling of 1000 cyclone track simulations using the ECHAM model in 2008 indicated that the number of intense cyclones having winds greater than 200 kilometers per hour is projected to increase from 14 percent to 20 percent of all cyclone events[230]. In addition, the modeling indicated that overall the northern part of the country is projected to more frequently affected by cyclones.

Additional modeling of projected future cyclone events was carried out in 2012 to refine the 2008 modeling by accounting for the effects of vertical shear on storm motion and for advances in quantifying surface exchange coefficients in the storm intensity model[231]. Such changes in the model lead to improvements in the accuracy of both storm tracks and intensities. The refined model investigated cyclone related wind risk under the RCP 4.5 scenario from the IPCC's forthcoming fifth assessment report in two specific areas of the country – Toamasina on the east coast and Majunga on the west coast. The modeling indicates that wind risk associated with cyclones is projected to decrease in these two sample areas (refer Figures 4.10 and 4.11). For example, a storm similar in severity to Cyclone Giovanna, which occurred in 2012, is estimated to occur once every 28 years under the current climate, but is projected to occur once every 45 years under future climate in the

[228] Dasgupta et al, 2011
[229] DGM, 2008
[230] Direction Generale de la Meterologie, 2008
[231] IEc, 2012

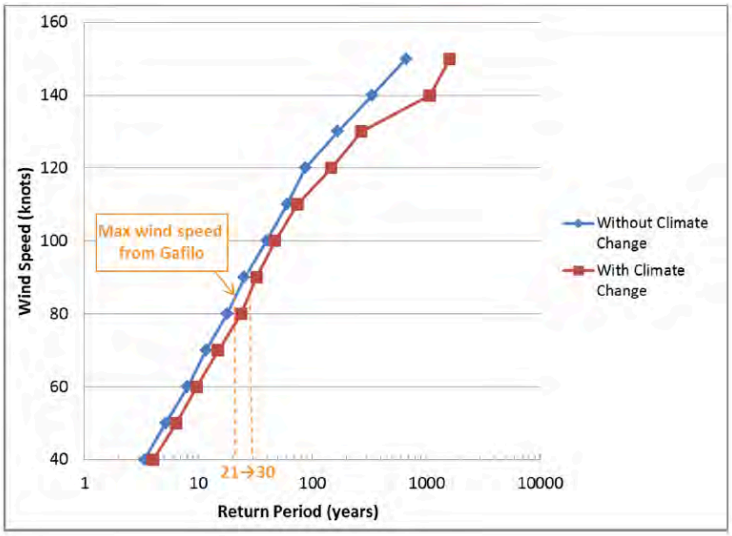
period 2051 to 2100. These results are however based only on model outcomes for one GCM and require further analyses using multiple GCMs.

Figure 4.10: Change in Wind Speed with Climate Change in 2051 to 2100 for Toamasina



Source: IEc, 2012

Figure 4.11: Change in Wind Speed with Climate Change in 2051 to 2100 for Majunga



Source: IEc, 2012

3. Future Economic and Social Impacts of Climate Change in Madagascar

In Madagascar no detailed analyses of the social impacts or economic costs of climate change exist. Consideration of the social and economic costs of past extreme climate events provides an indication of the possible scale of impacts. Since 1990, 41 major events have been recorded that have affected at least 8 million people – more than one third of the current population - and killed at least 1,800. However, statistics on the damage caused by such events are incomplete and it is likely that the real scale of the effects of natural disasters is much higher.

Table 4.4: Summary of Major Natural Disasters in Madagascar (1990 – 2011)[232]

Type of Event	Number of Events	Persons Killed	Persons Affected	Estimation of Damage (US$ million)
Drought	5	200	2,500,000	Unknown
Flooding	5	52	136,000	Unknown
Cyclone / storm	31	1544	5,500,000	600 – 1,550

Source: OFDA/CRED International Disaster Database www.emdat.be

In Madagascar tropical cyclones are the most frequent climate events and the only phenomenon for which historic economic costs have been calculated. Cyclones account for 65 percent of climate related disasters in Madagascar, and on average 250,000 persons are affected and US$50 million worth of damage is caused by each cyclone event. The 2008 cyclone season is considered to have been one of the most severe in recent history and thus provides a proxy for potential future climate scenarios that include projections of an increased number of intense cyclones. In 2008, three consecutive cyclones caused economic losses equivalent to 4 percent of the national GDP and affected 84 percent of the national territory[233]. Losses of US$103 million were experienced in the agricultural sector and damage of US$127 million in the housing and public administration sector, and US$46 million in the transport sector. The combined effects of the cyclones included a decline of 0.3 percent in real GDP growth in 2008, and a 38 percent decline in the balance of payments. Recovery and reconstruction costs were estimated at US$155 million. Damages from the recent 2012 cyclone season, where two cyclones affected Madagascar in short succession, are still being calculated but preliminary estimates indicate damages may rival those experienced in 2008 (refer Box 4.2).

Although no economic analysis of the effects of floods and droughts exists for Madagascar, experience in other southern African countries indicates that the economic impacts of such events can be significant (refer Box 4.3). Flooding is widespread throughout Madagascar and most commonly occurs after cyclones or tropical storms. Between 1990 and 2011, five major flood events affecting more than 135,000 people were recorded; however, these data underestimate the real effects of flooding as they do not account of smaller scale events that can have significant effects on livelihoods and infrastructure at the local and regional level. Between 1988 and 2011, 5 major drought events were recorded that affected at least 2.5 million persons. Each drought event lasted two to three years and occurred against a background of naturally high intra-annual and inter-annual rainfall variability. Of the 104 communes that are subject to drought monitoring in the south of the country, 53 communes with a population of 720,000 people (or 4 percent of the national population) were in a state of food insecurity during the last drought event in 2010.

Box 4.2: Preliminary Damage Estimates from 2012 Cyclone Season

In 2012, Cyclone Giovanna and Tropical Storm Irina made landfall in Madagascar within a space of two weeks. Cyclone Giovanna reached the east coast near Mahanoro on February 13 and Tropical Storm Irina reached the northeast coast, north of Antalaha on February 26. The economic and financial damages caused by these events are still being calculated, but a preliminary estimate of physical damages is provided below:

- Total no. of people affected: 332,204
- No. of deaths: 112
- No. of injuries: 299
- No. of houses damaged or destroyed: 73,334
- No. of schools damaged or destroyed: 564
- No. of bridges cut: 47
- No. of major roads damaged: 28

Source: BNGRC, 2012a and 2012b

The costs of climate change can also be considered by examining the costs of adaptation and while no comprehensive measures of the potential costs of adaptation exist for Madagascar, lessons can be drawn from global and regional analyses[234]**.** A rough calculation of adaptation needs in 2050 in Madagascar based on future average per capita adaptation needs in Sub-Saharan Africa

[232] Inadequate data on the effects of locust invasions was available to include in this analysis
[233] Republic of Madagascar, 2008
[234] The discussion on the costs of adaptation is drawn from 'The Economics of Adaptation to Climate Change (EACC)' project that was funded by the World Bank in collaboration with DFID, the Dutch Ministry for Foreign Affairs and the Swiss Agency for Development and Cooperation. For the purposes of the EACC project the 'cost of adaptation' was defined as the cost of implementing measures to reduce the effects of climate change to a negligible level; other approaches for evaluating the economic costs of adaptation can be based on marginal costs.

results in an estimate of US$300 to US$400 million/year[235]. The Madagascar NAPA estimates a budget of approximately US$4 million for priority adaptation measures; amongst the NAPAs prepared for the African region this is one of the lowest national estimates and is nearly certain to underestimate even the most urgent adaptation needs[236].

Similar trends in and influences on adaptation costs are likely to be observed in Madagascar as in other Sub-Saharan African countries. At approximately 0.6 percent of GDP between 2010 and 2019 the costs of adaptation as a percentage of GDP are expected to be higher in Sub-Saharan Africa than in any other region. This is related both to the lower average GDP in Sub-Saharan African countries and to the high costs of adaptation for water resources which will be a priority for the region. Absolute costs of adaptation in the Sub-Saharan African region are likely to be in the order of US$14.1 to US$17.1 billion / year by 2050[237]; compared to an annual cost of US$70 to US$100 billion for all developing countries. Absolute costs of adaptation are expected to rise over time, but fall as a share of GDP as economies develop.

Box 4.3: Examples of Economic Impacts of Flooding and Droughts in Southern Africa

- Drought losses in Zimbabwe and Zambia in 1992 were equivalent to 8 to 9 percent of GDP
- Rainfall variability in Zambia decreased agricultural sector growth by one percent per year and will cost US$4.3 billion in foregone GDP over the next ten years
- 200,000 additional people will be forced into poverty over the next ten years if rainfall variability in Zambia in the next decade mimics that of the period 1984 to 1995
- Droughts and floods in Malawi reduce total GDP by 1.7 percent per year
- The 2009 floods in northern Namibia had an impact equivalent to one percent of GDP for that year
- Floods in Mozambique in 2000 led to a fall in GDP growth to 1.5 percent compared to average growth over the decade of 7.5 percent per year

Source: Adapted from World Bank, 2011a

The highest costs of adaptation in Sub-Saharan Africa are forecast to occur in the areas of water supply / flood protection and agriculture. Sub-Saharan Africa is likely to have the highest costs of all regions in terms of water supply / flood protection adaptation. Representing 3 to 4 percent of total adaptation costs in developing countries; the costs of adaptation in the agriculture sector are perhaps lower than expected given the high dependence on this sector of national economies and livelihoods. However, regional variations and national variations exist and these global figures understate the unequal degree of reliance of poor and vulnerable populations on agricultural activities. Sub-Saharan Africa is also likely to experience the greatest increase over time in terms of infrastructure adaptation – notably in terms of urban infrastructure and rail and road infrastructure – and will shoulder 80 percent of health sector adaptation costs by 2050.

4. Institutional, Policy and Legislative Challenges and Possible Responses

The future stakes of climate change in Madagascar are substantial, but current knowledge, policies and institutions are unlikely to be adequate to meet the challenges that lie ahead. To date Government, donor and NGO climate response related activities have focused largely on disaster relief responses and have not addressed climate change adaptation or resilience building in a comprehensive or systematic manner. Several small-scale projects exist but these are in the form of pilot projects and are being carried out outside of a defined national framework on adaptation priorities. Disaster relief operations will always be required, however in the long-term, damages will be reduced and cost-effectiveness improved through an increased focus on proactive activities that reduce communities' vulnerabilities to natural disasters before they occur. Future climate and natural disaster related activities in Madagascar should thus focus on building long-term resilience to natural disasters both now and under future climate change scenarios. The situation in Madagascar where no substantial climate change adaptation programs are being implemented is an anomaly

[235] Assuming future population growth of 2.9 percent per year and using average per capita adaptation cost estimates from World Bank, 2010b

[236] Comparisons of estimated NAPA budgets have concluded that NAPAs are highly variable and are a poor indicator of required adaptation expenditures in vulnerable countries; in Africa budget estimates for implementation of priority adaptation measures range from $4 million (e.g. Madagascar and Central African Republic) to several hundred million (e.g. Ethiopia and The Gambia) (Source: Parry et al, 2009).

[237] World Bank, 2010b

if compared to other African countries where significant investments are already being made to build resilience in key sectors such as agriculture, infrastructure and protection of coastal development.

A short-term priority for Madagascar is to improve understanding on future climate change projections, the associated economic and social effects of climate change, and the costs and benefits of different adaptation approaches. Such information will have a dual purpose of informing decision makers and the general public about the potential severity of climate change for Madagascar, and will provide strong technical underpinnings for policy, program and project development and decisions on resource allocation. The World Bank is currently supporting a technical investigation that is updating climate modeling and evaluation economic effects in two priority sectors, and this work will need to be continued and expanded in collaboration with the Government, and with the support of technical and financial partners. In the longer term, it will be important to ensure that national agencies have the resources and capacity to generate, update, and disseminate climate change information in the future. For example, the Direction-General of Meteorology (DGM) needs to be provided with additional capacity building and equipment and resources to undertake modeling and remain abreast of technical advances in climate science. The Ministry of Finance and Budget needs to be provided with the tools and capacity to evaluate and take account of the economic and financial effects of climate change thus allowing decisions to be made regarding resource allocation for adaptation activities and consideration given to the development of contingency funds and disaster insurance schemes.

Efforts are also urgently required to clearly define a national climate change adaptation strategy that has wide buy-in from Government and development partners. The national strategic framework for climate change adaptation is contained in the National Climate Change Policy that was adopted by the Government in 2010 and the National Adaptation Program of Action (NAPA) that was developed in 2006. The high-level National Climate Change Policy is based on a sweeping objective to promote measures to reduce the vulnerability of Madagascar to climate change and emissions of greenhouse gases, and the development of behaviors that aid in the combat against climate change. Adaptation to climate change is one of five pillars of this Policy but the policy lacks concrete details on activities and priorities related to adaptation. The NAPA, due to a lack of stakeholder buy-in it has never fully played its intended role as a strategic guide for adaptation activities in Madagascar and implementation of the 15 priority actions contained therein has not commenced in a substantive way. At the time of writing the Government was in the process of preparing its National Adaptation Plan (NAP), a plan that is intended to build on the NAPA by further assessing vulnerabilities, mainstreaming climate change risks and addressing adaptation needs.

Priority climate resilience building and climate change adaptation measures need to be identified in a consensual manner with input from a range of stakeholders. This activity should start in priority economic development sectors in the short-term, and progressively be expanded to cover all sectors. The most cost-effective adaptation approaches in developing countries have common characteristics that can guide Madagascar in its choice of adaptation strategies. The most cost-effective approaches are those that: (i) focus on low-regrets activities and delay investments in expensive, long-term adaptation measures; (ii) commence by targeting measures that tackle weather risks; (iii) emphasize the need to plan development to be climate resilient; and (iv) view 'soft' and 'hard' measures as integral parts of an overall adaptation package[238]. A small number of practical adaptation activities such as paving unsealed roads, improving road design standards and investing in agricultural research and development can have significant climate change adaptation benefits. Another powerful and cost effective strategy relates to improved education that increases human capital and helps economies to grow and diversify away from reliance on climate sensitive sectors, such as agriculture, and generates additional resources for risk management activities.

Support will be needed at the national and sector level to mainstream priority activities in development planning. Mainstreaming of concepts related to climate change adaptation and resilience building into national development planning or sector level planning is very limited in Madagascar. Once knowledge on the likely impacts, and cost-effectiveness of different adaptation strategies is improved, national and sector level climate change adaptation priorities need to be integrated into development planning. The Government has commenced preparation of a National Adaptation Plan, a process that could act as a starting point for this mainstreaming; ideally this Plan should be prepared in a way that attracts high-level Government and partner

[238] World Bank, 2010b

support and it should be prepared in a participative cross-sectoral manner with the results mainstreamed into national development policies and planning.

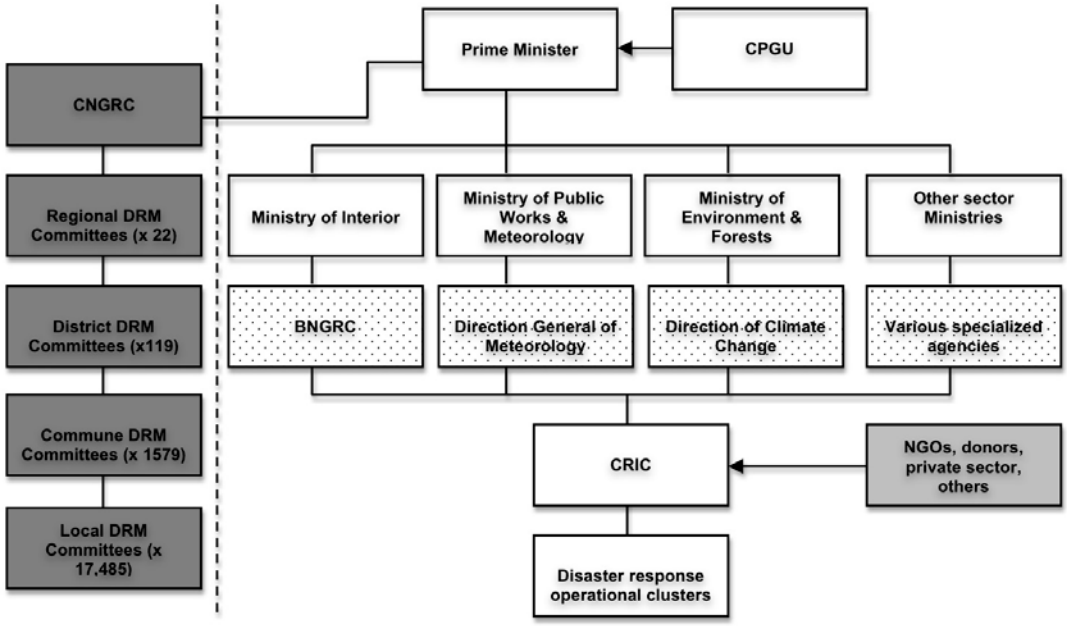
At an institutional level, given the complexity and scale of the challenges that will be posed by climate change there is a longer-term to ensure that there is high-level leadership and coordination on climate change issues. Climate change adaptation strategy development and activities are currently under the mandate of the Direction of Climate Change (DCC). The DCC was created in 2010 under the Ministry of Environment and Forests and is responsible for coordinating national responses for adaptation to climate change, representing Madagascar in international negotiations and maintaining a database of climate change projections. The DCC is relatively new department that is still in the process of establishing its identity and role in relation to other Government departments, donors and civil society organizations that are working in the area of climate change adaptation. Staffed with an enthusiastic but relatively young staff the DCC lacks the strong technical capacity required to meet the challenges associated with climate change adaptation. In addition, the recent creation of the DCC has resulted in conflict with the pre-existing roles that were mandated to other Government agencies. For example, there is overlap in the mandated roles of the DCC in respect of climate change modeling with the role currently played by the DGM.

The DCC has been criticized by some stakeholders - both internal and external to Government - for a lack of coordination with other initiatives, a lack of consultation in the development of strategic directions for climate change responses in Madagascar, and for a lack of results in national dialogue and international negotiations on climate change. The DCC is working under real constraints in terms of technical capacity and resources and substantial technical support, together with a willingness on the part of the DCC to coordinate and communicate with Government and technical and financial partners will be required to ensure that the DCC can play its mandated role.

The types of decisions that need to be made on adaptation planning are high-level, cross-cutting decisions that intersect with sector based development planning and national planning for poverty reduction and economic development. Decisions on adaptation planning cannot be taken in isolation of these broader concerns. Line Ministries need to be involved in high-level reflections and discussions on climate change adaptation to ensure that there is a strong alignment between sector priorities and decisions on adaptation priorities. The ultimate responsibility for climate change adaptation planning decisions needs to be vested at the highest levels of Government and decisions based on robust technical information. Technical and financial partners could provide support for a detailed audit and analysis of current institutional arrangements for climate change that could be used as a basis for discussion with the Government to raise the profile of this issue within Government, create a strengthened institutional structure, and ensure that existing conflicts between institutions are resolved and that appropriate resources and capacity building are focused in the correct institutions.

Climate change adaptation is separated institutionally and in practice from disaster risk management (DRM) despite the links between these two communities of practice. Notwithstanding the nature of the climate change challenge in Madagascar - whereby intensification of extreme events is likely to be an important short to medium term effect of climate change - is such that future climate change adaptation strategies and actions will need to be closely linked to disaster risk management (DRM) and disaster risk reduction activities. There is thus a need for improved communication between Government, donor and civil society actors in the DRM domain and those in the climate change adaptation domain, and a harmonization of strategies and approaches.

Figure 4.12: Institutional Structure for Climate Change and DRM in Madagascar



Source: World Bank Study Team

Even with the re-focusing of efforts on resilience building, some level of disaster relief activity will remain essential; however, in the event of a disaster there is currently limited access to adequate financing for relief and reconstruction efforts. In 2009, the Government earmarked 1 billion Ariary (approx. US$500,000) for a post-disaster contingency fund. The Track II technical assistance project funded by the Global Facility for Disaster Reduction and Recovery (GFDRR) has supported the Government to develop a procedures manual for a national contingency fund; however, this fund is yet to become operational. The BNGRC, certain sector ministries with responsibilities for post-disaster interventions and certain development partners (e.g. USAID and UN agencies) have some provision for immediate post-disaster financing, but there is a need for a national and coordinated approach to this question to assure the availability of adequate contingency financing for future post-disaster situations. Disaster risk insurance schemes do not currently exist in Madagascar. Further analysis and dialogue on appropriate support mechanisms for contingency funding will be required between Government and partners. Technical analyses to pave the way for a contingency fund should be continued in the short-term, while implementation may be a longer-term goal.

III. Environmental Regulation of Madagascar's Mining Industry

The mining sector in Madagascar is characterized by several sub-sectors: unregulated mining rushes, a mixture of formal and informal artisanal and small-scale mines, and a nascent yet highly regulated large-scale mining sub-sector. Mining activity in all its forms has significant socio-economic importance. Mining rushes and artisanal and small-scale mines provide permanent or seasonal employment for up to 6 percent of the national workforce[239] and large-scale mines are of increasing importance to the national economy. Mining activity also has the potential for significant impacts on the natural environment in terms of conflicts with the protected area network, direct effects on biodiversity, pollution of water and soil resources, and the effects of induced development. The resulting challenges for environmental regulation will require robust responses that are tailored to the specific characteristics of each type of mining activity[240]. This section of the CEA investigates the environmental implications of the sector, examines the application of the current environmental regulation framework, and identified priority areas for reform in relation to this framework.

1. Overview of Madagascar's Mining Sector

With its extensive mineral and non-mineral sub-soil assets, Madagascar is recognized as a geologically rich country with resources that have the potential to generate large economic gains over a relatively short period. With the recent development of the first two large-scale mining operations in Madagascar, the formal mining sector's contribution to GDP is expected to grow from less than 1 percent to 15 percent in coming years. Numerous other large-scale mining operations are in the exploration phase throughout the country and Madagascar is considered to be on the cusp of a major increase in large-scale mining activities. Royalties captured by the State from existing large-scale mining operations are low compared to other countries. The informal sector, which is focused predominantly on gold and gemstones, provides permanent or seasonal employment for up to 500,000 people and generates significant economic benefits that are not captured by the Government or the Malagasy population. The Extractive Industries Transparency Initiative (EITI) process is active in Madagascar, and given the growing awareness on the part of communities and civil society regarding the potential economic benefits of mining activities, and the growing interest of international companies in Madagascar's mineral resources, these issues are expected to remain at the forefront of the political debate regardless of the outcome of the current political situation.

For the purposes of the CEA, mining activities in Madagascar have been categorized as follows:
(i) Large-scale mining: refers to mines with a significant footprint and high production volumes, employing large numbers of employees. Such mines are often at least partially funded and managed by international companies. These mines operate on an industrial scale, sometimes undertake processing of minerals on site, and have significant construction and operational costs. QMM/Rio Tinto's ilmenite mining operation in the southeast and Ambatovy's nickel / cobalt operation the east are the two most visible examples of large-scale mining operations with foreign investment, and the State-owned Kraoma is the oldest large-scale mining operation in Madagascar. In addition to these three large-scale mining projects that are in development or operation, there is a dynamic exploration sector (refer Table 4.5).

2.

Table 4.5: Overview of Large-Scale Mining Exploration and Exploitation in Madagascar

Operator	Mineral(s)	Location	Estimated Reserves (tons)	Status of Project
Kraomita Malagasy SA (Kraoma)	Chromium	Andriamena, Region Betsiboka	Approx. 140,000 t/year	Exploitation (Commenced in 1969)
Rio Tinto / QIT Madagascar Minerals (QMM) SA	Ilmenite / zirsill	Tolagnaro, Region Anosy	500,000t / year ilmenite currently, with capacity of 750,000t 25,000t / year zircon	Exploitation (Commenced in 2009)

[239] Calculation based on an estimated working age population of 8.7 million (Instat, 2011) - up to 500,000 persons are engaged either permanently or seasonally in the artisanal and small-scale mining sector (World Bank, 2010a).
[240] In the context of this discussion, the environmental regulation framework is taken to mean both the legislative instruments and the Government institutions that are involved in regulating the environmental impacts during the development and operation of mining projects.

Operator	Mineral(s)	Location	Estimated Reserves (tons)	Status of Project
Ambatovy Minerals SA / Dynatec Madagascar SA	Nickel / cobalt	Ambatovy, Regions Aloatra Mangoro and Atsinanana	60,000t / year nickel 5,600 t/year cobalt	Development – exploitation due to start in 2012
Mainland Mining	Ilmenite	Manakara, Region Vatovavy-Fitovinany	n/a	Exploitation – commenced in 2010 activities suspended due to lack of environmental permit
Toliara Sands / Madagascar Resources MRNL	Ilmenite, rutile, zircon	Ranobe, Region Atsimo-Atsinanana	n/a	Exploration
Mainland Mining	Ilmenite	Anjahabe / Fenerive Est, Region Analanjirofo	n/a	Exploration
Wuhan Iron and Steel Corporation (WISCO)	Iron	Soalala, Region Boeny	n/a	Exploration
Energizer Resources Inc.	Vanadium / graphite	Fotadrevo, Region Atsimo-Andrefanana	n/a	Exploration
Asia Thai Mining Ltd / Madagascar Consolidated Coal Mining Madagascar	Coal	Sakoa, Region Atsimo-Andrefanana	n/a	Exploration

n/a = data not available

Source: Ministry of Mines, 2011; Chamber of Mines Madagascar, 2011

3.

(ii) Artisanal and Small-scale mining (ASM): refers to mines that employ smaller numbers of individuals, use limited or no mechanized equipment and have a relatively small footprint. Such mines carry out little or no processing of minerals on site. Miners working in these operations tend to be poor, with few resources and employment is highly informal. Since 2005, nearly 3,200 environmental permits for ASM activities have been granted[241]; however, the official statistics do not include the many mines that operate without the relevant permits. Formal fiscal returns to the Government from artisanal mining are negligible due to the unregulated nature of such operations, which involve high levels of corruption and smuggling[242].

(iii) Mining rushes: refers to mining activity carried out by a large number of individuals or small groups concentrated in a particular zone; such activity is often spontaneous in response to news of finds of minerals in a particular area and is carried out in an unregulated and illegal manner. As for ASM mining, miners tend to be poor, with few resources and highly transient; sometimes only working in the rushes seasonally. Gemstones and gold are common minerals exploited during mining rushes. Having reached a peak in the 1990s in Madagascar, there are currently three principal mining rush areas in Madagascar: Ambanja in the northern region of Diana, where demantoid (a form of green garnet) is mined, and Firovahana to the west of Antananarivo and Ifanadiana to the south of Antananarivo where gold is mined. The dynamics of mining rushes are such that mining activity can commence, intensify and then trail off in a relatively short period of time; Figure 4.13 provides visual evidence of this dynamic in the mining rush of Ambanja where thousands of new dwellings were constructed between 2005 and 2009 in response to finds of demantoid, but where activity decreased quickly between 2009 and 2011 as resources were exhausted.

[241] Data sourced from database held by PGRM, 2012

[242] Declared gold exports in 2009 amounted to 70kg; it is considered likely that 1,000 to 2,000 kg of gold was smuggled out of the country in the same period. In 2005, declared sapphire exports amounted to 4,361 kg and it is estimated that an additional 2,600 kg was smuggled out of the country. (USGS, 2009; Tilghman et al, 2007).

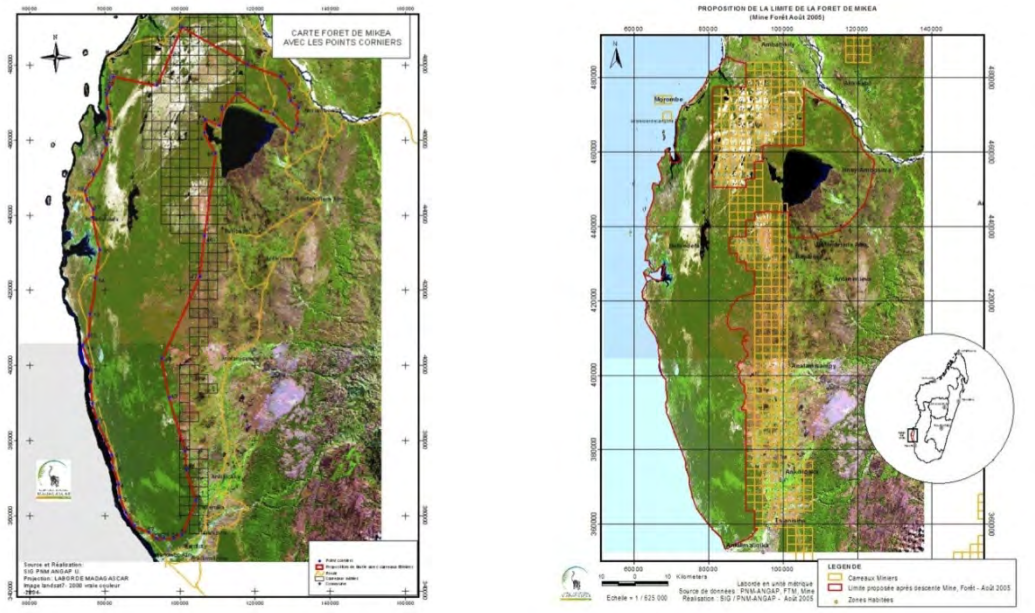
Figure 4.13: Illustration of Mining Rush Dynamics at Antetezambato, north of Ambanja, 2003 to 2011

4.

Source: Google Earth, CEA Study Team (with thanks to AQUATERRE)

Mining activities in protected areas have been prohibited since the adoption of the original Mining Code in 1999. With the establishment of the national mining cadastral office in 2000, the boundaries of all protected areas that existed at that time were input into the mining cadastre database and in line with the Mining Code it became illegal from that time on to grant new mining permits in these areas. With the announcement of the 'Durban Vision' in 2003, new protected areas were created in certain areas that were already covered by existing mining permits, and conflicts arose between the expanded protected area network and mining activities. In 2003, to resolve these issues, an Inter-ministerial Committee on Mines and Forests (CIMF) was established to oversee a process to identify and resolve conflicts between mines and protected areas. The facilitation of the re-definition of the boundaries of the Mikea protected area in south-west Madagascar to allow a compromise to be reached between Madagascar National Parks, the protected area manager, and the mining operator that held mining leases granted for mineral sands mining prior to the creation of the protected area was an example of the work carried out by the CIMF (refer Figure 4.14).

Figure 4.14: Evolution of Boundaries of Mikea National Park through intervention of CIMF



(i) Boundaries before CIMF intervention ((ii) Boundaries following CIMF intervention

Source: Madagascar National Parks

In 2004, this Committee facilitated the promulgation of an Inter-Ministerial Order that identified protected area sites within which no new mining permits could be granted. Subsequent Inter-Ministerial Orders were adopted in 2006, 2008 and 2010, which refined the boundaries of the protected area network as it evolved. The latest Inter-ministerial Order promulgated in 2010[243] prohibits the granting of any new exploration or exploitation permits across the 6.9 million hectares of the SAPM network and 13 million hectares of potential future protected area sites (refer Figure 4.1).

In 2008, nearly 900,000 hectares (14 percent) of existing or new protected areas still overlapped with mining concessions for research and exploitation permits, as did 700,000 hectares of forested areas identified as potential future protected area sites[244]. Since that time, the Inter-Ministerial Committee on Mines and Forest has continued to undertake ground-truthing of the overlap between mine permit boundaries and protected areas certain of large, active or soon to be active operations. However, since the onset of the political crisis this Committee has been largely inactive and conflicts persist. There is little information on the overlap that exists between artisanal or small-scale mines or inactive mining licenses for large-scale mines.

[243] *Arrêté interministériel n° 52005/2010 modifiant l'arrêté interministerial mines-forêts n° 183633 du 17 octobre 2008 portant mise en protection temporaire globale des sites vises par l'arrêté n° 17914 du 18 octobre 206 et levant la suspension de l'octroi des permis*

[244] Rebioma Project, 2009

Two large scale mining projects currently underway in Madagascar – Ambatovy and QMM/Rio Tinto – have required clearing of sensitive ecosystems. The Ambatovy mine site is located in humid forest ecosystems on the western edge of the CAZ protected area and immediately adjacent to the Torotorofotsy Wetlands Ramsar site. Approximately 1,336 hectares of natural forest have been cleared at the mine site. The mine's slurry pipeline traverses the CAZ protected area and has resulted in clearing of 16.5 hectares of natural forest. Biodiversity inventories have identified 29 flora species that are locally endemic to the mine site and an additional 40 flora species, three terrestrial fauna species and two fish species that are endemic to the area surrounding the mine site[245]. The QMM/Rio Tinto development in the southeast will cause the progressive loss of approximately 6,280 hectares of littoral forest[246]. This loss represents 23 percent of the total remaining area of this forest type[247] which is of high conservation priority because of its notable level of local floristic endemism, the small area that remains, and the high level of threats to which it is subject.

Both these projects adhere voluntarily to international standards on biodiversity protection and have adopted principles that aim for "net-gain" of biodiversity. The Ambatovy project is developing an 11,600 hectare biodiversity offset area to the north-east of the mine site to compensate for the biodiversity losses associated with the project[248]. QMM / Rio Tinto is developing in-kind (littoral forest ecosystems at St Luce and Mahabo) and out-of-kind (non-littoral forest ecosystems in the Tsitongambarika protected area) conservation offsets for its activities, and undertaking ecosystem restoration and progressive rehabilitation activities to compensate for the impacts on ecosystems within its development footprint[249]. The voluntary efforts of these companies are driven by their accountability to owners and stakeholders and their activities go beyond the requirements of the national legislative or policy framework. There is no guarantee that future large-scale mining operations will adhere to the same principles of international best-practice as there is currently no legal requirement for them to do so.

Informal gemstone, gold and quartz mining rushes affect the integrity of protected areas, and have direct and indirect effects on biodiversity. A recent mapping exercise as part the ASM-PACE project indicates a high degree of overlap between gemstone and gold deposits and the protected area network, particularly in the east of the country[250]. Sapphire mining is a major threat to the protected areas of Ankarana in the north-west where between one and ten percent of the surface of the protected area has been affected by mining[251] and Zombitse-Vahibasia and Isalo protected areas in the south[252]. Ankarana Special Reserve and Isalo National Park are the amongst the top five most visited protected areas in Madagascar[253] and their degradation also has social and economic impacts both for local communities and at the national level. Gold mining is carried out predominantly in the east and northeast of the country including, in Ranomafana National Park and the CAZ and COFAV protected areas, while quartz mining is carried out in the south of the Makira protected area and in Masoala National Park. The impacts of mining rushes in protected areas include deforestation to clear land in preparation for mining activities, to construct camps, and to source wood for construction of mining supports and equipment; disturbance of fauna; pollution of waterways and aquatic habitats; and soil erosion. The presence of miners in the protected areas also leads to a range of secondary impacts including hunting of wildlife (particularly nocturnal lemurs) for consumption by miners, fuelwood collection, slash and burn agriculture, and inducement of related illegal activities such as precious timber exploitation[254].

Large-scale mining operations engender the risk of environmental pollution on a scale and of a type unseen to date in Madagascar. The production of nickel and cobalt at the Ambatovy operation will generate slurries that will be subject to acid leaching at a processing plant in Toamasina on the east coast of Madagascar; any accidents could have significant environmental and social impacts. The production of ilmenite and zirsill by QMM/Rio Tinto is theoretically an operation that generated relatively low levels of chemical pollution. The main environmental pollution risks are changes to salinity, sedimentation and flows in watercourses, potential

[245] Dickinson & Berner, 2010
[246] Vincelette et al, 2003
[247] Moat & Smith, 2007
[248] Dickinson & Berner, 2010
[249] Olsen et al, 2011; Vincelette et al, 2007
[250] Cook & Healy, 2012
[251] Cardiff & Befourouack, 2003
[252] Duffy, 2007
[253] World Bank, 2011c
[254] Tilghman et al, 2007

soil contamination from accidental spills of heavy minerals[255], and risks of spills during operation of the new port at Tolagnaro. Both the Ambatovy and QMM/Rio Tinto mining operations have committed to implementing internationally recognized pollution control measures. However, the high degree of sensitivity of the receiving environment, combined with the low resources and technical capacity of Malagasy regulatory and incident response agencies mean that residual risks remain both for these projects and for future projects that may not have the capacity nor the will to commit to international best-practice in terms of pollution control.

Environmental pollution effects of the artisanal mining sub-sector are to date relatively limited as miners typically use few chemicals in the mining or processing of their products. Artisanal mining activities cause sedimentation of waterways and diversion of watercourses affecting aquatic habitats and downstream users. To date, mercury, which is a major pollutant arising from artisanal gold mining in other counties, has not been observed in use in Madagascar.

All types of mining activities induce development that can result in unplanned and unmanaged adverse social, environmental and economic effects. Mining rush towns that spring up in areas of high concentration of artisanal mining activities are often not recognized (at least initially) as formal settlements by the Government and are thus typically poorly planned and managed, without the provision of basic services. The rapid development of these towns can have adverse environmental effects through demand for natural resources such as fuelwood or hunting, poor sanitation and waste management practices, and increased demand for water resources[256]. Ilakaka near Isalo National provides a historic example. While now a formal settlement, this town grew from a population of 30,000 to 100,000 in two years between 1998 and 2000; during this period the local water source became contaminated because of poor sanitation and runoff from mining and water had to be trucked in at exorbitant prices from the nearby town of Ranohira. Rice also needed to be imported, as local water supplies were no longer sufficient for agricultural activities[257]. Health impacts related to worker safety and accidents, poor sanitation, and sexually transmitted diseases are common in rush towns.

Large-scale mining activities employ a significant temporary construction workforce that requires provision of housing and services. While worker camps and services may be well planned and controlled by mining companies, unplanned development of housing or businesses by itinerant or migrant workers either seeking employment or looking to develop businesses to service workers can cause adverse impacts similar to those described for the artisanal mining sector rush towns above. The introduction of a comparatively well-paid construction workforce can also adversely affect local economies by catalyzing local inflation. Large scale mines typically require the development of ancillary infrastructure such as roads, ports and pipelines that have their own environmental footprint, such infrastructure is subject to the national environmental regulation framework and is included in the discussion below.

2. Overview of Existing Environmental Regulation Framework

Environmental regulation of the mining sector is based around the following legislation[258]:

i. Law No. 2005-025 modifying Law No. 99-022 relating to the Mining Code: this Law sets out the Mining Code including the procedures to obtain mining permits as well as requirements for rehabilitation of mine sites.
ii. Decree 99-954 as modified by Decree 2004-167 pertaining to the compatibility of investments with the environment (known as the MECIE) and associated regulations related to public participation: this Decree is the main legislative instrument for environmental assessment in the mining sector and identifies the assessment regime that applies to different types of activities.

[255] QMM SA, 2001
[256] Duffy, 2005
[257] Duffy, 2005
[258] The official names of these instruments are: La loi n°99-022 du 19 août 1999 portant code minier et le décret n°2000-170 fixant les conditions d'application du code minier; Le décret n°99-954 du 15 décembre 1999 modifié par le décret n°2004-167 du 03 février 2004 relatif à la Mise en Compatibilité des Investissements avec l'Environnement (MECIE) ; and L'arrêté interministériel n°12032/2000 sur la réglementation du secteur minier en matière de protection de l'environnement

iii. Inter-ministerial Order (IMO) 12032-2000 on the regulation of the mining sector in relation to environmental protection: this instrument harmonizes the requirements of the Mining Code and the MECIE in relation to the mining sector; it has not yet been updated following changes to the MECIE in 2004.

This legislative framework requires environmental impacts to be analyzed either through preparation of a full-scale environmental assessment study (*EIE - Etude d'Impact Environnemental*) and an accompanying project specific environment management plan (PGES – *Plan de gestion environnementale et sociale*), or a smaller-scale Environmental Commitment Program (*PEE – Program d'Engagement Environnemental*) depending on the type of permit that is being sought and the location of the operation (refer Table 4.6). Notably all mining activities in defined "sensitive zones" are subject to an EIE regardless of their size. Sensitive zones are defined in *Order No. 4355-97 dated 13 May 1997, defining the boundaries of sensitive zones*. Projects requiring EIEs are subject to evaluation by ONE and approval by the Minister of Environment, while projects requiring PEEs are subject to approval by the Minister of Mines (for Research Permits) or the Regional Director of Mines (for Permits Reserved for Small Mining Exploitations). Mining permits are issued under a separate legislative process defined in the Mining Code and the associated regulations; since 1998 significant efforts have been made to coordinate and harmonize the processes for issuing of mining permits and environmental permits notably through the promulgation of IMO 12032.

Table 4.6: Summary of Environmental Assessment Requirements for Mining Activities

Permit Type	Type of Technology Allowed	Maximum Surface (km^2)	Level of Environmental Assessment Required	Evaluation and Approval Process
Exclusive Authorization for Reservation of Perimeter (AERP)	Not specified	15,000	EIE if in "sensitive zone" otherwise none	If EIE, then evaluated by ONE / CTE and environment permit issued by Minister of Environment.
Permit Reserved for Small Mining Exploitations (PRE)	Artisanal; maximum of 20 employees and maximum of 20m depth	100	EIE if in sensitive zone otherwise PEE	If EIE, then evaluated by ONE / CTE and environment permit issued by Minister of Environment. If PEE, then evaluated by decentralized environmental unit and environmental authorization issued by Regional Director of Mines
Research Permit (R)	Mechanized	10,000	EIE if in sensitive zone otherwise PEE	If EIE, then evaluated by ONE / CTE and environment permit issued by Minister of Environment. If PEE, then evaluated by central environmental unit and authorization issued by Minister of Mines
Exploitation Permit (E)	Mechanized	1,000	EIE	Evaluated by ONE / CTE and permit issued by Minister of Environment.

Source: Adapted from Cardiff & Andriamanalina, 2007; Republic of Madagascar, 2004

The national institutional structure for environmental regulation recognizes that there is a clear role for both an environmental regulator external to the mining sector, and for environmental expertise within the mining sector itself. The key agencies in this regard are the *Office National pour l'Environnement* (ONE) in the role of environmental regulator, and the central and regional environment units of the Ministry of Mines. ONE was traditionally supported by the Environment Program – although funding was suspended in 2009 due to the political crisis, and the Environment Units have been traditionally supported by the PGRM. The SIGE, an integrated GIS database that incorporates environmental issues was a groundbreaking tool developed with the

support of the PGRM that aimed to harmonize the roles of these agencies and integrate the information used and generated by their activities (refer Box 4.4).

ONE is the national environmental regulating agency, and is charged under the MECIE with coordinating the evaluation of EIEs in the mining sector and carrying out post-EIE monitoring. It establishes and coordinates an ad-hoc evaluation committee (CTE) made up of members of environment units of relevant Government ministries that evaluates the EIE, establishes and coordinates public participation processes, and is responsible for advising on the delivery of the environment permit, which is issued by the Minister of Environment. Following granting of the environmental permit, ONE is charged with the coordination of monitoring during project construction and operation to ensure conformity with environmental management plans.

Box 4.4: The SIGE: a best-practice tool for integration of environmental issues in the mining sector

Lack of access to data and lack of data sharing between agencies has been an obstacle to close cooperation and the adoption of a harmonized approach to environmental regulation in the mining sector. The SIGE – or *Systeme d'Information pour la Gestion Environnementale* – is an environmental-focused GIS-based tool developed with the support of the World Bank funded PGRM project that has the objective of consolidating environmental data related to large-scale and small-scale mining projects and making this data available to ONE and environmental units within the Ministry of Mines. As well as mining permit and cadastral information, the SIGE, which is based around up to date satellite photography on a Google Earth platform, contains information on the requirements of environmental permits and management plans, the results of environmental monitoring activities, and any past environmental incidents. The SIGE thus allows rapid access for stakeholders to a common database on key environmental issues. The PGRM project has purchased software and computing equipment and provided training for ONE and the Ministry Environmental Units in the use of the SIGE. The operationalization of the SIGE was disrupted by the onset of the political crisis but the PGRM project has recently re-launched this activity and the tool is expected to be completely functional before June 2012.

Source: PGRM, 2012

Environment Units within the Ministry of Mines and Energy were established by Decree in 2007[259] and are currently operational at the central level and within six regions where mining activity is concentrated. The central environment unit has the role of assessing and advising the Minister of Mines on the dossiers for PEEs for Research Permits and a representative of this unit sits on the evaluation committee for the EIE of any mining project. The operational focus of the decentralized environment units includes awareness raising and training of regional authorities; the evaluation of PEEs for small-scale exploitation permits; monitoring of environmental management plans; and the management and investigation of complaints. Environment units in some regions are not fully operational due a lack of qualified personnel. Since 2008 staff in the environmental units at both the central and regional levels have been integrated into the public service and are no longer financed by external sources.

3. Challenges in the Application of the Existing Environmental Regulation Framework

Industrial Mining

The current environmental assessment framework (the MECIE) and the supporting guidance documents for large-scale mines were developed prior to the recent surge of interest in large-scale mining operations in Madagascar. Regulation of the sector has been significantly improved in recent years on all aspects except those pertaining to environment regulation, where the regulatory framework remains out of step with the evolution of the industry. The current framework has struggled to fully keep pace with the scale of developments that are underway. The resulting barriers to effective environmental regulation of the sector are technical, institutional and financial. However, the high visibility of large-scale projects combined with the companies' own environmental policies and engagements have ensured that, despite institutional and technical deficiencies in the framework, there has been systematic application of the environmental regulation framework and certain companies have voluntarily adhered to international best practice standards on issues

[259] Décret n° 2007-088 fixant les attributions du Ministre des Mines ainsi que l'organisation de générale de son Ministère où à part la mise en place et les rattachements des cellules environnementales au niveau central et interrégional

such as biodiversity offsets and pollution control. A key challenge will be to ensure that future large-scale mining operations that may be carried out by companies with fewer internal environmental engagements continue to be subject to a sound national environmental regulation framework, and that all companies are encouraged to adhere to voluntary international best-practice in environmental protection.

The technical expertise of ONE staff and the ad hoc technical evaluation committee members is not yet adequate to fully address the range and scope of issues that are encountered in projects of this scale. The mining projects that have been developed or that are in the planning stages are highly complex operations carried out in sensitive ecosystems. These projects raise numerous, interrelated issues linked to biodiversity, environmental pollution and socio-economic development. To date only two EIEs for large-scale projects have been evaluated and approved by ONE and the ad-hoc evaluation committees, and it will take time and technical support for personnel to develop the skills required to critically evaluate such projects and develop appropriate management and monitoring requirements. This is a particular challenge for committee members due to relatively low levels of technical capacity and high staff turnover within the environmental units of many ministries.

Few environmental pollution standards exist for Madagascar. Standards for effluent quality exist[260] but are not specific to the mining sector. Despite previous studies into the question[261], no other pollution discharge standards exist and there are no ambient standards. In the development and evaluation of mining projects, proponents are advised to refer to standards developed by '*international organizations affiliated with the UN*[262]'. To date international projects including QMM/Rio Tinto and Ambatovy have voluntarily adhered to the 'Equator Principles' that require IFC environmental standards to be used. However, there is no legal definition of the criteria to be applied in the selection of appropriate standards, which calls into question the consistency of standards used for different projects, and the relevance of such standards to the specific environmental conditions of Madagascar.

Challenges exist in the post-EIE monitoring phase of projects. Under the MECIE legislation ONE is charged with coordinating post-EIE monitoring of the environmental management plan. An analysis of the monitoring strategy developed in 2007 by ONE for major mining projects revealed weaknesses related to the role of ONE in relation to project proponents, lack of technical and financial resources for monitoring for complex and long-term projects, integration of social and economic issues in monitoring, and participation in monitoring processes by outside parties[263]. Throughout the post-EIE monitoring process, there is criticism that socio-economic issues are overlooked in favor of biophysical issues. Following the 2007 evaluation, ONE has worked with QMM/Rio Tinto to improve the monitoring framework to adopt an integrated sustainability approach and is currently undertaking a similar process with Ambatovy.

Real-time monitoring data is not available to ONE and limits the ability to carry out spot-checks of environmental performance or detect environmental pollution incidents. Current practice involves biannual monitoring missions by ONE; a frequency which is inadequate to allow in-depth monitoring of the evolution of environmental conditions. Systems to detect and respond to environmental incidents are poorly defined and resourced, and are spread throughout different Government agencies. The ability of emergency services to effectively respond to pollution incidents is weak and there is a strong reliance on mine operators to be able to play this role.

The role of ONE in post-EIE environmental monitoring in not adequately supported by the financial resources available over the lifespans of the projects. Annex III of the MECIE sets out the fees associated with processing of an EIE; fees are charged on a once-off basis when the EIE is submitted for evaluation and used throughout the life of the project. The MECIE underestimates the true costs of monitoring of these types of projects[264]. Discussions with ONE revealed that large-scale projects pay a one-off fee of approximately US$350,000. Roughly two thirds of this fee is used during the EIE evaluation period, meaning that for a project with a lifespan of 30 to 40 years, around US$3,000 to US$4,000 per year is available for monitoring activities.

[260] Décret n° 2003 / 464 du 15/04/03 portant classification des eaux de surface et réglementation des rejets d'effluents liquides
[261] Consortium ECR-CNRE-BRGM, 1997
[262] Paragraph 1.2.4 of the *Direction Generale pour la Realisation d'une Etude d'Impact Environnemental à Madagascar* (ONE, 2005)
[263] Gagnon, 2010
[264] Gagnon, 2010

Such a budget is clearly inadequate to allow more than a superficial monitoring exercise and it does not allow ONE to fulfill its legally prescribed role to coordinate the monitoring of compliance with the environmental management plan.

An imbalance of resources between ONE and project proponents means that ONE relies almost entirely on data produced and treated by the project proponent; it does not have adequate resources to engage its own experts or equipment to undertake independent environmental monitoring[265]. It also limits ONE's ability to implement regional and local monitoring committees, which are important element to encourage public participation. Such committees are currently largely supported by external financing; a situation that is not sustainable. ONE has reported that it has reached individual agreements with mining companies to financially support monitoring activities; such agreements are a stopgap solution as they raise perceptions about the independence of ONE and because they are not reached within the prevailing legislative framework, they are entered into only at the discretion of the mining company.

Provisions for environmental rehabilitation following closure of large-scale mines exist but require improved harmonization and transparency. Under the Mining Code, the Ministry of Mines theoretically collects a financial bond from the mining company. This bond is held until ONE gives an 'environmental release' approving post-mining rehabilitation works; in theory if environmental rehabilitation works are not carried out satisfactorily the bond is used to finance such works. It is not clear if the Ministry of Mines systematically collects bonds and little information is available on the methodologies used to calculate the amount of any such bond.

Box 4.5: Principles for Environmental Pollution Standard Development

The development of environmental pollution standards is a complex undertaking. A number of principles need to be considered in the development of such standards to ensure their acceptance and effectiveness:

- While adoption of international standards is a common starting point for many developing countries, adaptation of standards to the priorities of the national environment sector and the sensitivities of the receiving environment is essential.
- Standards need to be developed in a participatory manner with Government, private sector, civil society and donors. A comprehensive campaign of awareness raising, information and training should accompany the adoption of standards. An assessment of the potential economic impacts of standards adoption can be a useful tool to communicate with industry and private sector.
- There needs to be a clearly defined mandate for control and monitoring against standards and the relevant agency(ies) need to be provided with the capacity and resources to fulfill their roles.
- The "hardware" to support standards needs to be considered in the form of a national reference laboratory and a laboratory accreditation scheme. The standards adopted need to be in line with the analytical capacities of the country.

Source: Adapted from Consortium ECR-CNRE-BRGM, 1997

Public participation is required for all proposed mines requiring an EIE, and is potentially an important means of allowing civil society and the community to play an independent watchdog role. Large-scale mining projects tend to be highly visible and generate large amounts of interest within civil society and affected communities. However as discussed in Section 3.I.4, true public participation in the environmental assessment process is challenging because of capacity constraints within the community, the means of presenting and accessing information which presents obstacles for rural communities, and the tendency for 'sensitive' information to be withheld by mining companies. The PGRM has been working closely with both the QMM and Ambatovy projects to improve the mechanisms for community involvement, with a focus on ensuring a better integration of large-scale mines with regional development. As well as providing financial support for discrete activities undertaken by regional and local monitoring committees, the PGRM is supporting a process of developing participatory budget planning for the use of mining revenues at the local level, supporting the development of inter-communal development plans and aiding investigations into the development of a regional trust fund in which a part of mining revenues could be invested.

[265] Gagnon, 2010

Small Scale and Artisanal Mining

Responsibility for application of the current environmental regulation framework for small-scale and artisanal mining is split between ONE and regional mining departments. ONE is involved when projects require an EIE due to their location in a predefined 'sensitive zone' or because they use mechanized mining techniques or carry out mineral processing on site. Regional mining departments, based on technical advice provided by the decentralized environmental units, regulate all other projects. This split responsibility creates a dual system with implications for the effectiveness of environmental regulation and the viability of mining operations. Full application of the legislative framework means that a large number of small mines require a full EIE.

ONE estimates that the vast majority of small-scale or artisanal mining operations that should require an EIE do not prepare one. Environmental regulations are complex and costly for small operators or individuals to implement and there is a very low level of understanding of their obligations. Deliverance of an environmental authorization is not a pre-condition for a mining permit, and controls by mining police who are charged with the on-the-ground checking of mines including the validity of environmental authorizations are not adequate. Many mines thus operate without environmental controls, and without enforcement of the requirement for environmental rehabilitation.

However, even with the majority of operations not submitting an EIE, ONE still receives a large number of EIEs for small-scale or artisanal mining operations: In 2009, 183 such EIEs were evaluated. Such EIEs require a full technical evaluation, and development and implementation of a monitoring program, yet because of their low investment value, the fees paid for such evaluations are derisory and do not begin to cover the full costs of such a process. In addition, for small-scale or artisanal mines that do not require an EIE, there is no legal requirement for public participation in the evaluation or monitoring process. Nonetheless, individual mines or a concentration of mines in one area can have localized yet important impacts.

Mining Rushes

Mining rushes – due to their illegal and covert nature – are arguably the most difficult component of the mining sector to control in terms of environmental regulation. To date intervention by Government and civil society in mining rush areas has been minimal and dispersed. Miners themselves are typically poor and economically and socially vulnerable. They are also somewhat nomadic – moving from one rush to the next - and it is thus difficult to organize them or engage them in improved environmental practices. Powerful smuggling networks often control mining activities, and it can be supposed that these networks have links to corrupt officials within the administration. While the impacts from any one mine are localized, the nature of the rushes means that there are large numbers of mining sites concentrated in a small area. The resulting direct and indirect cumulative effects can be significant particularly when a concentration of sites occurs in the vicinity of a protected area or other sensitive environmental zone.

4. Priority Issues for Strengthening of the Environmental Regulation Framework

Institutional Strengthening

ONE requires increased technical capacity on a focused range of issues such as socio-economic monitoring and evaluation, international best practice in pollution analyses and control, and data storage and treatment. ONE should be furnished with the appropriate equipment to allow it to carry out independent audits of mining projects in relation to these standards to validate proponents' monitoring reports. ONE is highly dependent on monitoring data provided by proponents[266] – the majority of which is not provided in raw form but already treated and analyzed. Evolution of the monitoring framework applied to large-scale mines should ensure that real-time monitoring information is provided to ONE. In the context of an improved pollution incident response framework (refer below) this would ensure that ONE can coordinate and communicate information to relevant response agencies in a timely manner.

[266] Gagnon, 2010

Assuring a sustainable and adequate source of revenue to allow ONE to fully carry out its evaluation and monitoring functions will be central to institutional strengthening endeavors. Several mechanisms have been identified to achieve this and require further evaluation as to their feasibility to be used in isolation or in combination[267]. These mechanisms include: (i) increasing the proportion of capital cost that is paid in evaluation and monitoring fees under Annex III of the MECIE from its current level of 0.5 percent; (ii) removing fees from Annex III of the MECIE and allowing increased flexibility for the setting of suitable fee rates for example through a ministerial order or decree; (iii) earmarking a proportion of the annual royalties that are paid to the Government for environmental regulation purposes; (iv) establishing a trust fund into which mining companies as well as donors could place money for environmental protection activities around mine sites; (v) establishing and enforcing a system of financial penalties for infractions of the regulatory framework (e.g. non-submission or untimely submission of monitoring reports, or exceedances of pollution; and/or (vi) external financing for discrete activities such as development of pollution standards or pilot testing of SEA procedures.

Capacity of central and decentralized Environment Units within the Ministry of Mines should continue to build on gains already achieved. The World Bank funded PGRM project has supported the establishment and reinforcement of environment units within the six decentralized environmental units; the first sector to achieve this. Ongoing capacity building themes could include development and implementation of environmental monitoring programs, socio-economic aspects of project evaluation, environmental rehabilitation, as well as training in the legal framework and on their rights and responsibilities under that framework.

A comprehensive evaluation of the national and sub-national framework for pollution incident response should be carried out. The purpose of such an evaluation would be to identify the responsibilities and mandates of key agencies and to critically assess their existing capacities, plans, resources and procedures in relation to potential pollution incidents from the mining sector. This evaluation would develop recommendations for the improvement as necessary of the institutional and policy framework for incident response on the part of the Government, including the development of contingency response plans and programs for simulation exercises similar to those that already exist for natural disaster management.

Finally, as part of future broad environmental education strategies, public awareness campaigns that target rural communities and locally based civil society organizations should be undertaken. These campaigns should aim to inform targets of their rights and obligations in relation to public participation in environmental assessment and monitoring processes in the mining sector.

Priority Issues for Large Scale Mines

Environmental assessment legislation and guidelines for the large-scale mining sector should be updated and widely communicated within Government and the private sector. Legislative reform should ensure consistency between the MECIE and the Inter-ministerial Order 12032/2000, which has not been updated since the modification of the MECIE in 2004, and making reference to appropriate environmental pollution standards (refer below). In the medium term, legislative reform should focus on increasing the environmental and social safeguards requirements of mining operations. Lessons could be drawn from the implementation of World Bank safeguards in the sector both in Madagascar and internationally, as well as experiences from the implementation of voluntary standards such as the Equator Principles, corporate social responsibility guidelines or the Business and Biodiversity Offsets Program (BBOP), to develop strengthened legislation that incorporates requirements for principles such as net-gain of biodiversity and strengthened community involvement.

The current ONE guidelines for EIE preparation for large-scale mines date back to 2005 the 'large-scale mines' to which they refer are equivalent to modest scale modern mines in other countries. The guidelines should be updated in the context of the different types and scale of mining operations that have the potential to be developed in Madagascar and the proposed legislative reform. The guidelines should require more detailed scoping and quantitative assessment activities – for example requirements for a water-balance analysis to be included in the EIE, and make reference to advances in environmental analyses techniques and

[267] Gagnon, 2010

attenuation measures. Reference should also be made to relevant environmental pollution standards and the revised monitoring framework that will apply to such projects (refer below). The periodic review of these guidelines should be undertaken to ensure that they keep pace with advances in mining sector operations and in environmental monitoring and control technologies. To encourage adherence to voluntary standards on issues such as biodiversity offsets, principles of biodiversity net-gains and pollution control, the guidelines should make reference to international best-practice and the advantages of such adherence [268].

National environmental pollution standards – both ambient and discharge – are required for the range of large-scale mining projects that could be developed in Madagascar. Given the significance of environmental pollution risks associated with large-scale mining it is considered important that national discharge and ambient standards for environmental pollution are developed and applied in a consistent manner to new projects. The mining sector in effect could act in this regard as the catalyst to restart the debate on environmental pollution standards in Madagascar; with this sector acting as a pilot for the eventual development of pollution standards in other economic activity sectors in Madagascar. Standards for water, soil and atmospheric pollution should be developed as a minimum based on international best practice and tailored to the specific conditions in Madagascar. Personnel within ONE, MEF and the environment units of the Ministry of Mines should be trained in the application and of these standards and the analysis of data produced by project proponents, and provided with resources to ensure periodic revision of standards as necessary.

Dialogue between the Ministry for Mines and ONE should be facilitated in relation to the monitoring mandate of any future mining inspectorate and environmental rehabilitation of large-scale mines. The Ministry of Mines is considering the feasibility of establishing a mining and environmental inspectorate (BIME[269]) as a means of strengthening its operational and environmental monitoring capacity. The proposed establishment of the BIME as an autonomous institution arises from Decree 98-394 relating to mining sector policy and to the outcomes of the high-level mining sector strategic decision meeting in 2006[270]. In any future process of developing a mining inspectorate, agreement will need to be reached between the Ministry of Mines and ONE in terms of the respective roles and responsibilities in terms of post-EIE monitoring, as well as opportunities to harmonize the use of technical and financial resources for monitoring. Procedures for calculating and collecting the environmental rehabilitation bond that is a legal obligation of mining operators should be clearly defined, together with procedures for its use in the case of non-issuance of an 'environmental release' by ONE.

The role of regional and local monitoring committees for large-scale projects should be strengthened and formalized. These committees will continue to play an essential role in community and regional authority engagement in mining sector development, and in validation of on the ground monitoring activities. The lessons learnt from the experience in Anosy Region should be seen as a first step in a process of committee evolution and should be capitalized and shared in order to improve the definition of the role, the participants and the operational procedures of these committees thereby increasing their efficiency and strengthening their mandate. Sustainable sources of financing for these committees should be identified to avoid dependence on external project-based financing and technical capacity building provided to members.

Priority Issues for Small Scale and Artisanal Mines

Reducing the burden of ONE related to the environmental evaluation of numerous small-scale and artisanal mining operations would have benefits both for the regulator and mining operators. Two categories of options appear possible to achieve this: (i) increase of the evaluation fees for small projects, although a significant increase would have the likely effect of reducing further the level of compliance with preparation of an EIE; (ii) rationalization of the types of small-scale or artisanal mining operations that require an EIE, thus transferring greater responsibility for environmental assessment of small-scale and artisanal mining to the

[268] For example the Business and Biodiversity Offsets Program and the Equator Principles
[269] Bureau d'Inspection Miniere et Environnementale
[270] The PGRM has recently completed a feasibility study on the role of the BIME, including the relationship with ONE which includes in the recommendations the need for a close partnership between the BIME and the ONE and proposes that a distinction be made between large-scale mining and small-scale mining in sensitive zones that would remain under the mandate of ONE, with a supporting role for the BIME and small-scale mining that is subject to regulation by the Ministry of Mines (ECR, 2012).

regional authorities. The second option appears the most viable but would require legislative reform. Mechanisms that would increase the simplicity of the approvals process and transfer the responsibility for evaluation for the majority of new operations to the regional level could include regulations for SEAs of mining operations within sensitive zones that would annul the need for project level EIEs, but require a PEE to be prepared for operations within the zone, and for the operator to demonstrate compliance with a general set of environmental controls. An important step to achieving this would be the development of an updated definition and mapping of 'sensitive zones' and ground-truthing of such zones. This approach would also need to be accompanied by adequate resourcing and technical capacity building for decentralized Environment Units to allow them to fulfill their functions and guidance on integration of SEA results into regional and local development planning. If such an approach were to be adopted, issues related to the need for public participation in the SEA process and development of pubic grievance procedures would need to be addressed, along with mechanisms for ensuring adequate financial resources to allow project evaluation and monitoring.

5.

Priority Issues for Mining Rushes

It is unlikely that nationwide bans on mining rushes will be effective due to the limited resources for enforcement on one hand and the potential economic gains for miners and illegal networks on the other. While it is clear that enforcement in certain zones such as protected areas needs to be stepped up to eliminate mining rush activities, in other areas there is a need for a coordinated strategy that allows for environmental regulation of mining rushes, while protecting the rights and livelihoods of miners, and ensuring that the economic benefits of resource exploitation are captured and used in a sustainable manner. However, the significant challenges that will be faced in the development and implementation of such a strategy should not be overlooked and high-level buy-in from a range of stakeholders will be required for its success.

There is a need to better understand the social and economic importance, as well as the environmental impacts of mining rushes. This could be achieved through an audit of existing and potential future rush locations that would generate to quantitative information on production and productivity, as well as social and environmental impacts and benefits. This would allow existing and potential future rushes to be categorized as follows: (i) rushes that should be prohibited because of unacceptable environmental impact such as rushes in protected areas – for these rushes concerted and coordinated efforts between different stakeholders would be required to achieve their prohibition; or (ii) rushes that could be subject to a new regime of environmental control as discussed below. For mining rush sites that continue to exist, the overall objective will be to incorporate the sub-sector into the formal economy in a manner that promotes environmental regulation and generates socio-economic benefits for miners. There is a need for a clear and simple process of environmental control to be linked to programs that provide direct benefits to miners in terms of improved revenue or wellbeing. The work currently being supported by the PGRM will be an important input to the development of a future management strategy for mining rushes.

IV. Combating Household Air Pollution and Deforestation through Improved Cookstoves

Approximately 19 million people in Madagascar, rely on woody biomass as their principal source of household energy. This dependence causes deforestation, carbon emissions, and significant adverse health effects due to indoor air pollution. In the long-term, development projects that lead to income growth will assist in reducing this reliance through increased access to cleaner forms of fuel; it is estimated that a doubling of typical developing country incomes can result in a 16 percent reduction in woody biomass use[271]. However, given the scale of impacts already being experienced by Malagasy communities and ecosystems as a result of their reliance on woody biomass, short to medium-term alternatives are urgently required to reduce dependence on fuelwood and charcoal, and thus generate benefits in terms of avoided deforestation, time savings and improvements in health. Improved cookstoves – including ethanol fuel cookstoves – are one such solution. The climate change debate and technological advances in stove and fuel production technology have led to renewed international interest in the question of improved cookstoves, and it is in this context that this section of the CEA draws on a recent World Bank-funded Feasibility Study[272] and investigates the feasibility and implications of the introduction of a program of improved ethanol cookstoves in Madagascar.

[271] World Bank, 2011b
[272] PAC, 2011

1. Feasibility and Benefits of a Large-Scale Ethanol Cookstove Program in Madagascar

Over 95 percent of households in Madagascar rely on woody biomass to meet their primary energy needs; 72.4 percent use fuelwood, 25.2 percent use charcoal and the remaining 2.4 percent use electricity or LPG. Differences in woody biomass consumption patterns exist between urban and rural households; fuelwood is the predominant source of energy in rural households with very few rural households using charcoal, while urban households consume predominantly charcoal and use more than double the annual average consumption per person of rural households (Table 4.7). As well as causing deforestation and ecosystem degradation, respiratory infections caused by burning of fuelwood and charcoal cause approximately 12,000 deaths per year, of which the vast majority of victims are children.

Table 4.7: Estimation of household annual consumption of timber for energy sources (2005)

Type of Timber Use	Rural (cubic meters / person / year)	Urban (cubic meters / person / year)	Total (million cubic meters)
Fuelwood	0.686	0.134	9.026
Charcoal	0	1.75	8.575
Total	0.686	1.88	17.6

Source: Adapted from PAC, 2011

By 2040, 1.3 million households, representing 16 percent of the Malagasy population, could adopt ethanol cookstoves either as a substitute for, or as a supplement to, their current cooking facilities[273]. Households that are likely to adopt ethanol stoves are those that while not being able to afford LPG for cooking are willing to pay a price premium above the cost of charcoal for the health and convenience benefits of ethanol. Take up rates in urban centers are likely to be higher than in rural areas because the costs of charcoal and ethanol are comparable, with ethanol being slightly more expensive. In rural areas, take-up rates would be lower as fuelwood is either gathered free of charge or is of a lower cost than charcoal; fewer rural households would therefore voluntarily switch to higher priced ethanol as a fuel source. 960,000 urban households and 360,000 rural households could potentially adopt ethanol stoves in the next 30 years (refer Figure 4.15). The lead-time for full market penetration and thus full realization of benefits is relatively long; by 2020 it is projected that 80,000 rural household and 180,000 urban households representing 1.3 million people and 20 percent of the full potential market would have adopted ethanol cookstoves.

In those households adopting ethanol stoves, evidence from field tests in Madagascar's east indicates that satisfaction rates are likely to be high. The field tests demonstrated that up to 97 percent of households were still using ethanol stoves five months after their introduction, with the majority using the stove as a supplement to traditional cooking methods. Access to ethanol supply and need for a bigger stove were cited as reasons that households had continued to use other cooking stoves in conjunction with the ethanol stove or as the reason for which a small number of households had discontinued using the ethanol cookstove.

Significant social benefits could occur in the form of health benefits, particularly for women and children, and labor savings. The World Health Organization estimated that in 2004 smoke from cooking fuels accounted for approximately 550,000 deaths in the African region and that exposure to household air pollution caused 2.7 percent of the global disease burden and more deaths worldwide than malaria or tuberculosis. By 2030 it is estimated that, globally, more than 4,000 people per day will die prematurely because of indoor air pollution. Exposure to indoor air pollution nearly doubles the risk of pneumonia in children less than 5 years of age and increases the risk of numerous other diseases (refer Table 4.8). In Madagascar, 442,000 DALYS[274] could be saved over a 30-year period through reduced incidence of childhood respiratory infections, and adult chronic obstructive pulmonary disease and ischemic heart disease[275]. This estimate does not include: (i) other

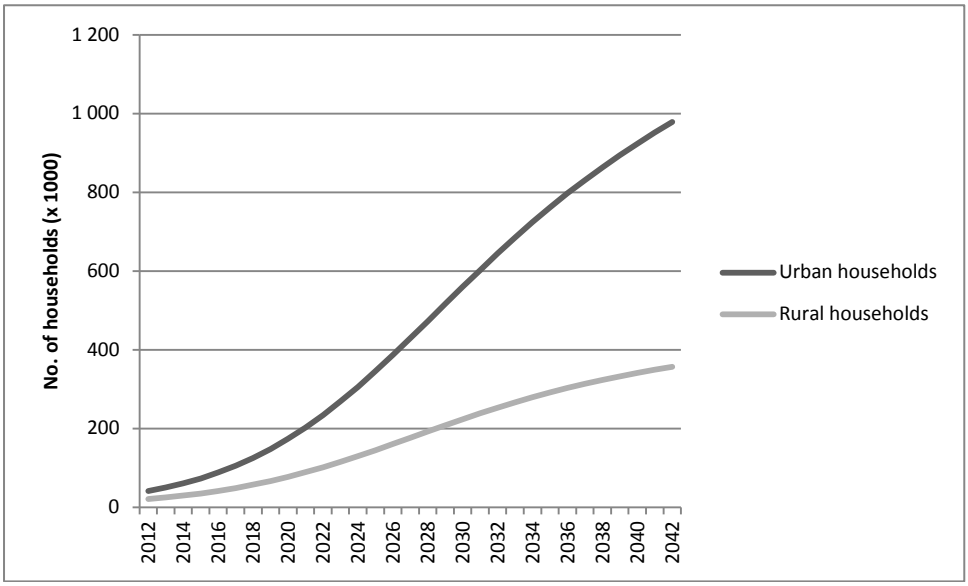
[273] Analyses are based on the assumption that current population growth of 2.9 percent / year remains relatively stable and that substantial efforts are made in promotion, access to credit or subsidies for stove purchase, and to support ethanol supply chains The analyses also assume that: (i) at the same price, households would prefer to use ethanol rather than charcoal or wood for most, but not all, cooking purposes due to its cleanliness and ease of use, and (ii) households will switch some, but not all, cooking from LPG to ethanol, if ethanol is cheaper.

[274] The sum of years of potential life lost due to premature mortality and the years of productive

[275] The analysis assumed a 90 percent reduction in exposure to HAP in the form of fine particulate matter ($PM_{2.5}$) and carbon monoxide which represents an ultimate goal; in field tests in Madagascar the rate of reduction in exposure was less than 90 percent as more than 80 percent of surveyed households used a secondary biomass stove in addition to the ethanol cookstoves that was being tested.

improved health outcomes for which the link with reduced indoor air pollution exposure is considered likely but not yet fully proved including low birth weight, tuberculosis and lung cancer; or (ii) health benefits that cannot be quantitatively estimated, such as reduced incidence of burns and scalds, eye irritation, and headaches.

Figure 4.15: Anticipated rate of adoption of ethanol cookstoves over 30-year period in Madagascar



Note: Assumes ethanol is priced at 35 cents per liter
Source, PAC, 2011

Reduced deforestation has been identified as a significant complementary benefit that could arise from the widespread adoption of ethanol cookstoves in Madagascar if such cookstoves replaced unsustainably harvested fuelwood. The substitution of urban charcoal use by ethanol use would be the main market entry point. As noted earlier in the CEA, the spatial pattern of fuelwood sources varies throughout the country with some zones almost entirely dependent on sustainably harvested plantation timber and other zones predominantly reliant on fuelwood sourced from native forests. Estimates for the supply of charcoal used by urban households that comes from managed (i.e. plantation timber) sources range between 10 percent[276] and 58 percent[277]. If the above rates of adoption for ethanol cookstoves hold true, then over a 30-year period the loss of between 670,000 hectares[278] and 1.4 million hectares[279] of non-production forest could be avoided. The spatial distribution of these projected deforestation savings, and thus the benefits for different types of forest ecosystems, requires further detailed analysis. The potential avoided deforestation benefits need to be viewed in the context of the estimated 100,000 hectares of land that would be required to produce feedstocks, notably sugar cane, for ethanol production. Deforestation benefits could be enhanced through complementary activities to increase the sustainability of fuelwood production and harvesting, such as sustainable resource use plans or increased development of plantation forests for fuelwood production in zones where extraction of native vegetation is predominant.

Table 4.8: Increased probability of various illnesses by population group from exposure to HAP

Health Outcome	Sex / Age Group	Range of Reported Increase in Risk (%)
Acute lower respiratory infection	Male and female children < 5 years	45 – 118
Chronic obstructive pulmonary disease	Male adults > 15 years	95 – 275

[276] Cited in PAC, 2011, p. 25. Assumes that charcoal use in rural areas is negligible and developed from data obtained from USAID stating that in 2006 150,000ha of plantations /managed forests had a productivity of 8 to 10 m^3/ha/year.
[277] Cited in Bertrand et al, 2010, p. 28 and refers to charcoal use in the 13 main urban centers of Madagascar covering a population of 4.52 million persons.
[278] Assuming 42 percent of charcoal from unmanaged sources as cited in Bertrand et al, 2010
[279] Assuming 90 percent of charcoal from unmanaged sources as cited in PAC, 2011

	Female adults > 15 years	15 - 213
Cataracts	Female adults > 30 years	61 – 273
Lung cancer	Female adults > 15 years	7 – 206

Source: World Bank, 2011b

There is increasing understanding of the climate change mitigation benefits of improved cookstove use. Traditional biomass cookstoves burn inefficiently and emit a range of products of incomplete combustion, certain of which have global warming potential including black carbon – which is a particularly potent greenhouse gas - aerosols, methane and nitrous oxide[280]. Residential emissions, namely cookstoves and open hearths, account for nearly one quarter of global black carbon emissions. In addition, carbon dioxide is generated. In developing countries approximately 730 million tons of biomass are currently burnt each year generating more than 1 billion tons of carbon dioxide. While this carbon dioxide is theoretically sequestered in the regeneration of biomass, there are significant variations in the amount and type of re-growth depending on the source of the biomass. Regional and local analyses are required to fully understand the biomass regeneration dynamic in any given location, but improved cookstoves have a strong potential for overall greenhouse gas emissions savings[281]. If the upstream emissions associated with charcoal production are included in the analyses the potential greenhouse gas emissions savings increase. The potential climate change mitigation benefits of adoption of ethanol stove use has implications for access to carbon financing sources as discussed in later sections.

An ethanol stove program in Madagascar could have net economic benefits in terms of avoided deforestation, time savings and health benefits. An optimistic estimate of net present value (NPV) of US$450 million over 30-years and using a 10 percent discount rate has been calculated[282]. This analysis assumed estimated economic benefits from avoided deforestation at between US$87.5 million and US$324 million over 30 years. These estimations incorporate probable over-estimations both of the amount of avoided deforestation that would be realized[283] and the amount of carbon stocked in Madagascar's forests[284]. A revised calculation that uses more conservative assumptions puts the potential benefits from avoided deforestation in the range of US$37.9 million to US$47.5 million over 30 years. The estimated benefits from time savings related to saved time in cooking and stove cleaning were calculated to be US$368 million over 30 years. Health benefits, in the form of saved DALYS, amount to US$34 million. Households would bear a cost of US$175 million for stove and fuel purchases; these costs would be outweighed by economic returns to the household through time savings, improved health and avoided medical costs. Combining the labor required to produce the sugarcane feedstock and the labor required to produce and transport the ethanol, and taking into account the reduction in employment in the charcoal industry, a net increase in employment of 571,000 additional jobs over a 30-year period is forecast as an additional benefit of program development.

2. Institutional and Technical Requirements for Ethanol Cookstove Program Development

The first step in the successful implementation of a large-scale ethanol cookstove program would be for the Government to develop a clear and unequivocal public policy to promote such a program. It would be essential that the Government is the driver of program development and implementation and draw on technical support as necessary; any program that is solely implemented by external partners is doomed to failure. Given the scale of benefits involved and the economic and technical feasibility of program

[280] Black carbon is emitted in large quantities and is the second or third largest warming agent after carbon dioxide and has 27 to 55 percent of the warming effect of carbon dioxide. Because of the interaction with organic carbon that is also emitted from inefficiently burnt biomass and which has a cooling effect, the full warming effect of black carbon is still being studied and is likely to have regional variations (World Bank, 2011b).

[281] World Bank, 2011b

[282] This NPV does not assume the sale of by-products from ethanol production, such as feed for animals and fertilizer for cash-crops for sale on local markets. Given the transport and marketing challenges involved, coupled with the low rates use of improved agricultural products and high rural poverty rates in Madagascar, the development of such a market may not be entirely feasible in the short to medium term.

[283] The economic analysis assumed avoided deforestation of 1.4 million hectares over 30 years; as noted earlier avoided deforestation could be approximately half of this value depending on the assumptions made for the proportion of urban charcoal that is sourced from plantations or managed forests.

[284] The economic analysis assumed a value of 418 t/ha of carbon. Recent estimates for Madagascar indicate that carbon stocks are more likely to be between 17t/ha C for spiny forests and 90 t/ha C for humid forests; with the global average for humid forests around 100 t/ha C (Asner et al, 2012).

implementation, such a public policy is likely to muster wide scale public and donor support. If Madagascar develops a successful, large-scale ethanol household fuel program it would be the first country to achieve this. However, the development and adoption of such a policy would be a major first step in assuring program success; the remaining steps in program implementation and development would require technical rather than political solutions.

The realization of the benefits associated with a large-scale ethanol cookstove program in Madagascar would require a shift in current patterns of production and consumption, and the resolution of a series of institutional, policy and technical barriers. While ethanol production is practiced in Madagascar, production levels are low and the predominantly artisanal facilities do not produce ethanol of an adequate quality; a new industry of micro-distilleries would need to be developed in line with appropriate social and environmental standards. The prevailing tax and legislative regime would require reform to catalyze growth in this nascent industry. Woody biomass is used largely in ignorance of its potential health effects and it is available at a reduced price that externalizes its environmental effects and significant efforts would need to be put into consumer education. Given the wealth of knowledge on the issue of ethanol cookstoves in the developing world, particularly in Africa and South Asia, south-south technical exchanges and collaboration should be a key part of the learning process for Madagascar[285].

A pre-requisite to the development of a successful program would be the identification of high-level 'champions' within Government, NGOs, donors and the private sector and the establishment of a high-level BioFuels Policy Working Group. Development of a large-scale ethanol cookstove program is a multi-disciplinary affair; it touches on issues of energy, gender, forestry, health and climate change and requires technical, financial and political support. It also involves a range of actors: Government is required to set the policy agenda and ensure a legislative and fiscal enabling environment; NGOs provide technical support, awareness raising and contact with local communities (the ultimate clients of the program) and businesses (the retailers of stoves and ethanol); donors provide financing and technical assistance; and the private sector develops, tests, markets and distributes the cookstove equipment, micro-distilleries and fuels required for project operation. High-level planning, communication, consensus and coordination between these different groups would be essential for a successful program. A high level Biofuels Policy Working Group, involving representatives of these groups, could be established as a means of creating a mechanism to garner the required high-level support and ensure policy dialogue between the various stakeholder groups.

The scale and location of ethanol production facilities would need to be integrated with market demand, and be developed to minimize adverse environmental or social impacts. An ethanol production model based around local-scale micro-distilleries that serve 100 to 500 households would be the most effective for Madagascar as it would: (i) reduce transport costs, (ii) reduce investment costs for distilleries[286], (iii) ensure local supply-demand chains are met and relatively isolated from external market fluctuations in supply and demand, (iv) allow progressive scaling up of the program, and (v) generate local employment for feedstock and ethanol production[287]. Such a model would need to be based on detailed biofuels mapping that ensures that all components of the supply and demand chain are spatially and economically integrated. Three criteria would need to be met, namely: (i) that sugar cane is grown where it is needed to supply micro-distilleries, (ii) that micro-distilleries are located where there is a customer base; and (iii) that the customer base is located in an area where the environmental benefits of avoided deforestation from switching to ethanol from biomass are optimized. A national mapping exercise followed by more detailed regional and local scale planning would be required to identify priority areas for program implementation, determine availability of land for feedstocks, and identify locations where biomass is currently sourced from natural forests. In the initial phases of program development it is likely that large rural centers or peri-urban areas will be prioritized due to the larger consumer base and easier access for technical support. Significant piloting, capacity building and technical support to micro-distillery development will be required together with development of standards for ethanol quality, production and transport.

[285] The recently launched Global Alliance for Clean Cookstoves (www.cleancookstoves.org) is a public-private initiative that would be a useful source of information for exchanging of experiences on past programs.
[286] Investment cost per liter of ethanol produced by micro-distilleries is around one third that of large-scale distilleries. This lower investment cost means that ethanol can be sold at more competitive prices on the local market; large scale distilleries tend to target the international transport fuel market where ethanol prices are roughly double the 35 cents/liter tariff assumed as being achievable for local household use Madagascar (PAC, 2011).
[287] PAC, 2011

Development of a network of micro-distilleries would also require consideration of social and environmental issues. Micro-distilleries and the associated feedstock production activities would need to be planned and operated to avoid direct or induced degradation of natural forests, adverse effects on local food security or food prices, or exposure of economically vulnerable populations to external market shocks. Significant levels of support to the currently low-yield sugar cane industry would be required at the national and farm level to minimize adverse effects and optimize economic opportunities for local communities. Issues of agricultural land supply[288], farmer land tenure, and competition with food crops would need to be considered, and planning of the ethanol production chain integrated with national and sub-national agriculture sector planning. In terms of environmental effects, adverse impacts on water availability, water and soil quality, sedimentation of downstream and coastal areas and emissions of air pollutants and greenhouse gas emissions have been linked to sugar cane and ethanol production internationally[289]. Development of an Environmental and Social Code of Practice for the ethanol production industry that links to the existing national regulatory framework for environmental assessment and management could be a means of addressing these issues.

In parallel with measures to overcome institutional and technical barriers, innovative financing mechanisms would need to be identified and targeted to support program development. While improved cookstoves, including ethanol cookstoves, are generating renewed interest on the part of financiers in part due to potential climate change mitigation benefits, large international donors are typically not large-scale funders of improved cookstove programs: For example, between 2000 and 2008 the World Bank directed less than 1 percent of development project financing towards clean cooking activities[290]. A range of financing sources that has come on-line in recent years could provide potential future sources of financing for development of an ethanol cookstove program in Madagascar[291], and public private partnerships should also be investigated.

[288] If full projected adoption of a program were realized, cultivated land area in Madagascar would need to increase by 3.5 percent.
[289] See for example: WWF Global Freshwater Programme, 2010; FAO, 2010; Moreira JR, undated. .
[290] World Bank, 2011b
[291] Selected examples include: (i) the Global Environmental Facility's (GEF) Earth Fund, Sustainable Forest Management Program, Small Grants Program and GEF5 climate change focal area; (ii) carbon funds managed by the World Bank's Carbon Finance Unit for sale of carbon credits through the CDM mechanism or on voluntary markets, the BioCarbon Fund, the Community Development Carbon Fund and the Forest Carbon Partnership Facility; and (iii) the Climate Investment Fund through the Forest Investment Program and Scaling Up Renewable Energy Program of the Strategic Climate Fund.

Chapter 5: Moving Forward

Chapter 5 draws together the analyses presented in the preceding chapters and presents recommendations for the World Bank's future interventions in the environment sector. The chapter describes the past and current engagements of the World Bank in the environment sector, and the lessons that can be drawn to influence future interventions. It concludes with a discussion a series of proposed short-term and medium-term interventions by the World Bank both for the current period of political transition, and for a longer-term scenario of re-engagement upon the resolution of the current political crisis.

I. Where to from here for Madagascar's Environment Sector?

1. Introduction

Despite over twenty years of concerted efforts by Government in collaboration with a large number of technical and financial partners, Madagascar's environment sector remains in a fragile state; the effects of the prolonged political instability that has reigned since 2009 have only served to exacerbate the fragile governance framework that underpins the sector. As with the political crises that have come before, the current instability is affecting previous investments and achievements in the sector and is undermining the ability to plan for the future to allow the concretization of past efforts and the pursuit of new and evolving priorities in the sector. Since 2009, the sector has suffered the dual setbacks of: (i) an almost total withdrawal of external financing, which before the onset of the political crisis contributed the majority of the sector's budget; and (ii) a power vacuum that has led to a breakdown in environmental governance in certain key sub-sectors.

The political crisis has served to magnify key weaknesses in the sector but will also allow lessons to be drawn for priority areas for future engagement. Firstly, the withdrawal of donor funding has served to highlight the inherent financial fragility of key institutions within the sector, including ONE and Madagascar National Parks and should act as a reminder that efforts to ensure their autonomy and financial sustainability should be at the forefront of future support. Secondly, the crisis has highlighted the relative ease with which environmental and natural resources governance structures can fail and be overrun by internal and external interests.

The political crisis was triggered at a moment when an era of unique collaboration between Government and technical and financial partners was drawing to a close with the completion of the Environment Program. There is a risk that the interruption caused by the political crisis will not only disrupt the momentum that was created during the previous two decades of cooperation, but will also catalyze a loss of collective institutional memory on the successes and failures of past experiences and the opportunity to draw on such lessons for the development of future interventions and partnerships. Following resolution of the current instability, external support to the environment sector will be essential and will hopefully hail a new era of cooperation between the Government and technical and financial partners. There will be a need for an intense period of reflection as to the way forward for the sector both in terms of the priority issues to be addressed and the principles and approaches that will underlie future external support.

2. Past and Current Engagement in the Environment Sector by the World Bank

Support to the Environment Program – EP1, EP2 & EP3

The World Bank was a driving force behind the development of the National Environmental Action Plan (NEAP) for Madagascar that was adopted by the Government in 1990 with the following objective "*natural resources are conserved and wisely utilized in support of sustainable economic development and a better quality of life*". Initially envisaged for a period of 15 years, the NEAP was accompanied by the 1990 Environmental Charter (now under revision), which acted as the legislative framework for the NEAP implementation. The implementation of the NEAP was through the three-phase Environmental Program (EP), which was supported by the World Bank; multi-lateral donors including the EU, GEF, IFAD and UNDP; bilateral donors such as USA, France, Germany, Japan, Norway, Switzerland and the Netherlands; and NGOs including WWF, Conservation International, WCS and CARE International. The EP was structured into five year tranches known as the EP1,

EP2 and EP3. The NEAP and the three phase EP represented a watershed moment in environmental planning and governance for the country. It heralded the establishment of the first national environmental institutions and provided a framework for a coordinated Government and external partner approach to environment sector interventions for a period of nearly twenty years.

The first phase of the EP (EP1) had the broad objectives of establishing institutions for environmental sector management – namely ONE, *Association Nationale pour la Gestion des Aires Protegées* (ANGAP - now Madagascar National Parks) and the *Agence Nationale d'Actions Environnementales* (ANAE), and addressing the most urgent conservation priorities through creation of a small number of protected areas. EP2 aimed to enhance the gains of EP1 and focused on the integration of biodiversity conservation with development and the decentralization of natural resources management. EP3 focused on embedding principles of sustainable development and the establishment of sustainable financing sources for environmental management.

Box 5.1: Successes of the Environment Program 1991 – 2009

The combined results of the three phases of the Environment Program are impressive and are due to a combination of a clearly expressed political will by successive Governments, and strong and sustained financial support from donors. As well as increasing the international profile of Madagascar and raising public awareness on environmental issues, the most striking results are the creation of 2.4 million hectares of protected areas managed by Madagascar National Parks, and 4.5 million hectares of new protected area forestry corridors being managed predominantly by NGOs on behalf of the Government. Institutions for the management, financial control and monitoring of environment related activities have been created including: a protected area manager (Madagascar National Parks), an environmental protection agency (*Office National pour l'Environnement (ONE)*), two foundations – one for protected areas (the Foundation) and the other for sustainable natural resource management by local communities (Tany Meva), and a forest monitoring unit. The rate of deforestation was reduced by 75 percent in 20 years (from just over 2 percent at the beginning of the period to 0.53 percent in 2005 - the year for which the most recent national level data is available), and there is systematic application of safeguards measures (through the MECIE – Madagascar's environmental assessment legal framework) for both public and private investments, particularly in sensitive zones. Community-based natural resource management contracts in mangrove, reef, and forest ecosystems, as well as forest zoning plans have commenced and have had significant benefits in certain regions. Environmental monitoring and reporting systems have been created to measure degradation and the results of conservation activities, and Madagascar has ratified the majority of international environmental conventions.

Source: Adapted from World Bank, 2011

In the current political transition period, the World Bank is one of few donors that continues to provide direct financial support to the environment sector. A US$52 million, three-year extension of the EP3 was approved on an exceptional basis by the World Bank Board in June 2011 and supports a single component of the original project relating to protected area management. The extension was approved to address a short-term need to fill a critical financing gap to the protected area network and thus ensure ongoing protection of 2.7 million hectares of protected areas, and a medium to long term need to scale up activities to enhance sustainable management of the network, including sustainable financing mechanisms[292]. The implementation of the EP has been subject to a high degree of national and international interest. The NEAP / EP was viewed as an innovative approach to financing of a country's environment sector and, as the first NEAP developed in Africa, it was seen as a potential model for other countries in the region. The successes of the EP until the onset of the 2009 political crisis were significant and highly visible (refer Box 5.1).

The World Bank carried out formal evaluations of the EP1 and EP2, and a preliminary evaluation of the EP3 was carried out at mid-term restructuring in 2007. These evaluations not only reflect the natural evolution of best-practice in environmental management on the part of the World Bank and partners (e.g. the initial adoption and subsequent dropping of ineffective and cumbersome ICDPs after EP1), but allow a suite of lessons to be drawn from two decades of project and program implementation that will be critically important for the development of future World Bank interventions in the environment sector (refer Table 5.1).

[292] World Bank, 2011

Table 5.1: Summary of Lessons Learnt from EP Implementation (1991 – 2007)

Political Context	A period of political instability occurred during each phase of the EP: EP1 was affected by the political crisis in 1991; EP2 was affected during a six-month period in the political crisis of 2002; and EP3 was affected by the current political crisis that commenced in 2009. During each period of instability, the effects on project implementation were significant and caused delays in implementation, loss of key counterpart staff, loss of community support and institutional momentum, and/or reduction and redirection of external and counterpart financing.
Governance Issues	Weak governance was a common theme throughout all three phases of the EP. The evaluation of each stage of the EP concluded that without improvements to governance in the environment and natural resources sector, technical drivers of environmental degradation could not be satisfactorily addressed and sustainability of program outcomes would not be achieved.
Institutional Structure	Conflicts between project implementing agencies and Government agencies occurred as a result of overlapping responsibilities and mandates and lack of arbitration mechanisms. A drain of staff and a lowering of morale in line ministries were observed in relation to the better-resourced project implementing agencies. There was inadequate integration of project activities in the core business of Government agencies. The financial sustainability of implementing agencies including ONE and ANGAP (now Madagascar National Parks) was identified as an issue following their establishment. The role of ONE evolved over the course of the program, from its initially conceived role as an implementing agency with an advisory/consulting function (post EP1) to its current role as the national environmental regulator.
Support to Policy Development	A key lesson learnt in respect to policy development was that policy frameworks needed to be developed with a clear understanding of the capacity available to implement the resulting policies. Additionally, high-level Government buy-in to policy development was essential to ensure that policies were formulated to meet Government needs and priorities and thus increase the likelihood that the resulting policies would be adopted.
Project Design	The design of each phase of the EP was seen as too ambitious and complex with project objectives that required simplification. Project monitoring and evaluation was criticized for being weak and lacking indicators of long term program impact; an important oversight given the long-term nature of many of the expected program outcomes. Economic analyses were found to be lacking in project development. There was an identified need to better integrate project design with other developments and projects in other sectors (including Government, donor and private sector concerns) in order to achieve true mainstreaming of environmental and rural development concerns and to facilitate management of conflicts with external pressures such as mining operations. There was an identified need to develop mechanisms for community involvement that resulted in short-term and tangible, economic benefits to communities. A regional and local presence was recommended for field-based activities.

Source: World Bank Study Team adapted from: World Bank & UNDP, 1996; World Bank, 2003; World Bank, 2007; World Bank, 2011, Andriamahefazafy et al, 2007

Climate Change Adaptation and Disaster Risk Management Activities

To date, the World Bank's support to climate change adaptation and disaster risk management activities have been managed separately from activities supporting the environment sector writ large as these activities commenced in earnest after the preparation and implementation of the final phase of the EP. Since 2006, the World Bank has provided technical assistance to Government on disaster risk management and climate change issues.

Examples of past activities include support for the preparation of the country's NAPA in 2006 through the financial support of the Least Developed Countries Fund (LDCF), support for national level climate change modeling in 2008 in collaboration with the Direction Générale de la Météorologie, and support to a Post Disaster Needs Assessment following the 2008 cyclone season. Currently the World Bank is operationalizing key outcomes of its technical assistance through support to strengthening of the hydro-meteorological and early warning system networks, investments in disaster response equipment and capacity, and preparation and application of additional climate resilient norms for infrastructure through the Emergency Infrastructure Preservation and Vulnerability Reduction Project that was approved by the World Bank Board in late 2012.

Carbon Finance Activities

Through the Forest Carbon Partnership Facility (FCPF), technical assistance was provided to the Government prior to the onset of the political crisis to finance preparation of Madagascar's draft R-PP for REDD+

preparation. At the project level, since 2006 the BioCarbon Fund[293] of the World Bank has supported two carbon-finance projects. The TAMS reforestation project aimed to restore natural forests in the south of the CAZ corridor to link remnant native vegetation, and demonstrate a financing model for reforestation projects with ecological objectives. Between 2007 and 2010 the EP3 financed reforestation of 1,128 hectares on State and privately owned land. An Emissions Reduction Purchase Agreement (ERPA) was signed between the BioCarbon Fund and the MEF to purchase 200,000 tons of "Verified Emissions Reductions" at a price of US$4.10 per ton that would be generated to 2017. However, the ERPA never became effective as certain pre-conditions related to the project institutional arrangements were not met and the contract was subsequently cancelled.

The CAZ REDD+ project aims to reduce deforestation in an area of 425,000 hectares in the CAZ protected area through development of alternative revenue generation and livelihoods activities for local communities and support to decentralized natural resource management. The project aimed to test the voluntary carbon market as a potential source of sustainable financing. The BioCarbon Fund signed an ERPA with the Ministry of Finance in 2008 for the purchase of 430,000 tons of emissions reductions at a price of US$3.5/ton. A complementary GEF financing aims to strengthen capacities in carbon monitoring, including local community involvement in monitoring.

In addition to continued BioCarbon Fund support that is planned to run until 2017, the World Bank continues to provide support to technical activities linked to carbon finance as part of the EP3 through development of an reference scenario for carbon stocks in the eastern humid forests ecoregion.

3. Future Priorities for the World Bank in the Environment Sector

In the short term, the World Bank's operations in Madagascar are guided by an Interim Strategy Note (ISN) that was approved by the World Bank Board in February 2012. Madagascar's most recent Country Assistance Strategy (CAS) expired in June 2011 and given the political instability, the country is not in a position to prepare a new full CAS given the absence of normal dialogue with the Government. The ISN was prepared as a short-term strategy that has been developed to respond to the current political instability in the country and guide the future activities of the World Bank until mid-2014. During this period, future interventions in the environment sector will be aligned with the ISN, which documents the following approach for the World Bank's activities[294]: (i) focus on the most pressing short term issues affecting the country, while keeping a medium term view on the key strategic pillars of governance, employment and vulnerability to prepare the ground for re-engagement; (ii) use of the existing portfolio more strategically through a restructuring effort that would improve project performance to achieve greater impact in areas of urgent needs through reallocation of existing funds; (iii) pursuit of an analytical effort to update the knowledge base in priority areas on which to re-engage when conditions permit; (iv) promotion of enhanced partnership with technical and financial partners to maximize the impact of existing interventions and approaches; and (v) adoption of a cautious, strategic and selective approach to new lending so as to address emergency situations in social sectors and to deal with major external shocks or humanitarian crises as they may occur.

The analyses in the preceding sections of the CEA identified a large number of suggested actions to improve environment sector performance in Madagascar; the following sections identify which of those actions are likely to be suitable for future World Bank support in the short and long-term. The development of recommendations for future interventions of the World Bank has been based on a consideration of: (i) the need to build on and protect existing investments in the sector; (ii) the need to commence engagement on 'hidden' environmental priorities that have received less attention to date from Government and development partners; and (iii) the need to address underlying causes of weak environment sector performance without which any other future interventions will not succeed. Suggestions for the future role of the World Bank in the environment sector are structured around three themes. These strategic themes and the recommended future interventions of the World Bank will be discussed with the Government of Madagascar as part of dialogue on a future partnership strategy that will take place upon resolution of the current political crisis.

[293] The World Bank's BioCarbon Fund becaome operational in 2004 with the objective to support demonstration projects that sequester or conserve carbon in forest and agro-ecosystems. The Fund, a public/private initiative administered by the World Bank, aims to deliver cost-effective emission reductions, while promoting biodiversity conservation and poverty alleviation.
[294] World Bank, 2012

I. Improved valuation of natural capital and development of market mechanisms for revenue generation

Madagascar's natural resources represent a substantial component of the country's total wealth. The country's degraded and patchy infrastructure and poorly qualified workforce, ensure that the effective capture and management of revenues generated by renewable and non-renewable natural capital will be essential to future economic development. No robust quantitative analyses of the scale of the country's total wealth exist and there are few policies to facilitate the transformation of economic benefits provided by natural capital in a way that could facilitate the country's progress along a more sustainable development pathway.

A clear example of the need for improved valuation of natural capital manifests in the case of the protected area network. There remains a mismatch between the value of the protected area network, both in terms of its tangible economic values and the conservation of its biodiversity resources, and the sources of financing available to support it. A financing gap percent exists and while initial forays into sustainable financing approaches have been made through the establishment of a national conservation trust fund and ecotourism development, much remains to be done. International support to the network will continue to play a role due to the status of the country's biodiversity as a global public good. However, increased strengthening of sustainable financing mechanisms and an enabling policy framework that captures, transforms and earmarks the economic benefits of tourism and carbon finance for use in protected area management is required.

➔ ***Role of the World Bank:*** *In the short-term the World Bank will provide technical support to the Government to better understand the country's natural capital values in the mining, fisheries, water resources and forestry sectors, and integrate them into policy development through the WAVES Global Partnership. The WAVES Workplan includes technical support to commence the implementation of natural capital accounting across five themes: large-scale mining, water resources, forestry and protected areas, coastal resources, and complementary macro-economic indicators. Protected areas will be a priority work area of WAVES with a range of natural capital accounting activities proposed that will allow a characterization of the potential economic benefits of the network. In parallel, the EP3 will support the development of market mechanisms – including tourism and forest carbon – that will help to assure the longer-term sustainability of the network.*

In the longer term, the World Bank will continue dialogue with the Government on the development of market mechanisms for the transformation of economic values of natural resources and environmental services into revenues that can support management of the environment sector. Such mechanisms represent one of the only means by which adequate revenues for sector management can be generated given the breadth of the challenges identified in the CEA.

II. Improved environment sector governance

Experience in other African countries shows that, depending on the economic development pathway taken, substantial wealth in the form of natural capital can either be a blessing or a curse. The strength of environmental governance frameworks is a key determinant in the pathway that is followed and the ability to manage the various stages of natural capital transformation. Strong governance is required to ensure that non-renewable resources are extracted in a manner that optimizes the revenues generated, allows equitable distribution and investment of revenues and protects other forms of natural capital. Similarly, governance structures must be adequate to ensure that renewable resources are managed in a sustainable manner that ensures their integrity and ongoing productivity.

Robust governance in the environment sector has always been and will remain to be a challenge in Madagascar. However, as long as governance structures are weak, the ability to achieve sustainable outcomes across other facets of the sector risks being undermined. Additionally, weak governance undermines the ability to capture and transform economic values of natural resources to allow better management of the country's environmental riches and to support a sustainable development pathway for Madagascar.

➔ ***Role of the World Bank:*** *The World Bank is currently financing a technical assistance for the disposal of stocks of precious timber. In the medium term, and dependent upon resolution of the political crisis, the World Bank, through the Forest Carbon Partnership Facility, is also likely to resume funding for the development of a strategy on forest carbon. In the longer term, the World Bank may consider financing a governance project for natural resources. This project could take the form of budget support that would involve financing of ex post financing reforms, rather than financing ex ante activities. The same instrument could also be used to introduce the principles of reduction of pollution in domestic households into public policy, and prepare the foundations for a public policy related to adaptation to climate change.*

III. Reduction of social and climate related vulnerability

Madagascar is a highly vulnerable country to natural disasters and climate change. The wide range of natural disasters that occur in Madagascar, coupled with the high rates of dependence on natural resource based sectors such as agriculture and fisheries for the livelihoods of the predominantly rural population, compound climate related vulnerability. Global climate change is expected to increase current levels of vulnerability through increasing intensity and frequency of climate related natural disasters particularly in terms of more severe droughts in the south of the country, increased frequency of intense cyclones and rising sea levels that will threaten coastal development.

➔ ***Role of the World Bank:*** *The World Bank has for several years supported technical assistance in disaster risk management and intends to continue this assistance. The Bank is also supporting certain investments, especially in relation to early warning systems and disaster response investments through the multi-sectoral emergency operation that was approved by the Board of Directors at the end of 2012. In the longer term, the World Bank could fund a multi-sector operation aimed at enhancing the resilience of the population in southern Madagascar to the recurring droughts that are experienced in this region.*

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Chapter 1: Introduction

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Chapter 2: Identification of Enviroment - Development Priorities

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ANNEX 1: PRINCIPAL VEGETATION TYPES AND CHARACTERISTICS IN MADAGASCAR

Vegetation Type	Surface (km^2)	Principal Characteristics and Threats	% in PA (2006)
Humid forest	47,737	Evergreen vegetation with closed canopy and multi-layered understory structure; canopy height can reach 30 – 35m. High annual rainfall. Vegetation spans wide range of elevation (up to 2750m) and latitude/longitude. Provides exceptional ecosystem services including watershed protection and erosion control but sensitive to disturbance. Main pressures include tavy and cyclones in the north-east. An additional 58,058km^2 of degraded humid forest is found on the eastern and central plateau of Madagascar and contains a mixture of forest remnants and degraded vegetation.	39.0
Western dry forest	31,970	Sub-humid to dry climatic conditions from sea level generally to 800m, but up to 1600m in north. Floristically diverse depending on rainfall and substrate ranging from forest to impenetrable thickets to bushland and low scrub. Largely deciduous with the exception of riparian elements along rivers. Of great conservation importance, containing many endemic woody species and indigenous fauna species. Cutting for firewood and charcoal and clearing for agriculture are the main threats.	17.1
South western dry spiny forest thicket	18,355	Emblematic vegetation type found in sub-arid zone up to 300m. Ranges from forest to impenetrable thicket to bushland and low scrub. Dominated by four endemic genera of Didieraceae family with the dominant species varying by substrate and location. Contains very high levels of endemism. Lack of formal protection, cutting for charcoal and firewood, together with agricultural clearing are the greatest threats. Invasive plant species are also causing degradation. An additional 5,427km2 of degraded vegetation type is located in the southwest.	4.5
Western sub-humid forest	4,010	Found in sub-arid to sub-humid zone on sandstone soils on wide ranging elevations. Vegetation canopy consists of continuous stand of trees with interlocking crowns. Contains deciduous and evergreen elements. Severely fragmented and encroached. Of great conservation importance, containing many endemic woody species and indigenous fauna species. Clearing to support informal settlements for sapphire mining, together with cutting for firewood and charcoal and clearing for agriculture are the main threats.	6.88
South-western coastal bushland	1,761	Found in sub-arid climatic zone on the southwest coastal belt at low elevation. Comprises open stands of bushes 3-7m tall with 40percent canopy coverage. Not floristically unique but an important source of ecosystem services for fishing and subsistence communities. . Lack of formal protection, cutting for charcoal and firewood, together with agricultural clearing are the greatest threats. Invasive plant species are also causing degradation.	0.53
Tapia forest	1,319	Sub-humid to sub-arid climate on mid-elevation topography. Evergreen canopy of 10-12m with shrubby understory and moderate to rich herbaceous layer dominated by grasses. Characterized by two endemic plant families. High floral and faunal diversity. Well adapted to fire, but threatened by charcoal production, firewood and timber collection and grazing.	20.6
Littoral forest	274	Perihumid to humid climate and low elevation. Has three main components: sandy soil forest, marsh forest and grassland. Occurs on fragile soils derived from unconsolidated sand. Despite its small area, littoral forest supports 13 percent of Madagascar's total native flora and 25 percent of species are endemic to this vegetation type. It is thought to have played an important role as a climate refuge during past climate disturbances. Main pressures include wood collection for construction and fuelwood, tavy, bushfires and increasingly mining exploration in the south-east.	13.8
Western humid	72	Cool or temperate subhumid microclimate on mid-elevation topography. Small patch of mixed evergreen and sclerophyll high forest with closed	0.3

Vegetation Type	Surface (km^2)	Principal Characteristics and Threats	% in PA (2006)
forest		canopy and well defined understory. Satellite imagery suggests that this is a separate vegetation class, but this requires further verification. Considered sacred by local people but used to hide cattle and honey collection. Main threats arise from the lack of formal protection and burning on forest edges for creation of pastures.	

(Source: adapted from Moat & Smith, 2007)

ANNEX 2: TRUE OR FALSE?: ENVIRONMENTAL MYTHS IN MADAGASCAR

Understanding the extent and root causes of environmental degradation and natural resource loss in Madagascar is a preliminary step to addressing these problems. However, the history of Madagascar's environmental challenges has been fraught with epistemological difficulties. For decades, actors in the environmental space have seized upon incomplete explanations of degradation to justify their policy choices. Conservation groups, development agencies, and researchers alike have not shied away from dramatizing the extent of the country's environmental problems, often with particularly vivid imagery. The island of Madagascar, with its rust-colored sediment-laden rivers, has been described as "bleeding to death,"[295] and its *lavakas* likened to "gangrenous wounds"[296] or "lunar landscapes"[297] "gouged from barren hills."[298] These colorful descriptions are typically backed with striking estimates of environmental devastation: accounts that 80-90 percent of the country's forests have been lost,[299] or that a whopping 400 tons of soil per hectare are lost to erosion each year.[300] Such estimates rest on assumptions that have become increasingly criticized. The "true" extent and causes of environmental degradation—particularly with respect to the related problems of deforestation and soil erosion—are more complex issues than the dominant narratives represent, and remain a subject of controversy. This annex provides a rapid overview of two of these dominant narratives, namely those concerning the twin problems of deforestation and soil erosion.

Deforestation

Debates over Madagascar's original forest cover date back to the 19th century. European geographers and botanists of that period were divided on whether the country's wide swaths of grassland were naturally tree-less or the result of human activity.[301] Alfred Grandidier, one of the era's best-known naturalists, contended that Madagascar's central highlands had been grassland prior to human arrival, extrapolating from earlier accounts by explorers and studies of soil composition.[302] However, this view was displaced around the turn of the century. In 1896, France colonized Madagascar; the French largely condemned Malagasy agricultural practices, which they saw as contributing to deforestation. The French colonial state pushed the development of logging concessions and export crop production, which displaced domestic food production and contributed to increased population pressures on natural resources. Under French rule, the theory of a fully-forested island came to dominate, in large part due to the work of two prominent French botanists, Henry Perrier de la Bâthie and Henri Humbert. These two botanists (and others following them) asserted that, predating human arrival, Madagascar was nearly entirely covered by forests, which thrived in the absence of human influence. After human arrival in Madagascar about 2,000 years ago, the story goes, these primeval forests, singularly maladapted to wildfire, were then severely diminished and degraded by human use of fire to manage pastures and clear woodland. In this narrative, the blame for forest loss is placed squarely on the shoulders of the Malagasy people.

This narrative has by and large persisted over the last century, appearing in academic publications and the documents of international development agencies (including the World Bank). In this view, grasslands represent degraded ecosystems, supposedly biodiversity-poor regions where lush forests once stood. The evidence advanced for this theory consists of such arguments as (i) the apparent poverty of species and endemism in grasslands in comparison with forest ecosystems,[303] where a "rich endemic herbaceous flora would have been expected" if grasslands had been the "original" vegetation[304]; (ii) that all of Madagascar's

[295] WildMadagascar.org, *Erosion in Madagascar*, accessed Feb. 17, 2012, *available at* http://www.wildmadagascar.org/conservation/erosion.html
[296] Dervla Murphy, MUDDLING THROUGH IN MADAGASCAR (Overlook TP, 1990), as cited in Christian Kull, *Deforestation, Erosion, and Fire: Degradation Myths in the Environmental History of Madagascar*, 6 ENVIRONMENT AND HISTORY 423, 2000.
[297] World Bank, *Environmental Program: Staff Appraisal Report*, 4, March 19, 1990.
[298] *As cited in* Christian Kull, *Deforestation, Erosion, and Fire: Degradation Myths in the Environmental History of Madagascar*, 6 ENVIRONMENT AND HISTORY 423, 2000.
[299] World Bank, *supra* note 297; Bryan Walsh, *Saving the Wildlife of Madagascar*, TIME, Sept. 25, 2008, http://www.time.com/time/health/article/0,8599,1844474,00.html
[300] WildMadagascar.org, *supra* note 295.
[301] Jørgen Klein, *Deforestation in the Madagascar Highlands – Established 'Truth' and Scientific Uncertainty*, 56 GEOJOURNAL 191, 192, Jan. 15, 2003.
[302] Kull, *supra* note 298.
[303] K. J. Willis, L. Gillson, and M. Virah-Sawmy, *Nature or Nurture: the Ambiguity of C4 Grasslands in Madagascar*, 35 JOURNAL OF BIOGEOGRAPHY 1741, 2008.
[304] Jorgen Klein, *supra* note 301.

mammals are forest-dwelling; (3) the fact that remains of ancient tree trunks and tree fruits, as well as pollen spectra from 1000 AD, indicate ancient forest cover; and (iv) the existence of oral folk tradition recounting tales of vast forest cover.[305]

From this theoretical baseline of a wholly forested island, a "consensus" of sorts emerged that 80-85 percent of the original forest cover was destroyed by human activities. This discourse "about the environment-society relationship . . . [has] been repeated over and over again until they have become institutionalized as facts."[306] Table A.1 below presents the deforestation estimates and original forest cover assumptions made by various entities over the course of the twentieth century.

Table A.1: Reports of forest degradation rates[307]

Source	Institutional Support	Year	Assumed original forest cover	Extent of deforestation
Pierre Boiteau[308]	N/A	1958	Entirely forested	
Humbert & Cours Darne	N/A	1965	Entirely forested	90%
Jolly et al.	N/A	1980	N/A	80%
Jenkins	IUCN	1987	Entirely forested	70-75%
Madagascar Environmental Action Plan 1, 2[309]	World Bank, USAID, Cooperation Suisse, UNDP, WWF, UNESCO	1988, 1996	Mostly forested	80%
Bakke	WWF, NORAD	1991	Entirely forested	88%
World Conservation Monitoring Centre	N/A	1994	Mostly forested	60-85%
USAID	N/A	1998	Mostly forested	> 80%

Source: Klein 2002; Klein 2004; Harper 2007.

Starting in the 1980s, a "counter-narrative" has emerged (or re-emerged) regarding the extent of deforestation in Madagascar, in large part based on scientific research whose results undermined the dominant narrative.[310] Publications by academics Christian Kull (2000, 2002) and Jørgen Klein (2003, 2004)[311] bring together much of this research to criticize the dominance of what they call the "deforestation narrative" and "degradation myths." This growing body of scientific evidence points to a different conclusion: the first humans arriving in Madagascar would have encountered not just dense forests, but also vast regions of grassland and shrubland. In direct contradiction to the dominant explanation, the new research suggested that

[305] Daniel Gade, *Deforestation and its Effects in Highland Madagascar*, MOUNTAIN RESEARCH AND DEVELOPMENT, Vol. 16, No. 2, 101, as cited by Jorgen Klein, *supra* note 301.

[306] Jørgen Klein, *supra* note 301. See also Jorgen Klein, *Fiddling While Madagascar Burns: Deforestation Discourses and Highland History*, NORWEGIAN JOURNAL OF GEOGRAPHY, Vol. 58, 2004.

[307] *See* Jørgen Klein *supra* note 306; Grady Harper, Marc Steininger, Compton Tucker, Daniel Juhn, and Frank Hawkins, *Fifty Years of Deforestation and Forest Fragmentation in Madagascar*, 34 ENVIRONMENTAL CONSERVATION 325, 2007.

[308] Chantal Blanc-Pamard and Hervé Rakoto Ramiarantsoa, *Madagascar: Les Enjeux Environnementaux* in L'AFRIQUE: VULNERABILITE ET DEFIS. 354-376, Éditions du Temps, 2003.

[309] See, e.g., World Bank, *supra* note 297, p. 71; EP2 Project Document, p. 15

[310] *See, e.g.*, W. Bond, J. A. Silander, J. Ranaivonasy and J. Ratsirarson, *The Antiquity of Madagascar's Grasslands and the Rise of C4 Grassy Biomes*, JOURNAL OF BIOGEOGRAPHY, 2008; Fernand Bourgeat and Georges Aubert, *Les Sols Ferralitiques à Madagascar*, 20 MADAGASCAR: REVUE DE GÉOGRAPHIE 1-23 (1972); David Burney, *Late Quaternary Stratigraphic Charcoal Records from Madagascar,* 28 QUATERNARY RESEARCH 274-280, 1987 (citing Robert E. Dewar, *Recent Extinctions in Madagascar: the Loss of the Subfossil Fauna*, *in* QUATERNARY EXTINCTIONS: A PREHISTORIC REVOLUTION, 574-593 (P.S. Martin and R.G. Klein eds., 1984)); David Burney, *Late Holocene Vegetational Change in Central Madagascar*, 20 QUATERNARY RESEARCH, 130-143, 1987; David Burney, *Pre-Settlement Vegetation Changes at Lake Tritrivakely, Madagascar*, 18 PALAEOECOLOGY OF AFRICA AND THE SURROUNDING ISLANDS, 357-381, 1987; David Burney; *Climate Change and Fire Ecology as Factors in the Quaternary Biogeography of Madagascar*, *in* BIOGÉOGRAPHIE DE MADAGASCAR, 49-58 (W.R. Lourenco ed., 1996); David Burney, *Theories and Facts Regarding Holocene Environmental Change Before and After Human Colonization*, *in* NATURAL AND HUMAN-INDUCED CHANGE IN MADAGASCAR, 75-89 (S. M. Goodman and B.D. Patterson eds., 1997); B. L. Fisher and H. G. Robertson, *Comparison and Origin of Forest and Grassland Ant Asemblages in the High Plateau of Madagascar (Hymenoptera: Formicidae)*, 34 BIOTROPICA, 155-167, 2002; F. Gasse and E. Van Campo, *Later Quaternary Environmental Changes from a Pollen and Diatom Record in the Southern Tropics*,167 PALAEOGEOGRAPHY, PALAEOCLIMATOLOGY, PALAEOECOLOGY 287-308, 2011; William McConnell, Sean Sweeney, Bradley Mulley, *Physical and Social Access to Land: Spatio-Temporal Patterns of Agricultural Expansion in Madagascar*, 101 AGRICULTURE, ECOSYSTEMS AND ENVIRONMENT 171-184, 2004; Ross MacPhee, David Burney, and N.A. Wells, *Early Holocene Chronology of Environment of Ampasambazimba, a Malagasy Subfossil Lemur Site*, INTERNATIONAL JOURNAL OF PRIMATOLOGY 6(5), 463-489, 1985; K. J. Willis et al, *supra* note 303.

[311] Jørgen Klein, *supra* note 301; Jørgen Klein, *Fiddling While Madagascar Burns: Deforestation Discourses and History*, 58 NORWEGIAN JOURNAL OF GEOGRAPHY 11, 11-22, 2004; Christian Kull, *Deforestation, Erosion, and Fire: Degradation Myths in the Environmental History of Madagascar*, ENVIRONMENT AND HISTORY 6(4), 423-450, Nov. 1, 2000; Christian Kull, ISLE OF FIRE: THE POLITICAL ECOLOGY OF LANDSCAPE BURNING IN MADAGASCAR, University of Chicago Geography Research Papers, July 7, 2004.

much of the West and the grasslands of Madagascar's highlands predated human arrival. Where changes in vegetation appear to have occurred, scientific research points to climatic factors as a potential culprit.[312] The fossil record also indicates mixed vegetation of woodland, shrubland, and grassland, supported by paleontological findings about the ground-dwelling nature of now-extinct fauna.[313] Furthermore, charcoal concentrations in sediment layers were higher *prior* to human arrival, indicating, perhaps, that fires, while they may have influenced patterns of vegetation, were not necessarily a result of human activity.[314] In fact, certain studies peg the fire history of Madagascar as extending back to 36,000 years ago. [315] Many plant species also show signs of adaptation to fire to gain an evolutionary edge, which is unlikely to have happened as a result of the relatively recent human arrival in Madagascar.

Soil Erosion

Although perhaps not as polemical as Madagascar's forest narrative, confusion regarding the extent of soil erosion abounds. This is not to discount the gravity of loss in soil quality in Madagascar. The country already has one of the lowest soil productivity levels in the world[316]; on top of this, erosion leads to reduced soil fertility and, accordingly, even lower agricultural productivity. However, measures of soil degradation are scarce and erratic, especially at the national level. Existing research tends to be at the field level scale; when soil loss rates are extrapolated from the local scale to a watershed or even national scale, the results differ wildly. Table A.2 below shows the divergence between the different estimates of erosion in Madagascar. Such erosion statistics, out of context, do not provide much information about the extent of actual soil degradation: soils vary in their tolerance to erosion, such that an area undergoing intense erosion can actually be less degraded than an area with only light erosion.

Table A.2: Different estimates of soil erosion in Madagascar

Source	Region	Estimate
INSTAT, 2000[317]	National average	200-400 tons/ha/year
Radrianarijoana, 1983	Highlands	25-250 tons/ha/year
Roffet, 1995	Eastern tavy plots	30 tons/ha/year
Bresson, 1996		0.5-4 tons/ha/year
Cox et al., 2009		0.16-0.54 tons/ha/year

Here, too, a narrative of sorts has emerged.[318] Development agencies and conservation organizations have used these estimates of soil erosion loosely. The World Bank's own use of erosion rates mirrors the variance in scientific estimates, and illustrates the uncertainty and difficulty of generalizing about erosion in Madagascar. For instance, in 1990, in its first Environmental Program, the World Bank's Program Document cited a figure of 100 tons per hectare per year of topsoil loss due to deforestation "on steep slopes."[319] Then, in 1996, in its EP2 Program Document, the World Bank cited an annual rate of topsoil loss from deforestation of up to 150-200 tons per hectare "on bare land."[320] Finally, in its EP3 Program Document in 2004, the annual figure cited for erosion due to deforestation was an order of magnitude lower: 15 tons per hectare.[321] Other international organizations (such as USAID and Global Vision) have drawn on figures of 200 – 400 tons per hectare of topsoil loss, which would be about 20-40 times above the global average.[322] However, these rates represent extreme cases of erosion, and must be placed in proper context—especially in light of the more modest rates listed in Table A.2 above.

[312] *See* Fernand Bourgeat, *supra* note 310; David Burney (1987, 1997), *supra* note 310; *see also* Jørgen Klein, *supra* note 301 (2003, 2004).
[313] *See* Ross MacPhee *supra* note 310; *see also* Jørgen Klein, *supra* note 301.
[314] Jørgen Klein, *supra* note 301, p. 193.
[315] David Burney, *Late Quaternary Stratigraphic Charcoal Records from Madagascar,* 28 QUATERNARY RESEARCH 274, 275, 1987.
[316] Milasoa Cherel-Robson and Bart Minten, *La Voix des Clients: Les Priorités de Développement d'Après une Approche Participative*, in AGRICULTURE, PAUVRETE RURALE ET POLITIQUES ÉCONOMIQUES A MADAGASCAR, Nov. 2003, *available at* http://www.ilo.cornell.edu/ilo/bookfr.html
[317] As cited in Michael Zavada, Yeqiao Wang, Gérard Rambolamanana, Andriamiranto Raveloson and Hélène Razanatsoa, *The Significance of Human Induced and Natural Erosion Features (lavakas) on the Central Highlands of Madagascar*, MADAGASCAR CONSERVATION & DEVELOPMENT 4(2), 120-27, 2009.
[318] See Christian Kull, *supra* note 302, p. 436.
[319] World Bank, *supra* note 297, at 4.
[320] World Bank, Second Environment Program Project Document, Nov. 1996, 3; World Bank, *supra* note 297, at 4.
[321] World Bank, Third Environmental Program, Project Appraisal Document, April 2004, 88.
[322] Ronadh Cox, Paul Bierman, Matthew C. Jungers, and A. F. Michel Rakotondrazafy, *Eroision Rates and Sediment Sources in Madagascar Inferred from 10Be Analysis of Lavaka, Slope, and River Sediment*, 117 JOURNAL OF GEOLOGY 363, 363, 2009.

It has become part of the accepted discourse that Madagascar's *lavakas* are caused by human agency, notably deforestation, grassland burning, and overgrazing. However, recent geological studies suggest that the central highlands were already marked by *lavakas* before human settlement,[323] which aligns with the fact that newly deforested areas reveal the outline of ancient *lavakas*.[324] The situation is analogous to that of deforestation: a phenomenon that is widely believed to be a result of anthropogenic influence is actually shown in some cases to predate human arrival. In line with this analogy, however, is the fact that while human agency may not be entirely responsible for the phenomenon, rural livelihood practices may well exacerbate them. Of the *lavakas* studied during one instance of field research, 25 percent of them were clearly linked to human activity, while 20 percent had definite, non-anthropogenic causes (such as climatic pressures, tectonic activity, or seismic shifts); however, the exact causes of the majority remain undetermined.[325] Furthermore, this focus on *lavakas* itself detracts from the significant—but less visually striking—problem of sheet erosion.[326]

Effect of Narratives

Both the deforestation and erosion narratives conflate the complex and different dynamics affecting the various regions of Madagascar to produce one, simple, streamlined explanation of environmental degradation—one that is not entirely accurate, but resonates with Western audiences. (It should be noted that these narratives were largely created by Western entities for Western audiences). While such narratives can be characterized as harmless exaggerations, they should not be dismissed too quickly. The scale of environmental degradation in Madagascar is severe enough and needs no undue amplification. However, environmental narratives affect policy decisions of both the Malagasy government and international donors. Obfuscating the true nature and causes of environmental degradation results in misinformed policy, legislation, and resource management plans. Ultimately, this is a disservice to the goals of poverty reduction and environmental protection. The emerging counter-narratives have responded to the dominant story by pointing to the multiplicity and complexity of the causes of natural resource loss, and contextualize the role human activity as one of many factors—and not the single cause—of deforestation and land degradation.

[323] *Id.*
[324] N. A. Wells and B. Andriamihaja, *The Initiation and Growth of Gullies in Madagascar: Are Humans to Blame?*, 8 GEOMORPHOLOGY 1, 1993; N. A. Wells and B. Andriamihaja, *Extreme Gully Erosion in Madagascar and its Natural and Anthropogenic Causes*, *in* NATURAL CHANGES AND HUMAN IMPACT IN MADAGASCAR 44-74 (Smithsonian Institute, 1997).
[325] Wells and Andriamihaja, *supra* note 325 (1993).
[326] Kull, *supra* note 302, at 436.

ANNEX 3: WAVES MADAGASCAR – POLICY BRIEF

1. Introduction to WAVES Madagascar & Activities to Date

"WAVES Madagascar aims to strengthen the capacity to manage Madagascar's natural capital and to promote sustainable development"

Madagascar is one of five developing countries that is a partner of the WAVES Global Partnership. With its abundant natural resources and a predominantly poor, rural population Madagascar is an ideal candidate within which to test the application of natural capital and ecosystem service accounting methods and the links to policy development. There are currently no quantitative analyses of the scale of the country's natural capital wealth and virtually no integration of natural capital economic values in the policy framework. WAVES Madagascar will establish a range of tools to start redressing this situation and allow the economic value of selected natural resources to be integrated into analysis and monitoring of macro-economic performance, as well as decisions and policy making related to natural resource management.

Since the launching of WAVES Madagascar in 2011, the Government of Madagascar has signaled its strong support for the Partnership through Cabinet endorsement of Madagascar's involvement in the partnership, the allocation of co-financing of USD500,000 for WAVES activities in and around protected areas, and the formal establishment of a national Steering Committee with high level technical representation from Government, including the Secretary-General of the Ministry or Economy and Industry that will act as the Co-president. The Government has also endorsed a communiqué and declaration arising from the Summit on Sustainability in Africa related to the implementation of natural capital accounting

Technical activities over the last two years have focused on consultations and awareness-raising with Government, civil society and development partners to introduce concepts of natural capital accounting and to undertake a scoping exercise to identify priority issues for consideration during WAVES activities. These discussions led to the development of a detailed workplan and budget for WAVES Madagascar, which was validated by the Steering Committee in August 2012. In recent months activities have focused on detailed planning and preparation for the first round of technical assistance activities that will commence in early 2013. In a parallel process, the Government has recruited a National Coordinator that will act as the Government focal point for WAVES and play an integral role in the team implementing the workplan.

This Policy Note has been prepared in advance of the 2013 WAVES Global Partnership Meeting (9 – 11 April, 2013) to provide background on WAVES Madagascar, an update of progress since the last Partnership meeting and present an overview of the priority activities for the next year of WAVES Madagascar.

2. Overview of Macro-economic Context in Madagascar

For the last thirty years, weak growth and fragility in the face of repeated political crises have characterized the macroeconomic performance of Madagascar. Between 1980 and 1995, average annual GDP growth was less than 2 percent. Improved GDP growth rates were evidenced from the late 1990s, and significant growth was seen between 2004 and 2008, with a peak in annual growth of 7.1 percent in 2008. With the onset of the political crisis in 2009, it dropped dramatically to negative growth of - 4.6%, before returning to positive growth of 1.6 percent in 2011.

The modest economic growth experienced by Madagascar in recent decades has been insufficient to compensate for the country's rapid population growth, currently estimated at 2.8 percent per annum. With GDP/capita estimated at US$453 in 2010, Madagascar is categorized amongst the poorest countries in the world. Since 1980, GDP/capita has decreased in real terms and an 18 percent decrease in real GDP/capita was evidenced between 2008 and 2010. The gap in terms of GDP/capita between Madagascar and the Sub-Saharan African region has widened over this period, with current national GDP/capita less than half the regional average. 76.5 percent of the population – representing 15.4 million persons - lives below the poverty line. Rural areas experience the highest levels of poverty with 82.2 percent compared to 54.2 percent in urban areas

The tertiary sector is the predominant sector in the Malagasy economy representing 52.9 percent of GDP in 2010 (refer Table 1). Transport and service activities dominate the GDP of the tertiary sector and while tourism continues to play an important role, economic activity in this sector, which has traditionally been one of the largest sources of foreign exchange earnings, has been significantly affected by the current political instability.

The primary sector accounts for 25.7 percent of the national GDP, with agricultural activity the most important contributor, followed by livestock and fisheries and forestry activities. Agriculture is the main livelihood source for the rural population and is essential to meet subsistence needs. Agricultural production – notably rice production – is in fact the single largest contributor to GDP constituting 14.1 percent of GDP in 2010. The contribution of coastal and marine resource exploitation has stagnated in recent years with economic activity decreasing annually by 2 percent between 2008 and 2010. The contribution of forestry to GDP has seen a net augmentation in the same period with annual growth of 30.4 percent linked to precious timber exploitation that had an export value of US$176 million in 2009.

Table 1: Structure of Madagascar's Economy

	2008	**2009**	**2010**
Population	19,071,811	19,601,026	20,142,015
GDP (US$ millions)	8,041	8,365	9,132
GDP (US$ per capita)	469	478	453
Structure of GDP (% of total):			
Primary Sector	22.3%	26.7%	25.7%
Agriculture	13.4%	14,9%	14,1%
Forestry	5.2%	5.4%	4.4%
Livestock and fisheries	3.7%	6.5%	7.2%
Non-primary Sector	77.7%	73.3%	74.3%
Food and agricultural feed industries	3.6%	3.9%	4.4%
Extractive industries	0.1%	0.2%	0.2%
Timber industries	0.2%	0.2%	0.1%
Production of mineral and metal products	1.7%	1.7%	1.4%
Transformation industries	7.0%	7.0%	6.8%
Other industries	1.9%	1.8%	1.8%
Services and others	54.6%	51.5%	52.9%

Source: Instat. 2012. Tableau de Bord de l'Economie en 2012.

Industrial economic activities are dominated by food, beverage and energy production however the mining sector is of growing importance. Investments by two large-scale mining operations (Rio Tinto's ilmenite mining operation in the south-east and Ambatovy's nickel and cobalt mining operation in the east) represented more than 65 percent of GDP in recent years. Exported production from these two operations is expected to contribute between 30 and 60 percent of national export earnings in coming years, and their contribution to the fiscal revenues of the State is expected to increase from 1 percent to 18 percent by 2018.

The national economy is not greatly diversified and is concentrated in several sectors and geographic regions that have become development hubs because of their higher population densities, their proximity to large development projects (such as mining projects) or their access to markets. The marginalization of other regions where poverty rates are significantly higher has influenced the poor economic performance of the entire country. This inequality of economic activity, particularly in rural areas, has led to a lack of employment opportunities for poor rural households, thus increasing their overall vulnerability.

Madagascar has an open economy and has favored regional economic integration, however exports to neighboring countries remain low and Europe, the USA and Asia have to date remained the most important

markets for Madagascar. In the last three years, the suspension of preferential trading treaties following the onset of the political crisis has however negatively affected export activities to these countries.

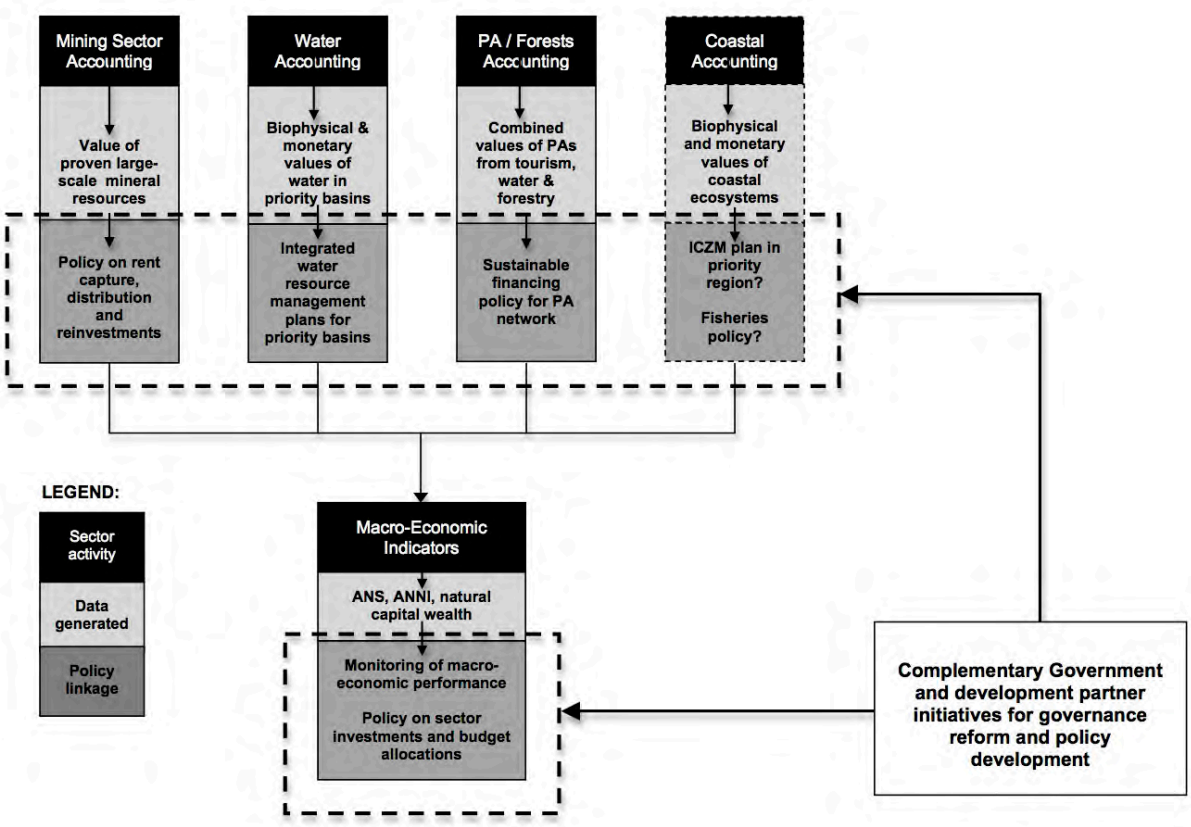
Weak national savings and high fiscal pressure (estimated at 11 percent of GDP in 2010) are limiting factors to development of the private sector and investments in human capital. The economy remains highly dependent on external aid, which before the 2009 political crisis accounted for approximately two thirds of the public investment budget, and foreign direct investment in a limited number of sectors such as mining and to a lesser extent tourism. Following the onset of the political crisis, suspension of foreign aid has severely affected public investments with a decrease of 60 percent between 2008 and 2009.

The national economy is vulnerable in the face of climatic shocks such as droughts, cyclones and flooding that affect the country every year. These events provoke considerable damages in key economic sectors such as the transport and agricultural sectors and the effects are unequally distributed with poor, rural populations being the hardest hit. The 2008 cyclone season, which was the last season for which a comprehensive evaluation was carried out, caused losses equivalent to 4 percent of GDP and the 2012 season is expected to cause similar levels of losses. Other exogenous factors, including the volatility of prices of key imports and exports on global markets (e.g. vanilla, shrimp, rice and petrol) have also affected recent economic performance.

3. Policy Linkages

The starting point for the development of the WAVES Madagascar workplan was the identification of a series of priority policy questions across several key sectors that could be informed by natural capital accounting activities. This process has identified five broad policy linkages that WAVES activities will seek to inform that are discussed below and illustrated in Figure 1. During the detailed activities in each of these sectors these policy linkages will be further investigated, discussed, and refined. Detailed road maps will be prepared outlining inputs, processes and outputs for each policy linkage to guide future WAVES activities.

Figure 1: WAVES Madagascar Outputs and Policy Linkages



Policy dialogue on natural resource rent capture, distribution and reinvestment in the mining sector

With its extensive mineral and non-mineral sub-soil assets, Madagascar is recognized as a geologically rich country with resources that have the potential to generate large economic gains over a relatively short period. With the recent development of the first two large-scale mining operations in Madagascar, the formal mining sector's contribution to GDP is expected to grow from less than 1 percent to 15 percent in coming years. Numerous other large-scale mining operations are in the exploration phase throughout the country and Madagascar is considered to be on the cusp of a major increase in large-scale mining activities.

Despite the potential economic benefits that exist, royalties captured by the State from existing large-scale operations are relatively low (between 1 and 2 percent) compared to other countries. Furthermore, despite Madagascar's position as a pioneer in terms of revenue distribution to regional and local communities, conflicts exist in terms of the proportion of revenues earmarked for different levels of the administration and the mechanisms used for revenue sharing. Many private sector operators have expressed their willingness to participate in dialogue on these issues through their implication in the EITI process, which is active in Madagascar. However, operators have also expressed frustration at the weak policy framework and inconsistent political decisions that have resulted in the suspension of exploration and development activities in the last few years. Given the growing awareness on the part of communities and civil society regarding the potential economic benefits of mining activities, and the growing interest of international companies in Madagascar's mineral resources, these issues are expected to remain at the forefront of the political debate in coming years.

The transformation of the country's non-renewable mineral natural capital to other productive forms of capital, will require a strong and consensual policy framework with identified policy needs in four areas: (i) policies to promote efficient resource extraction in order to maximize resource rent generated by the extractive sector; (ii) a system of taxes and royalties that allows Governments to recover equitable and proportionate shares of rents; (iii) a clear policy for the investment of resource rents in productive assets; and (iv) policies to manage land use conflicts and control adverse effects of resource extraction on other components of natural capital.

WAVES Madagascar will facilitate discussions with Government, civil society and private sector operators to determine the specific elements of a future policy framework that could most benefit from the results of natural capital accounting in the sector, in keeping with the available resources under the WAVES workplan. In particular, by estimating the rents generated through natural resource extraction, WAVES will allow the eventual creation of policy that helps to avoid dissipation of the country's natural wealth. Once mineral accounts have been developed WAVES Madagascar will provide technical assistance to integrate the results of mining accounts into the selected areas of policy development.

Basin level integrated water resources management planning

At the national level, internal renewable water resources are in the order of 337 cubic kilometers per year, 99 percent of which is surface water and the remaining 1 percent is groundwater. Water resources and availability throughout Madagascar are highly heterogeneous because of marked regional differences in rainfall. The east and north of the country typically have abundant rainfall, while the west and south are drier and experience recurrent water stress. National level data therefore mask important disparities at the basin and even sub-basin level.

Total water use is estimated at 14.97 cubic kilometers per year, or 4.5 percent of renewable water resources. The agricultural sector has the highest water use (estimated at 96 percent in 2000), followed by municipal use (3 percent) and industrial use predominantly for the textile, hydroelectricity generation and mining industries (2 percent). The irrigated agricultural surface in Madagascar, predominantly for rice growing, is estimated at 1 million hectares or 30 percent of the total of cultivated land. Irrigation infrastructure is generally small-scale and while nominally managed by local water users associations, such infrastructure is often in poor condition because of lack of financing for its maintenance. Municipal water use by households and small enterprises is predominantly assured by the State owned company JIRAMA, although contracts are also established with the private sector to supply water because of the lack of capacity of JIRAMA. In 2010, 45 percent of households had access to a secure water supply; although the rate was significantly higher in urban areas than in rural areas. The growing large-scale mining sector will have significant water needs and availability of adequate

secure resources will be essential to the development of this industry. Initial studies carried out by the World Bank and others indicate that the biophysical hydroelectric potential of the country's water resources is under-exploited and could be significantly increased. Currently hydroelectricity accounts for only two thirds of the national electricity production despite its potential economic advantages over thermal power production and efficiency of existing hydroelectric power stations is increasingly affected by sedimentation of dams.

Madagascar's national water policy dates from the mid 1990s and was developed without full consideration of the economic values of water resources, nor of equity considerations in terms of pricing policy and availability to water. Data availability in the sector is weak due to the number of actors in the sector and the lack of a coordinated approach to data collection and analysis. The Ministry of Water Resources is interested in the application of the principles of integrated water resources management, but has not yet developed integrated water basin management policy or plans. Future policy development in this area could be strengthened by a clearer understanding of the relative economic contribution of water to different user groups such as agricultural, municipal and industrial users.

There is an opportunity for WAVES Madagascar activities to contribute to increased knowledge of the water resources sector in Madagascar, through the development of basin and/or sub-basin water resources accounts and/or through generation of information on specific policy questions such as the monetary value of the untapped hydroelectric potential of water resources. Such accounts would assist the Ministry of Water Resources in its objective of developing national policy for integrated water resources management and plans for priority basins. Due to the scale of the data collection and analysis work, it is proposed to collaborate with other actors – such as UNDP and African Development Bank – who are working in the sector to define detailed policy linkages and collaborate on data collection and analysis tasks.

Sustainable financing of national protected area network

Madagascar's protected area network covers 6.9 million hectares. It contains unrivalled biodiversity, is the main draw-card for international tourists, provides essential watershed benefits to downstream users, and harbors significant forest carbon stocks. The network relies heavily on external aid for its operation, which is estimated at US$ 14 million per year. Yet the network represents a largely untapped source of economic benefits that, when converted into financial returns, could be used both to improve its own financial sustainability, and for the natural resources sector more generally.
The potential economic benefits from tourism and watershed across the entire network are in the order of US$48 million per year, of which US$28 million could be generated by ecotourism, and US$20 million by watershed protection[327]. Less is known about the economic values of carbon stocks but research into the biophysical aspects of such stocks is relatively well advanced. Current capture of the economic benefits harbored within the network is very low, with only US$0.5 million/year generated by tourist visitation fees earmarked for protected area management.

The need for a policy framework to improve the capture and distribution of the network's economic benefits and thus contribute to its sustainable financing has been identified as an entry point for natural capital accounting activities supported by WAVES Madagascar. Activities would include combining the results of ecotourism and forestry sector accounting with water resources accounting results (refer Section 3.2 above) to generate information on the economic valuation profile of protected areas. WAVES Madagascar would provide technical assistance to Government and civil society to use this information to develop sustainable financing mechanisms and policy for the protected area network.

Natural capital accounting for fisheries and coastal resource management

The fisheries and coastal resources sector is of economic importance to Madagascar both at the national level, and in terms of household livelihoods and provision of subsistence resources. Based on official statistics, which are likely to underestimate true economic values, the fisheries and coastal resources sector contributed US$146 million or nearly 2 percent of GDP. Official estimates are that there are 102,000 fishers in Madagascar, although this is also certainly a gross underestimate as there has been no recent census and many rural

[327] In USD (2003) and based on a network size of 6.9 million hectares, sourced from Carret & Loyer. 2003. *Comment financer durablement les aires protégées à Madagascar?* Agence Francaise de Developpement, Paris.

households practice fishing as seasonal or part-time occupation or as a means of supplementing their subsistence needs.

A policy framework for integrated coastal zone management (ICZM) has existed since 2010 and has received strong political support through the creation of a high-level national ICZM Committee. However, little translation of the policy into tangible actions on the ground has been carried out despite its potential as a tool to resolve conflicting resource management and land use issues in the coastal zone. Regional ICZM Committees have been put in place in pilot zones in Madagascar, but these committees lack the capacity to integrate ecosystem accounting into policy and action plan formulation.

The sector could benefit from ecosystem and natural capital accounting activities as a means of generating data on the economic value of the sector as a whole, and of important sub-sectors in order to inform policy on sustainable coastal and marine resource management, and generate a better understanding on households' dependency on such resources. However, the institutional, capacity and data availability constraints within the sector are significant and could undermine the ability to achieve tangible results in the sector in the short-term and/or to assure the sustainability of processes put in place during the WAVES partnership in the medium to long term.

A modest approach to WAVES Madagascar activities in the fisheries and coastal resources sector will be adopted in the short-term. WAVES Madagascar will support a detailed Scoping Study and Action Plan for ecosystem and natural capital accounting in the fisheries sector that identifies the data needs (and means of generating data), capacity and resource needs, possible collaborations with national and regional partners, and associated institutional strengthening needs (i.e. in data collection, management, and analyses) that would facilitate future ecosystem and natural capital accounting activities. During the implementation of WAVES Madagascar the evolution of the sector would be monitored and discussed during annual workplan reviews and if found to be feasible activities, such as piloting regional-level ecosystem accounting activities to feed into ICZM planning or developing fisheries sector accounts, would be implemented.

Macro-economic performance monitoring and natural resource management

Madagascar's system of national accounts and macro-economic indicators make scant reference to natural capital values. While data on volume and value of production is available for certain sub-sectors (e.g. large scale mining, large-scale forestry, large-scale and small-scale fisheries and agriculture), data on potentially important small-scale and informal activities in the mining, forestry and fisheries sectors is missing, and there is little information on royalties, fees and taxes for natural-resource based sectors.

Progressive inclusion of natural capital values in the system of national accounts for priority natural resource issues, and development of macro-economic indicators will thus improve the country's ability to: (i) monitor the sustainability of its economic development; and (ii) manage key natural resource based sectors. For the purposes of WAVES Madagascar activities, the focus will be on developing new, complementary macro-economic indicators including adjusted net savings (ANS), adjusted net national income (ANNI) and natural capital wealth. A progressive approach to development of these macro-economic indicators will be applied. In the short term, existing preliminary estimates prepared by the World Bank will be refined and adjusted using available country-specific data. In the medium to long term, the outcomes of natural resource accounting activities supported by WAVES Madagascar will be progressively included to further refine the indicators. Technical activities will be complemented by capacity building both in the development and maintenance of these indicators, as well as in their use and interpretation.

ANNEX 4: SUSTAINABLE FINANCING OF MADAGASCAR'S PROTECTED AREA NETWORK

This Annex provides selected information from the report Agreco. 2012. *Analyse des couts et sources de financement du systeme des aires protégées de Madagascar - Rapport Final.* World Bank, Antananarivo.

PA No.[328]	Name	Type of Protected Area	Stage of Creation (2011)
1	Ambatovaky	MNP managed	Under management
2	Ambohijanahary	MNP managed	Under management
3	Ambohitantely	MNP managed	Under management
4	Analamazaotra	MNP managed	Under management
5	Analamera	MNP managed	Under management
6	Andohahela	MNP managed	Under management
7	Andranomena	MNP managed	Under management
8	Andringitra	MNP managed	Under management
9	Anjanaharibe Sud	MNP managed	Under management
10	Ankarafantsika	MNP managed	Under management
11	Ankarana	MNP managed	Under management
12	Baie de baly	MNP managed	Under management
13	Bemaraha partie Nord	MNP managed	Under management
14	Bemaraha partie Sud	MNP managed	Under management
15	Bemarivo	MNP managed	Under management
16	Betampona	MNP managed	Under management
17	Bezà Mahafaly	MNP managed	Under management
18	Bora	MNP managed	Under management
19	Cap Ste Marie	MNP managed	Under management
20	Corridor Forestier Fandriana Marolambo	Extension of MNP PA	Procedure IV
21	Extension APMC Kirindy Mitea	Extension of MNP PA	Procedure IV
22	Forêt d'Ambre	MNP managed	Under management
23	Isalo	MNP managed	Under management
24	Kalambatritra	MNP managed	Under management
25	Kasijy	MNP managed	Under management
26	Kirindy Mitea	MNP managed	Under management
27	Lokobe	MNP managed	Under management
28	Lokobe extension	Extension of MNP PA	Procedure IV
29	Mananara - Nord	MNP managed	Under management
30	Mangerivola	MNP managed	Under management
31	Maningoza	MNP managed	Under management
32	Manombo	MNP managed	Under management
33	Manongarivo	MNP managed	Under management
34	Mantadia	MNP managed	Under management
35	Marojejy	MNP managed	Under management
36	Marotandrano	MNP managed	Under management
37	Masoala	MNP managed	Under management
38	Midongy du Sud	MNP managed	Under management
39	Mikea	Temporary protection status	Procedure IV
40	Montagne d'Ambre	MNP managed	Under management

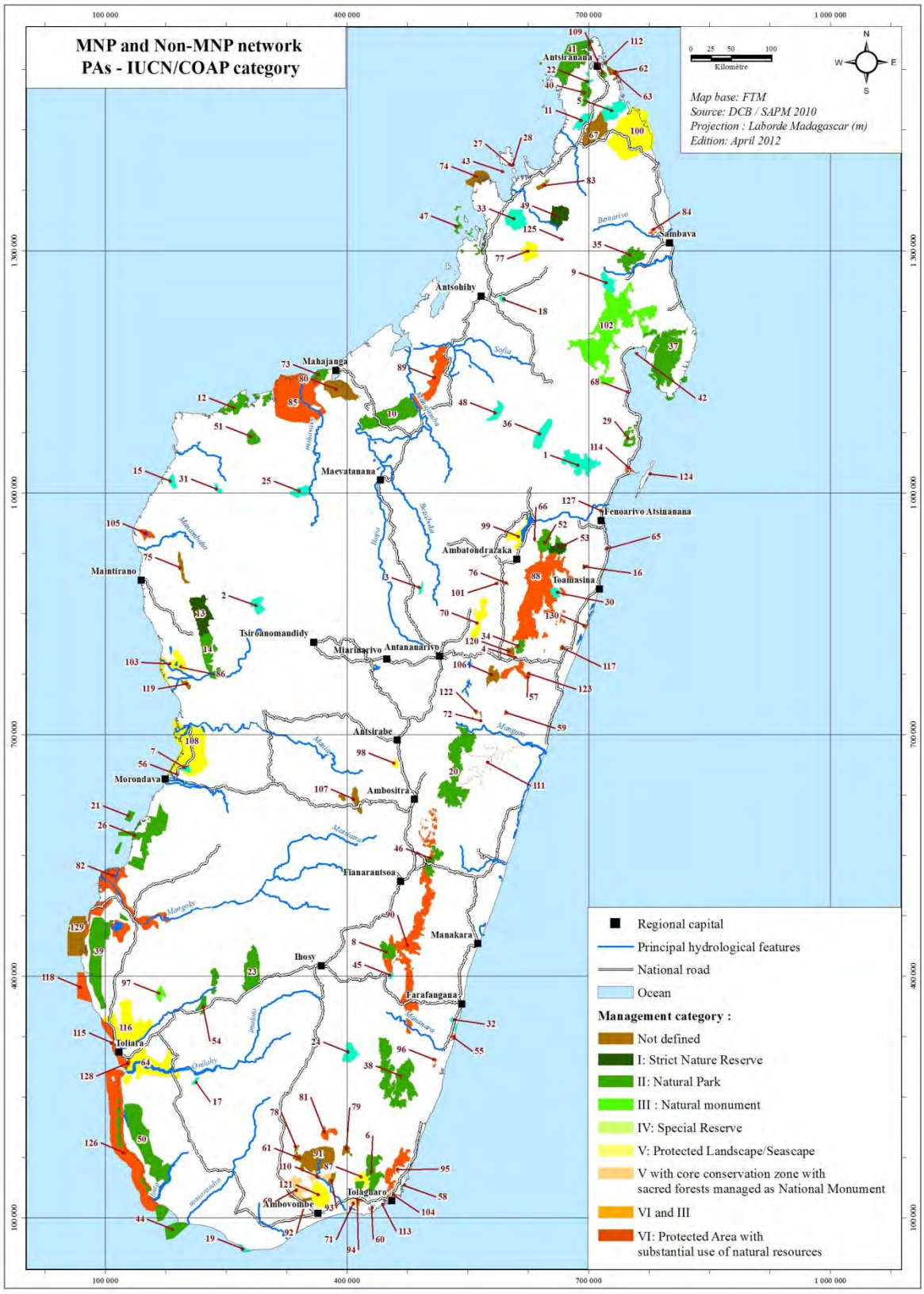
[328] Refer Figure 4.1

PA No.[328]	Name	Type of Protected Area	Stage of Creation (2011)
41	Nosy Hara	Temporary protection status	Procedure IV
42	Nosy Mangabe	MNP managed	Under management
43	Nosy Tanikely	Temporary protection status	Procedure IV
44	Nosy Ve Androka	NAP	Procedure I
45	Pic d'Ivohibe	MNP managed	Under management
46	Ranomafana	MNP managed	Under management
47	Sahamalaza-Iles Radama	MNP managed	Under management
48	Tampoketsa Analamaitso	MNP managed	Under management
49	Tsaratanana	MNP managed	Under management
50	Tsimanampesotse	MNP managed	Under management
51	Tsingy Namoroka	MNP managed	Under management
52	Zahamena	MNP managed	Under management
53	Zahamena RNI	MNP managed	Under management
54	Zombitse - Vohibasia	MNP managed	Under management
55	Alan'Agnalazaha	NAP	Not yet started
56	Allée des Baobabs	Temporary protection status	Procedure IV
57	Ambalabe	Temporary protection status	Procedure I
58	Ambato Atsinanana (Sainte Luce)	Temporary protection status	Under management
59	Ambatofotsy	NAP	Procedure IV
60	Ambatotsirongorongo	Temporary protection status	Procedure IV
61	Ambia	NAP	Not yet started
62	Ambodivahibe	NAP	Procedure II & III
63	Ambodivahibe	NAP	Procedure II & III
64	Amoron'i Onilahy	Temporary protection status	Under management
65	Analalava	Temporary protection status	Procedure II & III
66	Analalava I - II	NAP	Procedure II & III
67	Andrafiamena Andavakoera	NAP	Procedure I
68	Andreba	Temporary protection status	Procedure IV
69	Angavo	NAP	Not yet started
70	Anjozorobe Angavo	Temporary protection status	Procedure II & III
71	Ankodida	Temporary protection status	Procedure IV
72	Ankorabe	NAP	Procedure IV
73	Antrema	Temporary protection status	Procedure IV
74	APMC Nosy Iranja - Ankazoberavina - Baie de russe	Temporary protection status	Procedure II & III
75	Beanka	Temporary protection status	Procedure IV
76	Beasina/Ampananganandehibe	NAP	Procedure IV
77	Bemanevika	NAP	Procedure IV
78	Beompa	NAP	Not yet started
79	Beteny	NAP	Not yet started
80	Bombetoka-Belemboka	NAP	Procedure II & III
81	Complexe Anadabolava	NAP	Procedure I

PA No.[328]	Name	Type of Protected Area	Stage of Creation (2011)
82	Complexe de zones humides de la Mangoky	Temporary protection status	Procedure IV
83	Complexe forestier Kalabenono	NAP	Not yet started
84	Complexe forestier Makirovana Tsihomanaomby	NAP	Procedure I
85	Complexe Mahavavy Kinkony	Temporary protection status	Procedure IV
86	Complexe Manambolomaty	Temporary protection status	Procedure IV
87	Corridor entre Parcelles I et II d'Andohahela	NAP	Procedure I
88	Corridor Forestier Ankeniheny Zahamena	Temporary protection status	Procedure IV
89	Corridor forestier Bongolava	Temporary protection status	Procedure IV
90	Corridor forestier Fandriana - Vondrozo	Temporary protection status	Procedure IV
91	Ekintso	NAP	Procedure I
92	Extension ala maiky Ampamalora	NAP	Not yet started
93	Extension ala maiky Ankodida Tranomaro	NAP	Procedure I
94	Extension ala maiky Ankodida Tsimelahy	NAP	Not yet started
95	Forêt de Tsitongambarika	Temporary protection status	Procedure IV
96	Forêt de Vohipaho/Ankarabolava	NAP	Not yet started
97	Forêt sacrée d'Analavelona	NAP	Not yet started
98	Ibity	Temporary protection status	Procedure IV
99	Lac Alaotra	Temporary protection status	Procedure IV
100	Loky-Manambato	Temporary protection status	Procedure II & III
101	Mahialambo	NAP	Procedure IV
102	Makira	Temporary protection status	Procedure IV
103	Manambolomaty Wetland Complex & Tsimembo Classified Forest Future SAPM	Temporary protection status	Procedure IV
104	Mandena	Temporary protection status	Under management
105	Mandrozo	NAP	Procedure IV
106	Mangabe	NAP	Procedure IV
107	Massif d'Itremo	NAP	Not yet started
108	Menabe Antimena	Temporary protection status	Procedure II & III
109	Montagne des francais	Temporary protection status	Procedure II & III
110	Nord-Ifotaky	Temporary protection status	Procedure II & III
111	Nosivolo Marolambo	NAP	Procedure IV
112	Oronjia (Orangea)	NAP	Under management
113	Petriky	NAP	Not yet started
114	Pointe à Larrée	NAP	Procedure I
115	Ranobe Bay	NAP	Not yet started
116	Ranobe PK 32	Temporary protection status	Under management
117	Sahafina	Temporary protection status	Procedure IV
118	Salary Bay	NAP	Procedure IV
119	Site Ambondrobe	NAP	Procedure II & III
120	Site Ramsar Torotorofotsy	NAP	Procedure II & III

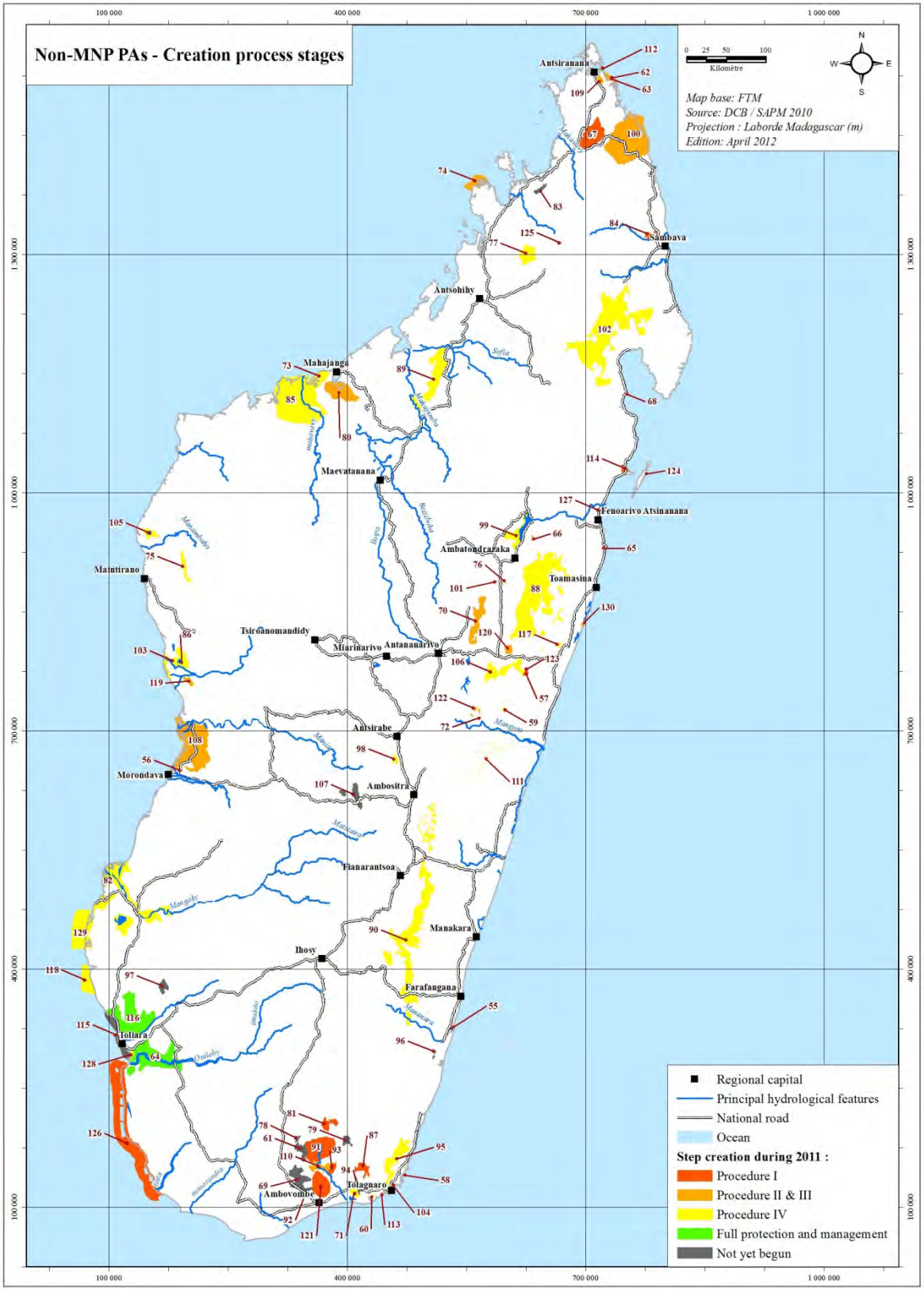
PA No.[328]	Name	Type of Protected Area	Stage of Creation (2011)
121	Sud-Ouest Ifotaky	NAP	Procedure I
122	Surounding area Complexe Sahavoa/ Andranalahy/ Ambanivato	Site potential	Procedure II & III
123	Surounding area Forêt d'Ivohibe	Site potential	Procedure IV
124	Surounding area Sainte Marie	Site potential	Procedure I
125	Surounding area Summit Tsaratanana - Ambohimirahavavy -Corridor Maroj	Site potential	Procedure II & III
126	Surounding area Toliara Sud	Site potential marine	Procedure I
127	Tampolo	Temporary protection status	Procedure IV
128	Tsinjoriake	Temporary protection status	Procedure IV
129	Velondriake	NAP	Procedure IV
130	Vohibola	Temporary protection status	Procedure II & III

Figure A.1: Protected Areas by IUCN Category



Source: Agreco, 2012

Figure A.2: Non-MNP Protected Areas by Stage of Creation



Source: Agreco, 2012

ANNEX 5: OVERVIEW OF METHODOLOGY FOR SEA LEVEL RISE PROJECTIONS UNDER CLIMATE CHANGE

Projecting Global and Relative SLR

The IPCC Fourth Assessment (AR4) Working Group I report provides estimates of projected global SLR from 1999 through 2099 for six emissions scenarios.[329] These estimates range from 18 to 59 centimeters.[330] However, these projections do not account for "future dynamical changes in ice flow," or dynamic ice-sheet melting. Dynamic ice-sheet melting is a positive feedback response of non-dynamic ice melt; for example, melt water may lubricate the ice-sheet bed or flow over the ice to create additional melting. Because IPCC does not account for these effects, the projections likely underestimate future global SLR. In addition, IPCC did not archive decadal or annual SLR results for all global climate models, or provide a trajectory of SLR through the 21st century as part of the AR4 report.

As an alternative to the IPCC projections, Vermeer and Rahmstorf (2009) account for the effects of dynamic ice-sheet melting by developing projections based on historical data from 1880 through 2000. Vermeer and Rahmstorf model the empirical relationship between historical temperature and sea-level, and apply this relationship to IPCC's temperature projections for each emissions scenario. By using historical relationships rather than the physics-based models of IPCC, Vermeer and Rahmstorf include the effects of dynamic ice-sheet melting in their projections. These projections estimate global SLR between 75 and 190 centimeters for the period 1990-2100.[331]

While global SLR projections are widely available, information on land movement influencing relative SLR is less well documented. Historical trends in global SLR (i.e., the sea-level change component of relative SLR) can be subtracted from trends in relative SLR, as estimated by satellite altimetry or tide-gauge measures, to provide estimates of land subsidence. Subsidence can then be incorporated into global SLR projections to estimate future SLR at a specific location.

Satellite altimeter data currently only exist for a 15-year period from 1992 through 2008, and are not available at detailed spatial scales. Tide-gauge data, however, are publicly available through the Permanent Service for Mean Sea Level (PSMSL) for more than 2,100 locations and much of the 20th century. The geographic coverage of these tide-gauge stations is poor, with the majority of the stations and the longest data records found in the Northern Hemisphere in Europe, North America, and Japan. Additionally, tide-gauge stations are primarily located along continental rather than island coasts.[332] Because land movement varies widely by location, this spatial bias in tide-gauge stations makes estimating relative SLR in nations such as Madagascar difficult, as there is only one PSMSL station in all of Madagascar.

Analytic Methods and Future Recommendations

In this analysis, we extrapolate annual SLR from the IPCC and Vermeer and Rahmstorf projections for three emissions scenarios. Using computer code provided by Vermeer and Rahmstorf, we estimate the trajectory of SLR between 1990 and 2100 for each scenario.[333] This trajectory captures the time lag between temperature changes and SLR by using historical data, and as a result, we are also able to scale the trajectory for each

[329] Meehl, G.A., T.F. Stocker, W.D. Collins, Friedlingstein, A.T. Gaye, J.M. Gregory, A. Kitoh, R. Knutti, J.M. Murphy, A. Noda, S.C.B. Raper,I.G. Watterson, A.J. Weaver and Z.-C. Zhao. (2007) Global Climate Projections. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S.,D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[330] Ranges in SLR presented in the IPCC AR4 report represent 5 and 95 percentiles for each emissions scenario.

[331] Vermeer, M. and S. Rahmstorf. 2009. Global sea level linked to global temperature. *Proceedings of the National Academy of Sciences of the United States of America* 106: 21527-21532.

[332] Mitchum, G.T., R.S. Nerem, M.A.Merrifield and W.R. Gehrels. (2010) Modern Sea-Level-Change Estimates. In: Understanding Sea-Level Rise and Variability, 1st edition. Edited by John A. Church, Philip L. Woodworth, Thorkild Aarup & Stanley Wilson. ©2010 Blackwell Publishing Ltd.

[333] Annual Vermeer and Rahmstorf SLR estimates were derived using matlab code provided as supplemental online material to Vermeer and Rahmstorf (2009). Note that our application of the matlab script did not precisely replicate the SLR estimates presented in the paper. To smooth the SLR data, Rahmstorf used a more sophisticated method than is included in the matlab script. As a result, we scaled the estimated trajectory to the SLR estimates for year 2100 published in Vermeer and Rahmstorf (2009).

emissions scenario to the 2099 SLR values projected by IPCC. The following bullets describe this approach in more detail:

- First, we limit our analysis to three of the six IPCC emissions scenarios. We use the B1, A1B, and A2 scenarios, as these are the scenarios most commonly referenced in impact analyses.
- Using the computer code provided by Vermeer and Rahmstorf, we generate the trajectory of annual SLR for each scenario.
- Because the SLR values generated for year 2100 do not precisely replicate those published by Vermeer and Rahmstorf (likely due to the exclusion of a smoothing script from the computer code), we scale the trajectory to published values by applying the ratio of published to generated endpoints.[334]
- To generate a trajectory for SLR as projected by the IPCC, we assume that the trajectory estimated by Vermeer and Rahmstorf accurately captures the relationship between temperature change and SLR. We scale this trajectory to the high and low endpoints of IPCC projections for each emissions scenario by applying the ratio of the published IPCC endpoint to the generated Vermeer and Rahmstorf endpoint.[335]

Ideally, we would modify these global projections for specific coastlines within Madagascar using tide-gauge data on uplift and subsidence. However, according to PSMSL, Madagascar has one tide-gauge station in Nosy-Be, and complete annual data for this site are only available for eight years between 1958 and 1972.[336] PSMSL does not analyze relative SLR trends for sites with less than 30 years of data; however, using regression methods specified by PSMSL, we estimate subsidence over these eight years of -5.9 millimeters per year.[337] This negative value indicates that Nosy-Be experienced uplift over the analysis period. Given Madagascar's geologic position on a separate tectonic plate, this result is not surprising. However, due to the significant data quality limitations, we are unsure whether this is a statistically significant or generalizable result, so this trend is not incorporated into our SLR projections. Although publicly available data on relative SLR in Madagascar are poor, additional tide-gauge data may exist in the records of Madagascar's ports or local organizations. If such data exist, land subsidence trends could be estimated and incorporated into SLR projections.

Additionally, as discussed in Nicholls and Cazenave (2010), SLR projections would ideally incorporate localized land movement data for coastal segments particularly susceptible to natural subsidence, such as river deltas.[338] Soil characteristics significantly affect the rate of subsidence, and in deltas, spongy soils compact under the weight of newly deposited sediment, causing higher rates of subsidence than in areas with rockier substrates. Dasgupta et al. (2010) and Nicholls at al. (2011) suggest accounting for this natural subsidence in SLR projections by applying an average subsidence rate of two millimeters per year to river deltas worldwide.[339] This approach requires spatial data on the location of river deltas; we are not aware of publicly available delta delineation data for Madagascar at this time.[340] Finally, to the extent that such information is available, SLR projections should also account for shoreline protection measures, such as sea dikes, that may affect the likelihood and severity of SLR impacts to specific coastlines within Madagascar.

[334] See "Rahmstorf Data" sheet in Excel file.

[335] See "IPCC Data" sheet in Excel file.

[336] Tide-gauge data for Madagascar is available from PSMSL at http://www.psmsl.org/data/obtaining/stations/926.php.

[337] See "Subsidence Trend" sheet in Excel file.

[338] Nicholls, R.J. and A. Cazenave. 2010. Sea-level rise and its impact on coastal zones. *Science* (328): 1517-1520.

[339] Dasgupta, S., B. Laplante, S. Murray and D. Wheeler. 2010. Exposure of developing countries to sea-level rise and storm surges. *Climatic Change* (106): 567-579; and Nicholls, R.J., N. Marinova, J.A. Lowe, S. Brown, P. Vellinga, D. de Gusmao, J. Hinkel and R.S.J. Tol. 2011. Sea-level rise and its possible impacts given a 'beyond 4ºC world' in the twenty-first century. *Philosophical Transactions of the Royal Society A* (369): 161-181.

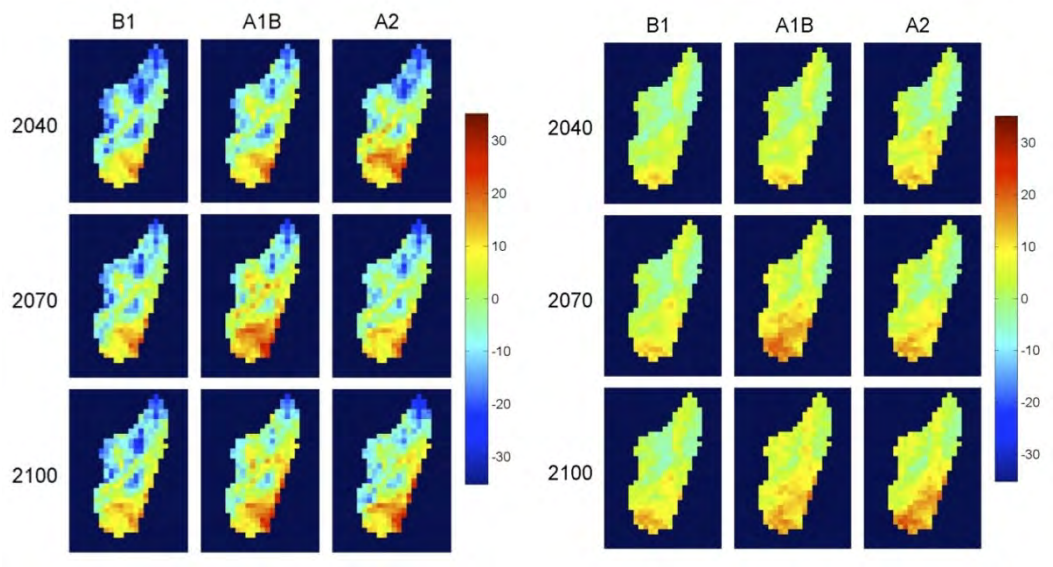
[340] The Dynamic Interactive Vulnerability Assessment (DIVA) database used by Dasgupta et al. to identify river deltas is no longer provided online, and other spatial data on Madagascar river deltas could not be located. Spatial data on soil type is available, and could be used in conjunction with proximity to a river as a proxy for presence of a delta.

ANNEX 6: ADDITIONAL DATA ON DROUGHT PROJECTIONS UNDER CLIMATE CHANGE

The scale on the right-hand y-axis indicates the increase or decrease in the number of months of drought conditions over the 30-year period in question. On the left-hand y-axis, 2040 represents the period 2011 – 2040, 2070 represents the period 2041 to 2070, and 2100 represents the period 2071 – 2100.

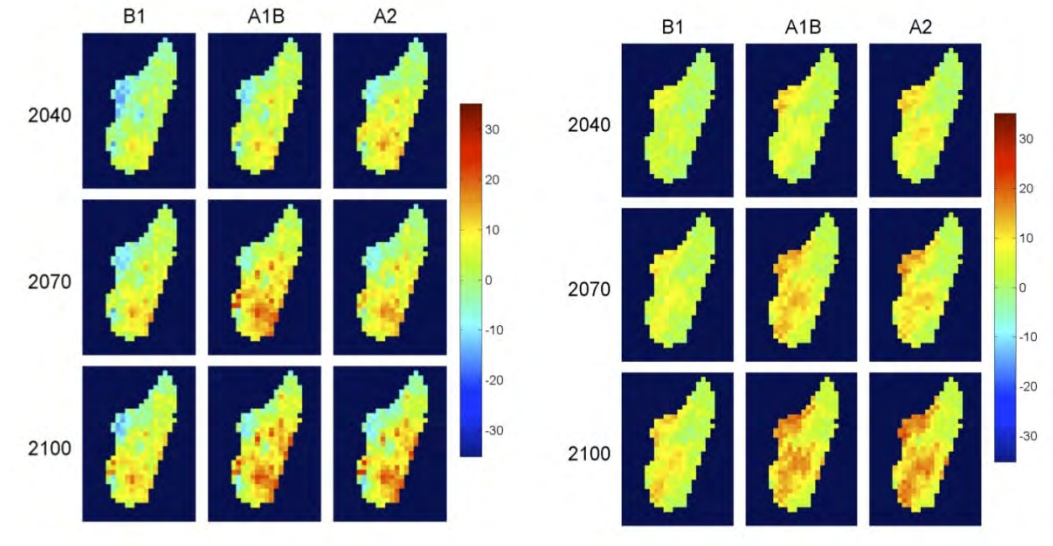
Source: IEc, 2012

Figure A.3: Projected change in duration of 1-month mild and moderate droughts based on SPI Results

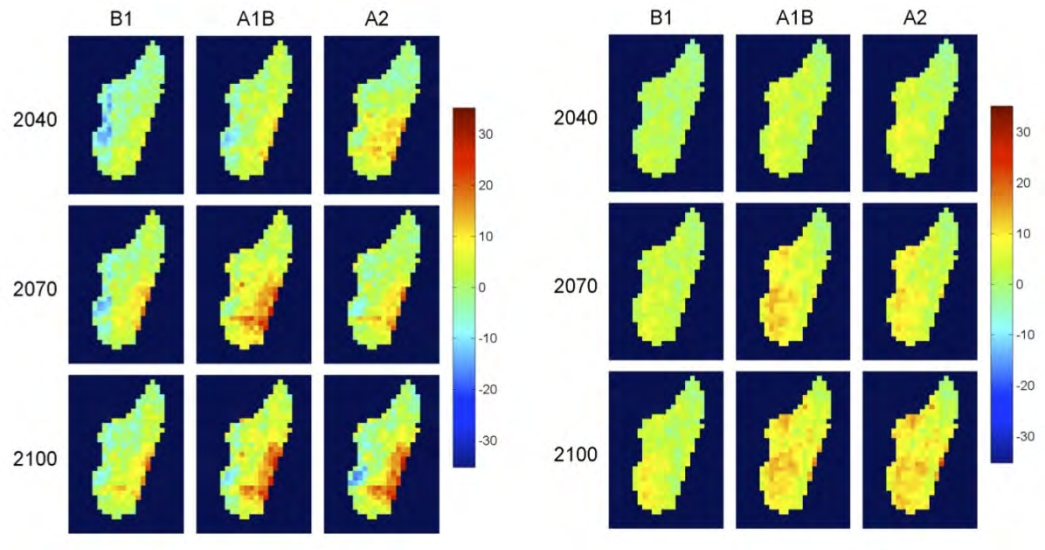


(i) 1-month mild drought conditions (ii) 1-month moderate drought conditions

Figure A.4: Projected change in duration of 3-month and 6-month mild and moderate droughts based on SPI Results

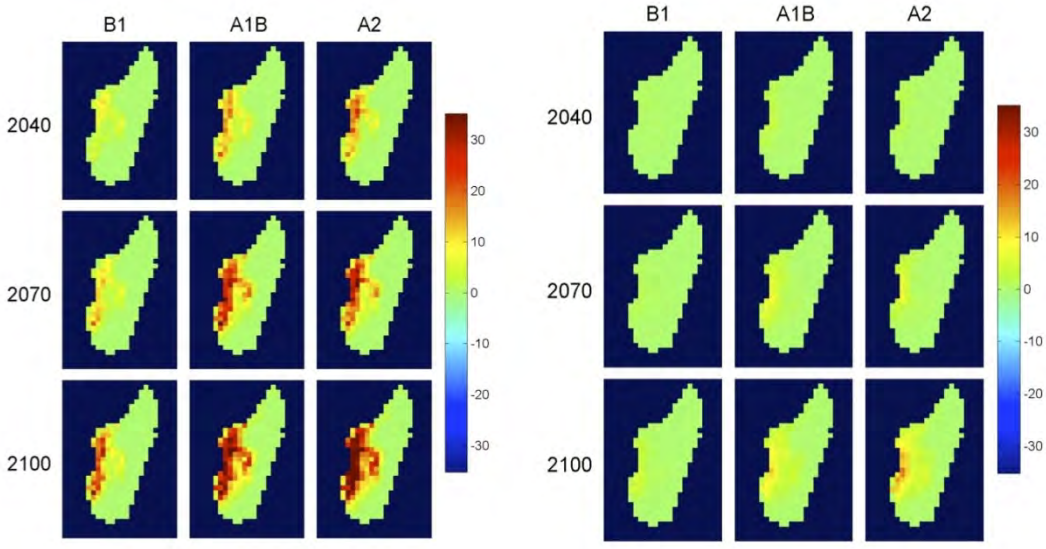


(i) 3-month mild drought conditions (ii) 3-month moderate drought conditions



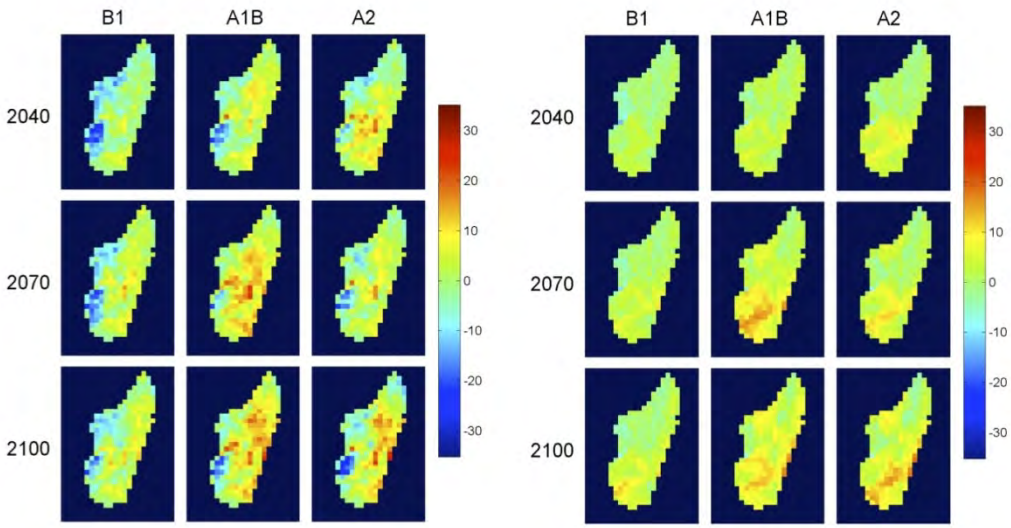
(i) 6-month mild drought conditions (ii) 6-month moderate drought conditions

Figure A.5: Projected change in duration of 3-month and 6-month extreme droughts based on SPI Results



(i) 3-month extreme drought conditions (ii) 6-month extreme drought conditions

Figure A.6: Projected change in duration of 12-month mild and moderate droughts based on SPI Results



(i) 12-month mild drought conditions (ii) 12-month moderate drought conditions

Figure A.7: Projected change in mild droughts based on PDSI Results

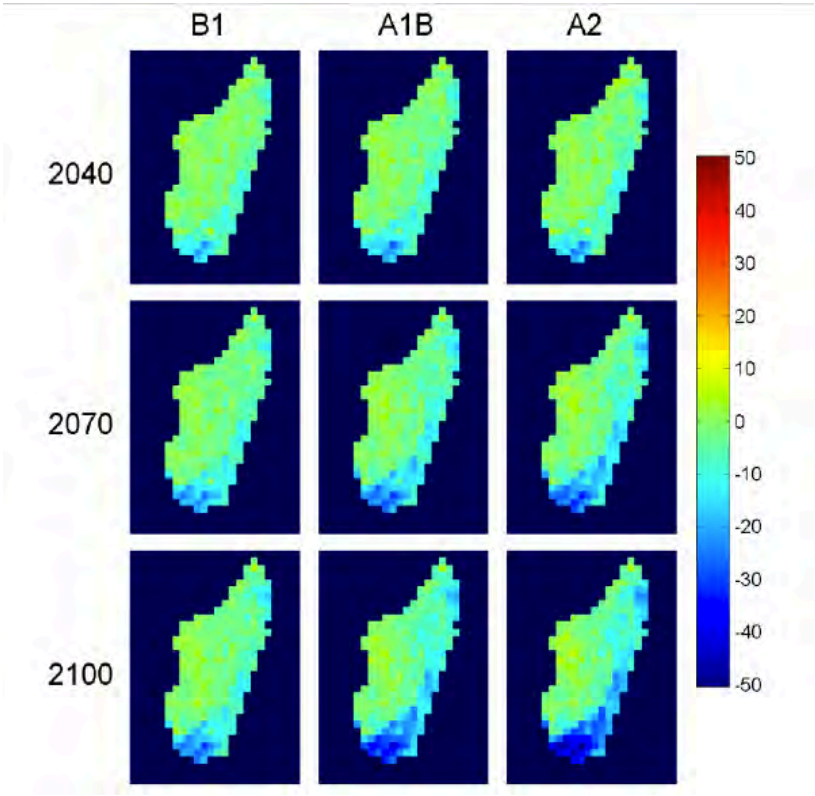
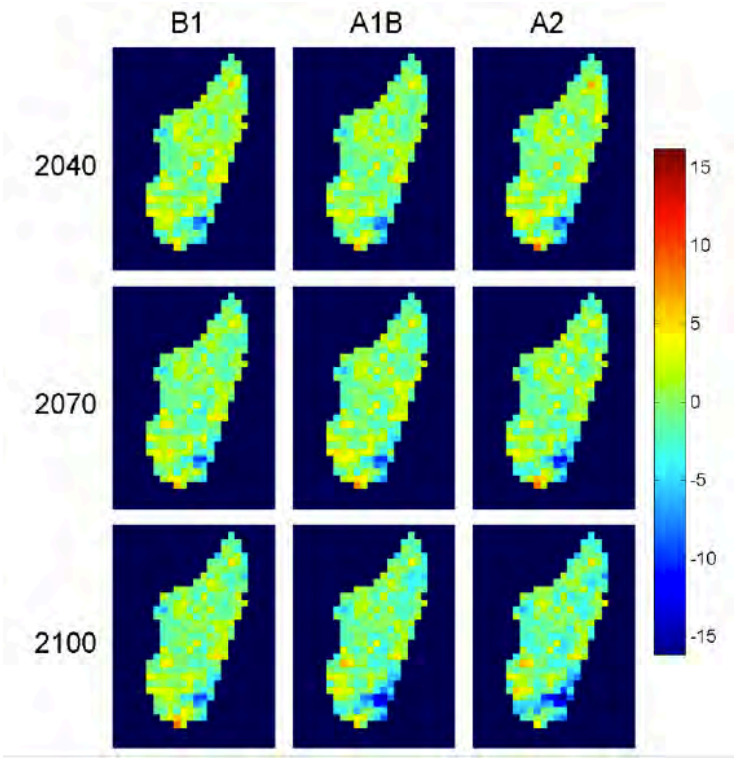


Figure A.8: Projected change in moderate droughts based on PDSI Results


B1
A1B
A2
2040
2070
2100
15
10
5
0
-5
-10
-15