

THE OTHER MIGRANTS PREPARING FOR CHANGE

ENVIRONMENTAL CHANGES AND MIGRATION
IN THE REPUBLIC OF MAURITIUS
AN ASSESSMENT REPORT



IOM International Organization for Migration

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ENVIRONMENTAL CHANGES AND MIGRATION IN THE REPUBLIC OF MAURITIUS AN ASSESSMENT REPORT

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December 2010



IOM International Organization for Migration



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Acronyms and abbreviations

AAP	Africa Adaptation Programme
AFRC	Albion Fisheries Research Centre
AREU	Agricultural Research and Extension Unit
CSR	Corporate social responsibility
GDP	Gross domestic product
GEF	Global Environment Facility
IOM	International Organization for Migration
IPCC	Intergovernmental Panel on Climate Change
MAA	Mouvement pour l'Autosuffisance Alimentaire
MID	Maurice Ile Durable
MOI	Mauritius Oceanography Institute
MSIRI	Mauritius Sugar Industry Research Institute
MWF	Mauritian Wildlife Foundation
NEF	National Empowerment Foundation
NGO	Non-governmental organization
SEMPA	South East Marine Protected Area
SMEDA	Small and Medium Enterprises Development Authority
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change



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Executive summary

This report presents the results of a field work and analytical study conducted in 2010 by two experts on environmental migration and adaptation to climate change, within the framework of the project The Other Migrants: Environmental changes and migration in the Republic of Mauritius carried out by the Mauritius office of the International Organization for Migration (IOM).

This document emphasizes the following key points:

- Despite its relatively high elevation, the island of Mauritius is highly vulnerable to the impacts of climate change. The whole coastal zone is particularly at risk, because of a combination of environmental disruptions (sea-level rise, cyclones, coastal erosion, tsunamis). Key economic activities could be affected and economic operators have only timidly started to adapt. The situation is relatively similar in Rodrigues where natural hazards often cause damage to the coast and have strong economic impacts. Migration is already a major issue in Rodrigues. Though this migration is currently mostly driven by economic reasons, environmental threats will exacerbate this situation. As in Mauritius, no adaptation to climate change strategy has yet been implemented in Rodrigues. Finally, Agalega represents an area of exacerbated vulnerability, due to the nature of the islands (atolls).

Consequently, the project has mainly been focused on coastal areas in Mauritius and Rodrigues.

- The project has also been focused on vulnerable local communities, perceived as the most threatened by current and future environmental changes. Focusing the investigations on a local scale, the two experts considered a local community as vulnerable when:
 - i. it is located in an exposed area, that is, it is directly threatened by natural hazards, or when its ecosystems and environmental features in general are degraded and/or sensitive to environmental stresses;

- ii. and/or it is not characterized by a “community spirit”– strong links of solidarity and support among a majority of the members of a community reduce its vulnerability;
- iii. and/or it is strongly dependent on environmental resources for its subsistence and/or for creating income;
- iv. and/or it is marginalized in the territory (geographical isolation) and/or in the organization of the country (institutional and socio-economic isolation);
- v. and/or its living conditions are fragile because of a lack of revenues, a lack of education, a lack of transportation means, for instance.

- On a local scale, people already suffer from environmental changes through the degradation of their means of livelihoods. Yet, many of those affected by environmental changes do not have the resources or land that would allow them to relocate their activity. Some of those amongst the most vulnerable feel neglected and abandoned to their fate. It is fundamental to understand that even though environmental factors could play a major trigger role in migration behaviours, these factors will be mediated by their impacts on economic activities. It is important to acknowledge the environmental dimension of internal migration associated with the search for new livelihoods. From such a perspective, national authorities and international cooperation agencies have a significant role to play through legislation, territorial planning, and funding for programmes and projects.
- Environmental changes are neither expected to induce mass migration out of the country nor to create cohorts of internal migrants. They could, however, result in significant physical or professional internal migration/relocation over time associated with the impacts of environmental changes on some key economic sectors. Given that Mauritius is a small island and that it is possible for people to commute to their areas of work on a daily basis, voluntary physical migration is often a decision of last resort. Even if people do move, they prefer to do so in the same geographical area. Physical migration is usually associated with generational mobility. Internal migration is thus likely to

increase as a result of these changes over time. Inter-island migration, in particular, is likely to increase considerably, especially from Rodrigues and Agalega to Mauritius. The pressure on internal lands will increase and cities in Mauritius will need to adapt and provide new resources (housing, jobs, etc.) in order to respond to these demographic changes.

- With regard to solutions, we suggest focusing initial efforts on vulnerable groups of population on a local scale, assuming that these groups would be the first in line to face environmental disruption. These potential migrants need to be prioritized in terms of support. With regard to possible future migration, we propose considering the following options:
 - i. Support adaptation in situ for populations who are unwilling to move.
 - ii. Improve resettlement, relocation and integration policies for populations who are willing to move, or when adaptation in situ is not possible.
 - iii. Focus primarily on adaptation to climate change rather than on mitigation – even though some obvious linkages exist between the two.
 - iv. Be innovative in the identification of relevant pilot projects for local communities, so that they can start adapting to environmental degradation and climate change.
- There are two different ways to fight climate change: mitigation (reducing greenhouse gases emissions) and adaptation (preparing societies to cope with future environmental

degradation). This report deals specifically with adaptation, and seeks to prevent forced migration and promote sustainable livelihoods. Consequently, though many actions can also be envisaged for reducing greenhouse gas emissions at the local level, we consider that adaptation is the key issue for local communities in the fight against climate change. As a result, this project has sought to identify pilot actions that aim to allow people, in the short and long terms, to stay where they currently live.

- However, adaptation to climate change remains difficult to translate into pragmatic actions. This is the reason why this study proposes a general framework in order to guide reflection on relevant pilot projects and make sure that they are consistent with the fight against current environmental degradation, in the short and medium terms, as well as with the adaptation to climate change challenge (in the long term). Further studies in the Indian Ocean region would allow for further application and refinement of this framework.
- Based on this general framework, the project also has started to concretely identify some relevant pilot projects. A first list of potentially relevant pilot projects is provided.
- This study focused on the intranational level. There is, however, ample room for regional cooperation on the topic of adaptation and climate-induced migration. It is hoped that this study could pave the way for further studies in the region, which would allow for a more comprehensive understanding of these issues in the Indian Ocean region.

Resume executif

Ce rapport présente les résultats d'un travail de terrain mené en 2010 par deux experts en migrations environnementales et en adaptation au changement climatique dans le cadre du projet The Other Migrants : Environmental changes and migration in the Republic of Mauritius, porté par le bureau de l'Organisation Internationale pour les Migrations (OIM) à Maurice.

Les points suivants doivent être mis en évidence :

- En dépit de sa surface relativement grande et de ses altitudes, l'île Maurice est potentiellement très vulnérable au changement climatique. L'ensemble de sa zone côtière est particulièrement à risque du fait d'une multitude d'aléas (érosion côtière, cyclones, tsunami, élévation du niveau moyen de la mer, etc.), qui par ailleurs peuvent se combiner pour démultiplier leurs effets respectifs. Des activités économiques clés sont ainsi menacées, et ce d'autant que la très grande majorité des opérateurs économiques n'ont pas commencé à initier de démarche d'adaptation. La situation, bien que différente sous certains aspects, est équivalente à l'île Rodrigues, elles aussi soumise régulièrement à des catastrophes naturelles qui affectent lourdement son économie et la vie de ses habitants. Des phénomènes migratoires ont déjà cours à Rodrigues, impulsés essentiellement pour des raisons économiques (manques d'emplois sur place), mais qui risquent fortement d'être amplifiés à l'avenir par les menaces environnementales (dégradation des ressources et événements catastrophiques). Et comme à Maurice, les démarches engagées d'adaptation aux changements environnementaux sont quasi-inexistantes à ce jour à Rodrigues. Enfin, les îles coralliennes d'Agalega présentent probablement la situation la plus préoccupante, même si elle concerne une population très peu nombreuse (entre 300 et 400 personnes) au regard de celle de Maurice et de Rodrigues (environ 1,3 millions de personnes cumulées).

Ces traits de la vulnérabilité de la République de Maurice expliquent que les experts se soient concentrés sur les zones côtières de Maurice et de Rodrigues.

- Le projet s'est également concentré sur les communautés locales vulnérables, lesquelles sont généralement considérées comme parmi les plus menacées par les dégradations environnementales présentes et futures. A l'échelle locale, les populations-cibles de l'étude ont été définies comme étant celles :
 - i. qui sont localisées dans des zones exposées, c'est-à-dire directement menacées par des aléas naturels, caractérisées par un environnement dégradé ou par des écosystèmes très sensibles, etc. ;
 - ii. et/ou qui se caractérisent par un manque de « solidarité communautaire », laquelle constitue un élément fondamental de réduction de la vulnérabilité d'une communauté ;
 - iii. et/ou qui est très dépendante des ressources environnementales pour sa subsistance et/ou pour ses revenus économiques ;
 - iv. et/ou qui est marginalisée d'un point de vue géographique, économique et/ou social ;
 - v. et/ou dont les conditions de vie sont très fragiles du fait d'un manque de revenus, d'un faible niveau de santé, d'un manque de réseaux et de moyens de transport, etc.
- A une échelle locale, une partie des communautés souffre déjà de problèmes liés aux dégradations environnementales, et donc d'une dégradation de leurs moyens d'existence. Or, nombre d'entre elles ne disposent ni des ressources économiques et sociales, ni des moyens techniques ou institutionnels qui leur permettraient de délocaliser leurs activités. Et certaines parmi les plus vulnérables se sentent relativement négligées et abandonnées à leur propre sort.

Il faut être conscient que si les dégradations environnementales vont avoir un effet sur les phénomènes migratoires, cet effet opérera essentiellement au travers de l'impact de ces dégradations environnementales sur les activités économiques et de subsistance. Ainsi, c'est la recherche de nouveaux moyens de subsistance qui pousse à la migration, bien que celle-ci puisse être largement impulsée par des problèmes d'ordre environnemental. Dans un tel contexte, les autorités nationales et les agences de coopération internationale

ont un rôle crucial à jouer en termes de législation et de planification du territoire, mais également en termes de financement de programmes et de projets, à diverses échelles territoriales.

- Il est peu vraisemblable que les changements environnementaux en cours et à venir conduisent à des mouvements migratoires massifs hors des frontières du pays, ou même qu'ils génèrent des cohortes très importantes de migrants. Ils vont cependant très certainement induire des mouvements migratoires significatifs ou des relocalisations d'activités à l'intérieur du pays, étalés dans le temps. Les migrations inter-îles, notamment de Rodrigues et Agalega à Maurice, vont également, très vraisemblablement, s'intensifier. La pression sur les terres va ainsi s'accroître et les espaces urbains de Maurice, souvent les lieux de destination de migrants, vont avoir besoin à la fois de nouvelles ressources (emplois, logements) et de stratégies d'adaptation à ces changements démographiques.
- Dans cette étude, nous avons choisi de concentrer les efforts sur les groupes de population les plus vulnérables et à une échelle locale ; l'hypothèse retenue au départ étant que ce sont ces communautés qui seront potentiellement les prochains « migrants environnementaux » et qu'elles ont dès lors besoin en priorité d'une attention particulière. L'objectif de fond de cette étude est d'agir en amont de la migration. Le positionnement de cette étude repose ainsi sur différents piliers :
 - i. Privilégier l'adaptation in situ, en amont de la migration, pour les populations qui ne souhaitent pas partir ;
 - ii. Améliorer les processus de relocalisation et d'intégration pour les populations qui souhaitent partir, ou lorsque l'adaptation in situ n'est pas possible.
 - iii. Placer les efforts dans le cadre de l'adaptation au changement climatique, plutôt que dans celui de l'atténuation des émissions de gaz à effet de serre ;
 - iv. Innover dans le domaine de la définition de ce que peuvent être des projets-pilotes soutenant l'adaptation des communautés locales aux dégradations environnementales actuelles et au changement climatique ;
- Deux voies existent en effet pour lutter contre le changement climatique : l'atténuation (des émissions de gaz à effet de serre) et l'adaptation (préparer les sociétés à se confronter aux aléas naturels et dégradations environnementales futurs). Le travail mené dans ce rapport s'est focalisé sur le volet 'adaptation', en cherchant à éviter des migrations forcées, à la fois par la réduction des pressions environnementales sur les moyens de subsistance, mais aussi par la réduction de la vulnérabilité des communautés locales à ces dégradations. Ainsi, si de nombreuses actions peuvent être envisagées en matière d'atténuation au niveau local, elles n'ont pas été retenues comme étant pertinentes au regard des objectifs spécifiques de ce rapport. Les investigations se sont donc concentrées sur l'identification de projets pouvant permettre aux communautés, à court ou long termes, de rester là où elles vivent actuellement.
- Cependant, l'adaptation au changement climatique est difficile à caractériser par des actions concrètes, constat valable aujourd'hui à l'échelle mondiale. Peu d'exemples existent, ce qui explique qu'en préalable à l'identification de projets-pilotes pertinents, nous avons proposé un cadre général d'analyse de ces projets-pilotes qui, accompagné d'une grille de caractérisation, doit garantir que les projets retenus contribuent bien à la fois à lutter contre les dégradations environnementales actuelles (court à moyen termes) et à aider les communautés à s'adapter au changement climatique (long terme).
- Il s'agit là d'une approche innovante, tant dans le domaine de l'analyse des migrations environnementales que dans celui de la mise en œuvre de l'adaptation au changement climatique. Cette approche pourrait utilement être répliquée et affinée dans d'autres territoires de l'Océan Indien.
- Enfin, sur la base de ce cadre d'analyse innovant et de la grille de caractérisation l'accompagnant, ce projet s'est appliqué à établir une première liste de projets-pilotes pertinents.
- Finalement, bien que l'étude se soit concentrée sur le niveau intranational, il existe de nombreuses possibilités de coopération régionale dans le domaine de l'adaptation et des migrations environnementales. Nous espérons que cette étude puisse ouvrir la voie à d'autres études dans la région, qui permettraient une compréhension plus globale des processus à l'œuvre.

PART I

GENERAL INTRODUCTION





Environmental changes, migration and vulnerability

Environmental changes are increasingly acknowledged as important drivers of migration. Recognizing this, IOM has long been engaged in working with communities affected by environmental changes. The impacts of climate change, which are already felt in some parts of the world, have led communities to migrate, either as a way to adapt to these impacts or because they have failed to adapt in situ. Most of the time, such migrations occur on short distances, at the intranational level. On the field, IOM has been working to support the adaptation strategies of these communities, either by facilitating migration or providing alternative livelihoods. At the international level, it has been working to push for better recognition and management of migration movements induced by environmental changes.

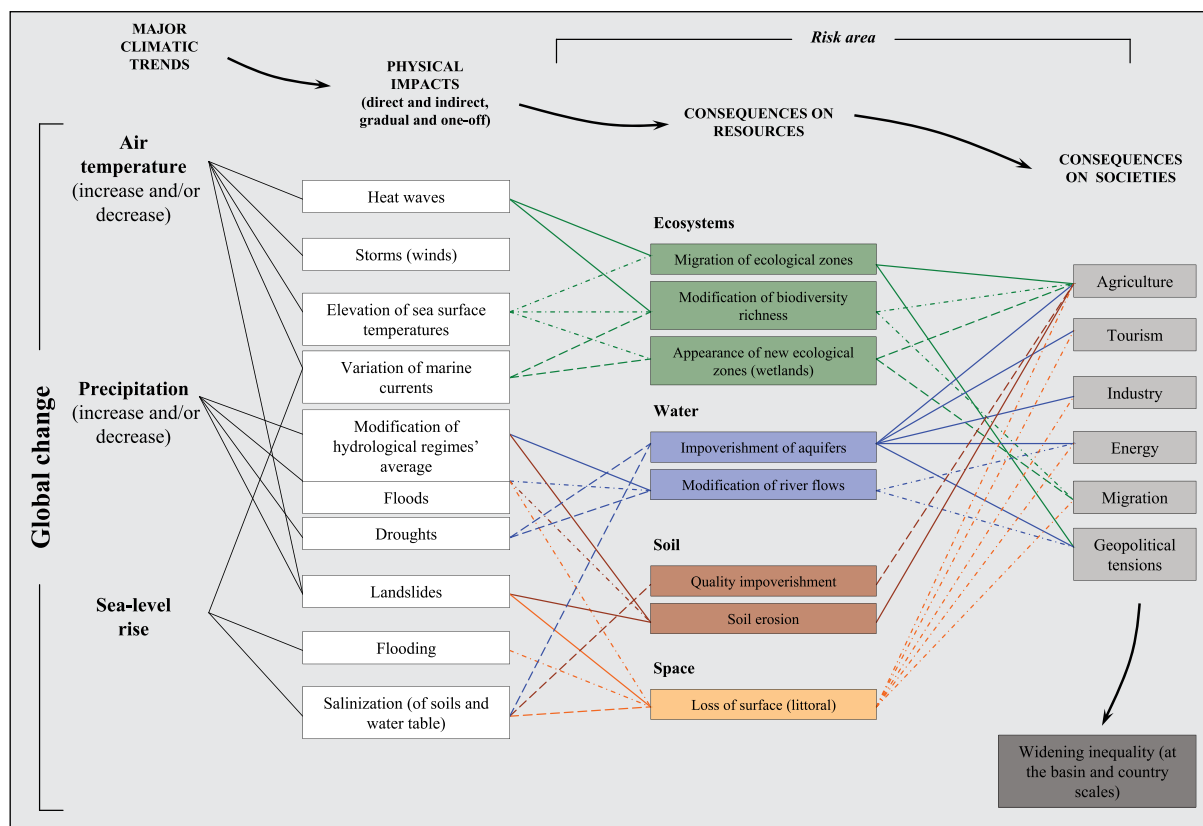
Indeed, environmental changes as migration drivers have long been ignored by scholars and policymakers alike. A growing body of research, however, suggests that environmental disruptions, either brutal or progressive, play a key role in the migration decision of many (Jäger et al., 2009). Though environmental factors played a major role in some major migration flows throughout history, such as the settlement of Europe or the Dust Bowl migration in the United States, these were overshadowed by other social, political and economic migration drivers. The impacts of climate change have recently highlighted the major importance of environmental changes on migration behaviours. The first goal of this report is to assess how environmental changes influence migration behaviours in the Republic of Mauritius.

Though “environmental migration” is often discussed within the framework of climate change, mobility can be induced by a wide range of environmental factors, from natural disasters to more gradual, slow-onset transformations. Some of these changes are directly related to climate change, others are not. Furthermore, in the current state of scientific research, it is impossible to attribute single environmental events to climate change, as these are most often the result of complex interactions between global warming and other environmental degradation. In any case, whether environmental

change is directly induced by the climate or not matters very little to the people affected. For these reasons, we have decided to consider environmental changes at large in the context of Mauritius. This report thus considers both the impacts of climate change and other types of environmental degradation, such as overfishing, pollution and development projects, though these need to be considered with a specific approach. Special attention is paid to understanding the way these changes interact with each other.

The populations most affected by environmental changes are often those who are the most vulnerable. Environmental disruptions and climate change in particular, are no longer just environmental issues; they induce serious economic, developmental and societal consequences. As a result of these changes, some families might lose their livelihoods and face major social disruption (see Figure 1). Given that many impacts of climate change have now become unavoidable, adaptation is quickly becoming a key aspect of the fight against climate change, and can be applied to other environmental changes as well. Adaptation to climate change is about preparing for future changes and reacting to current changes. In this regard, migration can be at the same time viewed as a failure to adapt, a solution of last resort when everything else has failed, as well as an adaptation strategy in itself, for those who have anticipated the changes and have decided to leave. Thus the second goal of the report is to provide alternative solutions to those whose livelihoods are threatened by the impacts of climate change. Following the identification of vulnerable groups, the report seeks to develop an innovative framework for the development of pilot projects that could provide alternative livelihoods to the people affected by environmental changes, as a way of adaptation. The report also starts to delineate some of these relevant pilot projects.

Figure 1: The “chain of impacts”: How climate change threatens activities and livelihoods



Note: The use of different colours and lines for the arrows serves only to facilitate appraisal of the links existing between major climatic tendencies, physical impacts, consequences on natural resources and effects on societies. The same applies for the coloured boxes for the impacts and consequences.

The other migrants project

Like most island states, Mauritius is particularly vulnerable to the impacts of climate change. This is especially the case given that some key sectors of its economy are highly dependent on environmental conditions, as will be shown in Part II. *The Other Migrants* project is thus highly relevant to the Mauritian context.

Furthermore, the project builds on and complements national efforts to implement climate change strategies and formalize a new vision for the Republic. Launched in 2008, the *Maurice île Durable* (MID) initiative aimed initially to mitigate emissions of greenhouse gases in Mauritius. One of the initiatives developed in the course of the MID initiative was the setting up of a fund to subsidize, inter alia, a solar water system for individual households, optimize the use of *bagasse* and cane field residues, new hydro units in Midlands and La Nicolière, and a wind farm in Bigara. A new vision to enable Mauritius to become holistically a “sustainable island” is currently being developed;

this vision will focus on several pillars, notably employment and environment. At the World Summit on Sustainable Development (WSSD) in Johannesburg in 2002, “changing unsustainable patterns of production and consumption” was singled out as one of the main elements of sustainable development. With the support of the United Nations Environment Programme (UNEP), the Government of Mauritius devised a national programme for 2008–2013 with an action plan which includes: (i) resources use efficiency with a focus on energy, water, and sustainable building and construction; (ii) education and communication for sustainable lifestyles; (iii) integrated solid waste management and recycling; (iv) sustainable public service practices; and (v) increased market supply and demand for sustainable products.

More recently, the Mauritian government also started the implementation of the Mauritian cluster of the Africa Adaptation Programme (AAP), which aims to foster adaptation strategies in Mauritius. Furthermore, the project finds its place amongst other complementary international projects, such as the vulnerability

assessment of the Indian Ocean region currently being conducted by the Indian Ocean Commission.

The Other Migrants is entirely funded by the IOM office in Mauritius, supported by the IOM Headquarters in Geneva, as well as IOM's Regional Office for Southern Africa in Pretoria. It can be broken down into different steps:

First phase, conducted by consultants:

- Collection and compilation of information related to the impacts of climate change and environmental degradation in Mauritius, potential internal displacement and cross-border migration flows, as well as the potential for adaptation to climate change in the creation of environmentally based businesses and income-generating activities;
- Assessment of the impacts of environmental changes on migration behaviours, and identification of vulnerable groups/sites;
- Identification of some pilot projects that could provide alternative activities for small and medium enterprises.

It is important to note that this assessment also includes the elaboration of a framework for better assessment of possible pilot projects to adapt to environmental changes. Indeed, translating adaptation into pragmatic actions is a key challenge at the local level.

On a local scale, people are already suffering from environmental changes through the degradation of their means of livelihood. Yet, many of those

affected by environmental changes have neither resources nor land to allow them to relocate their activity. And some of those amongst the most vulnerable feel neglected and abandoned to their fate. It is fundamental to understand that even though environmental factors could play a major direct trigger role on migration behaviours, these factors will often be mediated by their impacts on economic activities. It is also important to acknowledge the environmental dimension of internal migration associated with the search for new livelihoods. In this context, national authorities and international cooperation agencies have a significant role to play through legislation, territorial planning, and the development and funding of programmes and projects.

Second phase, conducted by the IOM office in Mauritius:

- Implementation of two to three pilot projects;
- Capacity-building and training of local populations with regard to the implementation of pilot projects;
- Awareness-raising and information campaigns throughout the Republic of Mauritius, highlighting the importance of environmental degradation on migration behaviours, as well as the possible environmental employment opportunities on the islands;
- Fostering of dialogue and information-sharing between the different ministries and institutions involved, and between the different regions and islands.

PART II



GENERAL OVERVIEW OF THE CONTEXT

This section aims to delineate the key impacts of climate change and other environmental changes on Mauritian ecosystems. This overview is the starting point of the study, as both migration behaviours and economic opportunities will depend on this analysis. Uncertainties regarding the local impacts of climate change make this analysis more complex however. This difficulty is further compounded by the lack of some statistical data and/or systematic measurements.

The second section examines sectors of the Mauritian economy that are particularly vulnerable to environmental changes, since they are highly dependent on climatic conditions. These sectors include fishing, sugar cane farming and tourism.

Finally, the third section attempts to reflect on the concepts of vulnerability and adaptation in the Mauritian context, laying ground for the analysis of migration behaviours and the identification of pilot projects.

I. Environmental changes in Mauritius

Even though the December 2004 tsunami did not lead to important damage in Mauritius, it produced a lasting effect on the way Mauritians regard environmental threats. Many inhabitants, especially those living on the coast, expressed their fear of a tsunami, which is often mistaken for an impact of global warming.

As is the case for most island states, climate change poses serious risks for Mauritius. In its latest assessment report, the Intergovernmental Panel on Climate Change (IPCC) notes that “small islands, whether located in the tropics or higher latitudes, have characteristics which make them especially vulnerable to the effects of climate change, sea-level rise, and extreme events” (Mimura et al., 2007). The report notes that both commercial agriculture as well as tourism will be adversely affected. As will be shown in the next section, these are two key sectors of the Mauritian economy. This section aims to delineate how Mauritius is and will be affected by the impacts of climate change, and how these impacts combine with other environmental disruptions.

I.1 Cyclones

Cyclones are a frequent occurrence in Mauritius. Every year, according to the Mauritius Meteorological Services,¹ about a dozen cyclones pass through the Indian Ocean region, resulting in about five to six days of cyclone alert in Mauritius. Cyclones are, by far, the major natural disaster in Mauritius. Between 1900 and 2010, disasters that affected the most number of people were cyclones:

Table 1: Top nine natural disasters in Mauritius for the period 1900–2010, sorted by total number of affected people²

Disaster	Date	Highest gust (km/h)	Total no. of people affected
Cyclone Gervaise	6 February 1975	280	826,258
Cyclone Claudette	22 December 1979	221	105,257
Cyclone Florine	16 January 1982	-	32,000
Cyclone Eugenie	17 February 1972	132	25,016
Cyclone Gilberte	25 December 1967	142	23,524
Cyclone Bella	29 January 1991	74	7,500
Cyclone Firinga	29 January 1989	190	4,507
Cyclone Hollanda	9 February 1994	216	2,300
Cyclone Dina	22 January 2002	228	1,050

Source: Mauritius Meteorological Services, 1 December 2010.

Figures from the Mauritius Meteorological services reveal an increasing trend in the number of intense cyclones, that is, cyclones with winds above 165 km/hr (Mauritius Meteorological Services, 2009).

Such figures are consistent with the predictions of IPCC, which note that “clear evidence exists that

¹ Interview with Mr Bebeejaun, Deputy Director, Mauritius Meteorological Services, 20 July 2010.

² Although Mauritius has known intense cyclones prior to 1967 such as Carol (February 1960), Alix (January 1960), Jenny (February 1962) and Danielle (January 1964), the numbers of persons affected are not available.

the number of storms reaching categories 4 and 5 globally have increased since 1970" (Mimura et al., 2007). Coastal regions are particularly affected by cyclones, because of the combined effects of heavy gusts of wind and storm surge.

1.2 Sea-level rise

The sea level is monitored with a tide gauge located at Trou Fanfaron near Port Louis. Over the last five years, the mean sea-level rise has been 3.5 mm/yr (Mauritius Meteorological Services, 2009). Over the second half of the last century, the sea level had risen by an estimated 1.5 mm/yr, on average (Church et al., 2004). More recent measurements therefore seem to indicate an acceleration of sea-level rise. Projections for sea-level rise are not easy to make at the local level, though the global mean average sea-level rise should be between 19 cm and 58 cm by the end of the century (IPCC, 2007). Local sea-level rise, however, depends highly on other factors such as changes in ocean circulation, tectonic conditions and, obviously, differences in the distribution of temperature rise.

In any case, sea-level rise in Mauritius should greatly exceed 20 cm by the end of the century. Similar observations have been made for Rodrigues. No monitoring, however, has yet been made in Agalega. The fact that the archipelago is made up of coral atoll, unlike other islands in the Republic of Mauritius, makes it particularly vulnerable to the impacts of climate change. Sea-level rise should thus first affect Agalega, which is certainly the most vulnerable spot in the whole Republic of Mauritius in this regard. It is regrettable that no sea-level monitoring is conducted in these islands.

Sea-level rise could result in significant coastal erosion on the whole littoral. This phenomenon has been amplified by the destruction of mangroves and other natural protection, such

as sea rocks. This destruction is often the direct result of the touristic transformation of beaches, which is aimed at removing all obstacles that could obstruct the way to the sea.

Coastal erosion is further aggravated by the anarchic development of coastal infrastructure. Sea-level rise could also result in saltwater intrusion, contaminating the soil and freshwater reservoirs, with a lasting impact on agriculture and freshwater availability.

1.3 Temperature rise

Meteorological stations scattered in the Republic of Mauritius have revealed a significant temperature increase over the last decades. The average temperature at all stations is rising at the rate of 0.15°C per decade. The average temperature at Vacoas for 1998–2008 was higher than that for 1951–1960 by 0.74°C. In Plaisance, the observed increase over the same period was 1.1°C. A similar rise has been observed in Rodrigues, St Brandon and Agalega (Mauritius Meteorological Services, 2009). In addition, summer maximum temperatures have sharply increased over the last decade, which could result in heat waves and adversely affect touristic activities.

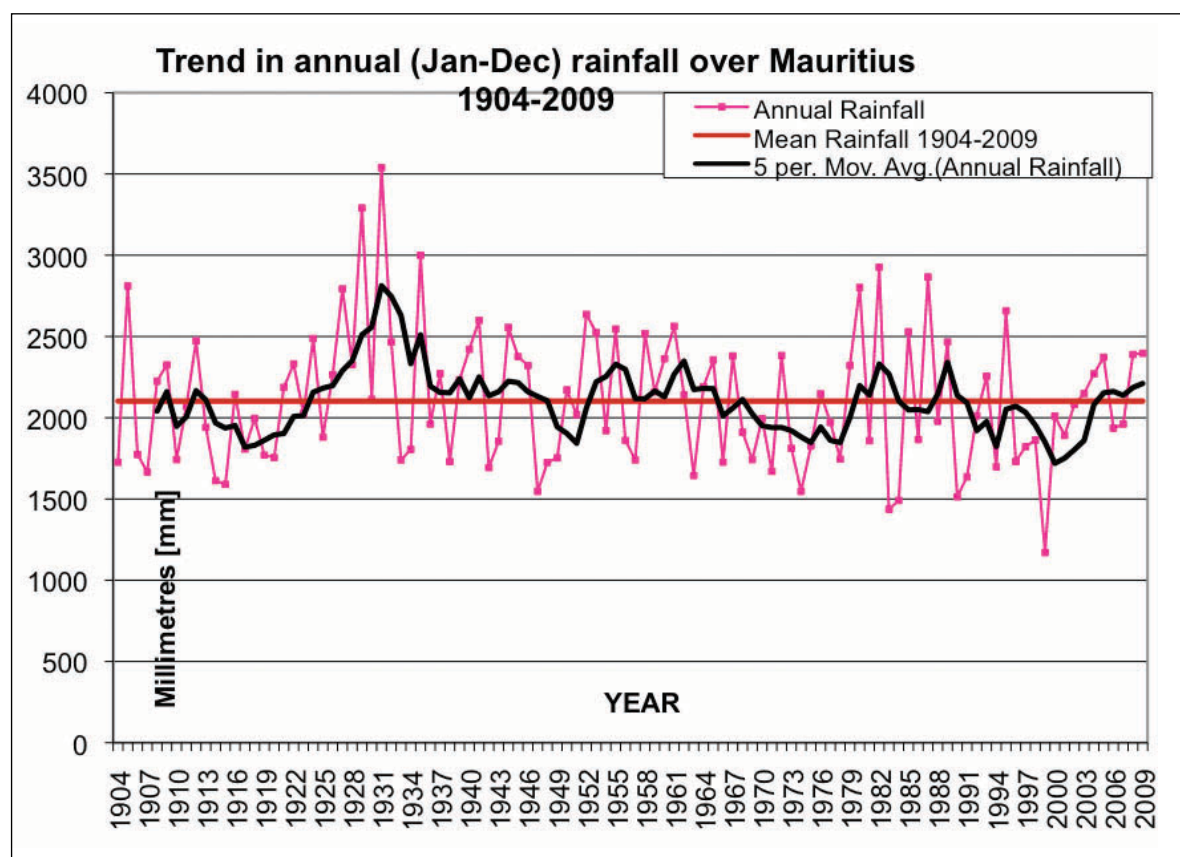
IPCC's projections of temperature rise for the Indian Ocean, relative to the 1961–1990 period, are as follows (Mimura et al., 2007):

- 0.51°C to 0.98°C from 2010 to 2039;
- 0.84°C to 2.10°C from 2040 to 2069; or
- 1.05°C to 3.77°C from 2040 to 2069, according to a different model than one used for the previous projection.

1.4 Rainfall patterns

A long-term time series that has been running over the last century shows a significant decrease in the amount of annual rainfall over Mauritius (see Figure 2).

Figure 2: Trend in annual (January–December) rainfall over Mauritius, 1904–2009



Source: Mauritius Meteorological Services.

Similar observations have been made for Rodrigues, St Brandon and Agalega. Decreasing rainfall could lead to an increased frequency of droughts. This trend is reinforced by a longer dry spell between winter and summer. It is now common for summer rains to start only in January, whereas they used to start in November in the 1960s and 1970s.

This trend in decreasing rainfall combines with an increase in the number of heavy rainfall events. Heavy rainfall results in flash floods, which are now common in February and March. Floods are now increasingly frequent and important as a result of this trend.

The projections of the IPCC about rainfall patterns in the Indian Ocean region remain highly ambiguous, however. This is due to contradictions between different climate models. Compared to the 1961–1990 period, it is not clear whether precipitations will increase or decrease:

- From 2010 to 2039, changes in precipitation for the region are expected to be between -5.4 per cent and +6.0 per cent;

- From 2040 to 2069, changes in precipitation for the region are expected to be between -6.9 per cent and +12.4 per cent, or between -9.8 per cent to +14.7 per cent, according to different models (Mimura et al., 2007).

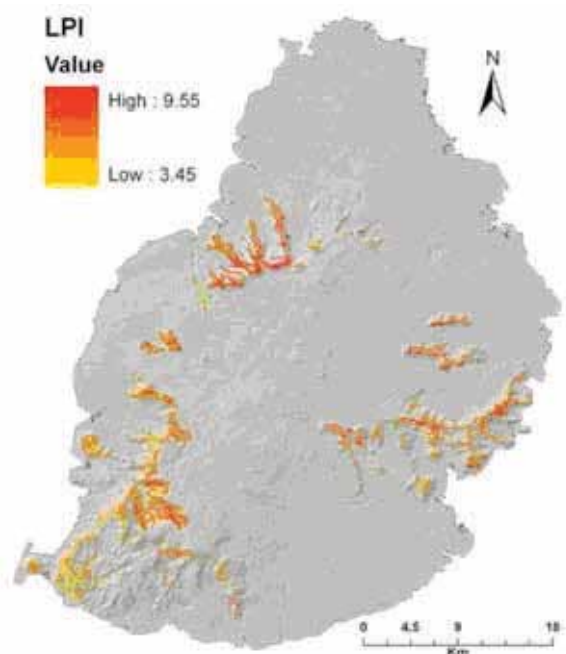
1.5 Non-climate-related changes

The sugar cane industry is a major driver of other environmental changes in Mauritius. In particular, the use of fertilizers and pesticides can induce different environmental changes. In the case of floods, these fertilizers are carried with the water and can affect other cultures and spread into the sea. The case of the planters of Petit Sable, described in part III, section 2, provides an example of this.

Landslides are another concern. Regular landslides occur in times of heavy rainfall in the region of Grand Sable and Petit Sable. As a result, crops are washed away at sea and houses are heavily damaged. Other landslides have resulted in population displacements in Port Louis. The risk of landslides could be further aggravated in cases where climate change translates into an

increase in heavy rainfall events. The following map shows a landslide potentiality index, based on the slope and geological composition of the soil, as well as on rainfall patterns. It appears that some areas around Grand Sable and Port Louis, inter alia, are at high risk of landslides.

Map 1: Landslide potentiality index in Mauritius



Source: Nigel and Rughooputh, 2009.

Finally, overfishing represents a major threat for fishers, especially in Rodrigues. Fish stocks in the lagoons of both Mauritius and Rodrigues have significantly decreased, partly due to intense fishing activity. Fishing has always been a traditional activity throughout the Republic of Mauritius, and a significant part of this activity has always taken place within the informal sector of the economy. As a consequence of this, fishing activity has gone unregulated for a long time, leading to overfishing and damage to marine ecosystems.

The government has responded to this challenge with the creation of marine protected areas and fishing reserves, which could greatly mitigate the problem. Also, lagoon fishing has been highly regulated, with shorter fishing seasons and larger meshes for fishnets so as not to catch small fish. However, it has become increasingly difficult to fish in the lagoon, and only few fishers dare venture out to the high sea, though they are encouraged to do so through incentives in

order to alleviate fishing pressures in the lagoon. Overfishing combines with a warmer and rougher sea, which can disturb traditional fish migratory routes. Overfishing also has a major impact on corals, as some fishing techniques involve damage to corals. This is the case with octopus fishing, for example, especially in Rodrigues. With the prospect of major disruptions to marine ecosystems induced by climate change, the whole activity of fishing needs to be reframed in a new framework.

1.6 Conclusion

Much uncertainty remains about the local impacts of climate change. Though climate models can predict environmental changes on a global scale, it is not yet possible to know precisely how local environments will be affected, especially in a small territory like the Republic of Mauritius. This difficulty is further compounded by incomplete monitoring of some crucial climate variables. This is especially the case in Rodrigues and Agalega, despite the fact that observations are taken daily and submitted to the Mauritius Meteorological Services for forecasting purposes. A specific concern is the incomplete monitoring of sea-level rise, as it is currently monitored by a single gauge ashore Port Louis.

One can reasonably assume, however, that the impacts of climate change in Mauritius will not be radically different from the impacts of climate change over the whole Indian Ocean. The Mauritian population is reasonably well-informed about these impacts, partly thanks to public information campaigns carried out by the Ministry of Environment and Sustainable Development. The Mauritius Meteorological Services are also well equipped and efficient.

The information provided for the population, however, could be improved by increasing the number of monitoring stations and monitored variables. This is especially true for information related to Rodrigues and Agalega, as well as for information related to sea-level rise.

Different studies and projects should also improve the quality of available information. Such projects include:

- a vulnerability assessment of the Indian Ocean region currently being conducted by the Indian Ocean Commission;

- the implementation of the AAP, administered by United Nations Development Programme (UNDP) and the Ministry of Environment and Sustainable Development. This programme involves a disaster risk reduction component, whereby areas vulnerable to flooding/inundation resulting from sea-level rise and flash floods will be mapped.

Furthermore, some important documents should be made available for the general public: flood maps, for example, have been realized in order to identify the regions which are most at risk of flooding. These maps, however, have not been made available to the public for fear that people might choose to leave these areas, resulting in a drop in real estate prices. Such information should be made available to the public, and economic interests should not prevail over the safety and well-being of the population.

The non-disclosure of flood maps illustrates the importance of perceptions and representations of environmental changes in people's migration behaviour. Though the importance of actual changes should not be denied, perceptions of these changes by the population are of utmost importance. It is often on the basis of perceived changes (instead of actual changes) that a migration decision is made (Castles, 2003; Kniveton et al., 2008). Hence, public information on environmental changes is crucially important. Numerous studies on environmental migration have often assumed a direct, causal relationship between environmental changes and the migration decision. However, such an assumption is overly deterministic, and neglects the importance of social representations and construction of changes. This report shall depart from this deterministic perspective and pay special attention to the social perception of environmental changes. This is one of the reasons why the focus group method has been chosen, as will be detailed in section 3.

2. An economy dependent on the environment

The effects of environmental changes on migration behaviours will often be felt through economic variables. Worldwide, environmental conditions are crucial to the livelihoods of many, and this is especially the case in Mauritius. When assessing the causes of migration, it is often difficult to disentangle environmental

drivers from economic and social drivers (Black, 2001; Jonsson, 2010). The reason for this is that these drivers are deeply intertwined with each other; hence, environmental conditions should not be envisioned as separate from their socio-economic settings.

This section attempts to show the extent to which key economic sectors of Mauritius are dependent on environmental variables, and how this can affect the livelihoods of Mauritians.

2.1 Fisheries

Though there has been a gradual decrease in fish production since 1996 and it currently only represents 1.5 per cent of gross domestic product (GDP), fishing remains a significant activity in Mauritius, and even more so in Rodrigues. There are about 11,000 people employed in the fishing industry in Mauritius and 4,000 in Rodrigues – for the latter, this is about 10 per cent of the total population.³ A lot of fishers are unregistered and work in the informal sector. Their number has been on the decline as a result of both the depletion of fish stocks and the cessation of activities of local purse seiners. They represent a social group that is particularly vulnerable and ageing.

Climate change is likely to have a significant impact on fisheries. In particular, the mortality rate of juvenile fish could increase dramatically if the sea surface temperature increases. Such an increase would also result in major changes in fish migratory routes, as well as devastating coral bleaching, a phenomenon that has already been observed in association with the El Niño oscillation in 1998. There has been little research, however, on the linkages between the quantities of available fish and climate change.

Overfishing is also a major concern, especially in the lagoon. In addition, some fishing areas or fishing techniques have been prohibited or discouraged. Marine parks have been created in Blue Bay and Balaclava, as well as six fishing reserves. A similar park, the South East Marine Protected Area (SEMPA), has been established in Rodrigues (see part III, section 2.4). Only leisure fishing is allowed in marine parks, which

³ Albion Fisheries Research Centre (AFRC). Meeting of 26 July 2010.

have been zoned, whereas only fishing lines are allowed in reserves. Fishers who used to fish in marine parks have been financially compensated. Different initiatives have been taken in order to encourage fishers to adopt new fishing techniques or fish outside the lagoon. However, it seems difficult for fishers to find alternative livelihoods, as will be explained in part III, section 2.4. Furthermore, many of them are reluctant to change jobs.

2.2 Sugar cane

Despite a continuing decline in its importance to the country's GDP, sugar cane remains a significant sector in the economy of Mauritius. Its significance, however, is probably more justified by its symbolic value and importance to the history of the island than by its actual economic weight.

In 2008, the total production of sugar cane in Mauritius was 572,316 tons, down from 572,000 tons in 2004. The extraction rate – 9.98 per cent in 2008 – has been on the decline for a few years. As of 2008, 65,440 hectares of the country were under cane, down from 70,790 hectares in 2004. The area harvested was 62,040 hectares in size, down from 69,700 hectares in 2004. About 60 per cent of this area was harvested by miller planters and corporate planters, whereas about 40 per cent of the area was harvested by small planters. In 2008, there were six sugar factories in Mauritius, down from 11 factories in 2004. There are currently about 24,000 small planters in Mauritius (MSIRI, 2009). Only half of them work full time in the sugar cane industry; for the other half, sugar cane is only a source of supplementary income.

Sugar cane crops also show some vulnerability to environmental changes. For example, sugar cane exports, especially in Fiji, were severely affected by the La Niña phenomenon between 1998 and 2000 (Mimura et al., 2007). In Mauritius, exports were affected by a severe drought in 1999. Sugar cane crops, however, tend to be resilient to cyclones, and they prevent soil erosion.

The industry also relies heavily on the use of fertilizers and herbicides, as will be shown in part III, section 2.2. Another major environmental impact of sugar cane is the burning of crops, which used to be standard practice in the lowlands. The trend has been greatly reduced in

recent years, partly thanks to public information campaigns, but it continues to exist in some places.

The sugar cane industry is also highly dependent on agreements with trade partners and compensation and subsidies from the European Union. Much of the EU's aid budget to Mauritius is indeed made up of sugar company measures, which have been implemented as part of the Sugar Protocol with African, Caribbean and Pacific Group of States (ACP). The decision by the World Trade Organization (WTO) in 2004 to forbid preferential quotas for ACP countries meant that Mauritius could no longer benefit from preferential access to the EU market. This resulted in a significant income loss for the Mauritian sugar industry. Following the dismantling of the agreement, the EU has worked with the sugar industry towards a reform of the industry, acknowledging its economic significance.

2.3 Tourism

Tourism has been a key driver of Mauritius' development over the last 30 years (Magnan, 2005, 2007). The transformation of Mauritius into a middle-income and diversified economy owes a lot to the development of the touristic sector, as well as to the textile industry and financial services. Touristic activities, however, are hardly diversified: they are centred on luxury beach tourism, with a minor focus on golf tourism. Tourism within the island is virtually non-existent, and only few tourists venture outside of beach resorts. Many tourists come on all-inclusive package-vacation schemes; this appears to be a key reason why there is no incentive for tourists to venture outside their resort.

In 2009, according to official government data, Mauritius welcomed about 900,000 international visitors, who stayed in roughly 100 hotels and resorts. The government aims to double the number of international visitors – at 2 million – by 2015. This would undoubtedly imply the construction of new hotels and resorts on the coastline, which is only 322 km long.

Beach tourism is highly contingent upon environmental conditions (Duvat, 2005). These conditions affect the weather, the sea and the beaches at the same time. An increase in

cyclonic activity and rainfall precipitation would have an adverse effect on the touristic sector. A hotter sea temperature could also result in a proliferation of seaweed and jellyfishes and, more importantly, in the bleaching of corals. The world-class diving sites of Mauritius are a key argument in the country's touristic strategy, which would be compromised if corals were bleached. Last but not least, beach erosion could also be significantly detrimental to the tourism sector. Erosion is exacerbated by important demographic and real estate pressure on the coast, as well as by illegal works undertaken by some hotels, such as the removal of sea rocks and mangroves. Tourism also has a significant impact on coral reefs. Overall, the natural protections of beaches have been badly damaged by human activity; this damage is in conjunction with climate change impacts: mangroves have been removed and access paths to the high sea have made their way through coral reefs, amongst others.

Perceptions of these environmental changes and threats, however, are not widespread amongst hoteliers. Adaptation, when considered, is often thought of only in the short-term, as an adjustment to current practices, rather than as a fundamental reshuffling of the industry. Field visits confirmed this assessment.

2.4 Conclusion

Fisheries, sugar industry and tourism represent three key sectors of the Mauritian economy. Agriculture and fisheries represent about 5 per cent of the country's GDP and employ 10 per cent of its workforce, whereas the tourism sector represents about 20 per cent of the GDP. Combined together, these three sectors generate a quarter of Mauritius' wealth. However, they are all highly dependent on environmental conditions, through different variables. At the same time, they also have major environmental impacts: overfishing, damage to coral reefs, pollution and coastal erosion, to name a few.

Though the fisheries sector seems to have grasped its environmental vulnerability and has initiated a number of policy responses such as the creation of marine parks, similar actions have been timid in the sectors of sugar cane farming and tourism. Both tend to downplay their environmental vulnerability and impacts, though adaptation measures are urgently needed for these sectors.

3. Vulnerability, adaptation and migration

This section aims to establish the basic notions and elements that will serve as the basis for vulnerability assessment. Building on this objective, this section also seeks to delineate the specific vulnerabilities of Mauritius and to assess its options for future adaptation.

Section 3.1 addresses the concepts of vulnerability and adaptation, in order to establish a coherent and comprehensive understanding of what the threat of climate change means at the local level. This section will also seek to define the determinants of a vulnerable community. This constitutes a necessary first step before moving on to the pilot projects per se.

Section 3.2 addresses some limitations of this report. In particular, in the absence of comprehensive data and maps, it has not been possible to include vulnerability mapping and scenarios. Such maps, however, are currently under preparation in the course of the AAP project.

Finally, section 3.3 shows the obvious and strong linkages between migration and adaptation to climate change. It makes the case for migration to not be systematically considered as a failure of adaptation, as is often said and written, but also as an anticipative strategy. Consequently, migration and adaptation could also go hand-in-hand, rather than being at odds with each other. Nevertheless, one needs to be aware that the current situation is characterized by the fact that climate change, though it is already occurring, has not yet unleashed its full effects on a local scale. Thus, though the effects of climate change have started to be felt and observed recently, it is difficult at this stage to assess all future ramifications. This uncertainty about the future impacts of climate change can also be regarded as an opportunity, as it means that communities can prepare themselves to address anticipated changes and that they have the time to choose the options best suited to them. This could allow for forced migration to be avoided, as communities can prepare in order to avoid forced displacement, or make a voluntary choice to relocate. The aim of this project shall be to either suggest alternative livelihoods that can avoid forced migration, or foster migration on a voluntary basis as an adaptation strategy.

3.1 Vulnerability and adaptation: what is at stake?

3.1.1 Definitions

Vulnerability and adaptation are two pillars for analysing both the potential impact(s) of climate change on societies and regions, and also their ability to cope with these consequences (Parry et al., 2007; Magnan, 2010a). These concepts share some common determinants that can provide an appropriate framework for analysis.

Interdependence between vulnerability and adaptation

Vulnerability is intrinsically linked to risk, as it refers to the factors that constrain a system during a perturbation, that is, when a natural hazard occurs. These factors can be punctual or gradual in the context of climate change. Schematically, vulnerability reflects the relationship between the strengths and weaknesses of an area, that is, between the characteristics that enable the area to be resilient to a perturbation and those that hinder this resilience.

From this perspective, the most commonly accepted definition of vulnerability to climate change is the one proposed by the IPCC:

[Vulnerability is] the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.

If the IPCC links vulnerability with adaptation, this is because the very essence of vulnerability assessment lies in understanding the interplay between these two concepts at the local level. This will then allow for envisioning future scenarios and proposing pragmatic responses. In return, the implementation of adaptation strategies aims to reduce the vulnerability of an area to natural hazards and other environmental changes.

Consequently, and within the framework of climate change, vulnerability can be seen as a good indicator of the effectiveness of adaptation choices, which will in turn influence the evolution

of vulnerability. A virtuous or vicious circle is then set in motion between vulnerability and adaptation.

The determinants of vulnerability and adaptive capacity

Some factors are common to both vulnerability and adaptation.

In the early 1990s, the idea was developed that a disaster lies at the intersection between the anthropogenic processes generating vulnerability and the territory's geographical exposure to natural hazards. Adopting a global and systemic point of view, we can emphasize six major factors that can be taken into consideration (Magnan, 2009). This six-factor framework, by itself, should not be seen as an assessment grid of vulnerability, but rather as an analytical matrix allowing for a better understanding of the general causes of vulnerability, which has been used for field work in Mauritius and Rodrigues. The six factors of vulnerability are as follows:

1. Spatial configuration provides a geographical framework that may or may not support development. Coastal plains and the relative abundance of beaches in the island of Mauritius, for example, have provided opportunities for the development of tourism. On the contrary, the sloping coasts of Rodrigues and the relative isolation of the island imposed more constraints.
2. Environmental sensitivity supplements this physical dimension of vulnerability by integrating the nature of existing ecosystems and their potential fragility in the face of climate change. Coral reefs, as well as mangrove areas, are already highly threatened in Mauritius and Rodrigues. This reduces the resilience of coastal systems to hazards.
3. Social cohesion characterizes relations between individuals belonging to a community. Indirectly, it refers to the degree of solidarity, which is decisive both in crisis situations and in the implementation of anticipative strategies.
4. Economic diversification also plays a structuring role: an area relying on a single economic activity will struggle to recover from a crisis affecting its key economic activity, as there are no other economic sectors that could offset this activity.

The diversified economy of Mauritius appears clearly as a positive element in the reduction of vulnerability. This is not the case with Rodrigues, which lacks economic perspectives.

5. Governance patterns refer to the mechanisms through which the different areas of a region (coastlines, hinterlands, urban areas, etc.) are linked to one another. This concept is deeply associated with regional coherence. The existence of a shared vision for the future of society, as well as good governance, is a central element here. In Mauritius, the MID project has been an opportunity to define a shared vision of sustainability. Its implementation needs to be improved in order to really concur with the reduction of vulnerability to natural hazards. A further problem lies in the remoteness of Rodrigues and Agalega, as well as the poor integration of their local population. This situation could increase the vulnerability of the whole country to natural hazards, as marginalized islands will require the support of the whole country in order to recover from a destructive event.
6. Finally, living conditions reflect the general level of development and provide an overall framework for vulnerability assessment. This level may be appreciated using the elements of demography, housing, education, employment, health, access to transport and the type of energy sources used on a daily basis by households. However, in order to avoid the classic misconception that richer societies are less vulnerable, we need to remember that the “living conditions” factor should not be considered as the primary factor, as the way it affects vulnerability remains ambiguous and highly dependent on contextual specificities. Mauritius belongs to the middle income countries group – major progress has been made in recent years with regard to improving the living conditions of its population, and these efforts must be continued. Once again, a key challenge for adaptation policy at the countrywide level will also be the reduction of inequalities between the main island (Mauritius) and the other islands (Rodrigues and Agalega). A deepening of these inequalities could further increase inter-island migratory pressures.

Furthermore, the last four factors of vulnerability (factors 3–6) explain a society’s adaptive capacity

(Magnan, 2010b). Table 2 shows the strong linkages between vulnerability and adaptation in a different format.

Table 2: Key factors of influence for vulnerability and adaptive capacity

Influencing factors	Vulnerability	Adaptive capacity
Spatial configuration	X	
Environmental sensitivity	X	
Social cohesion	X	X
Economic diversification	X	X
Governance patterns	X	X
Living conditions	X	X

3.1.2. Vulnerable communities

A community can be considered as vulnerable to environmental degradation when the following conditions are met:

- It is located in an exposed or potentially exposed area. An area is exposed either when it is directly threatened by natural hazards (coastal submersion, soil salinization, heavy precipitation, etc.), or when its ecosystems are degraded and/or sensitive to environmental stressors. One example in Mauritius is the Petit Sable region, where a narrow plain is dominated by relatively steep slopes. This could also be the case with Port Louis, which is located in a large but lowland plain. The coast of Rodrigues is less exposed because of the extraordinary development of the lagoon, which plays an important buffer function. On the other hand, the clearing of original vegetation increased the vulnerability of the island to heavy precipitation episodes and associated landslides. Finally, Agalega Islands represent an extreme case of exposure to sea hazards.
- It is not characterized by strong social cohesion, that is, relatively strong links of solidarity and support among a majority of its members. The community of planters in Petit Sable, for example, shows a strong level of social cohesion, which can counterbalance its highly exposed location. A similar statement can be made for Rodrigues and Agalega. In Mauritius Island, sociocultural communities still play a key role in maintaining or developing social cohesion. Social cohesion also bears a significant gender dimension, which is important to take into account.

Women often tend to be more vulnerable than men to environmental changes.

- It is strongly dependent on environmental resources for its subsistence and/or for creating revenues. This situation often occurs when communities or households only develop one main economic activity. The vulnerability of these communities can be greatly reduced through diversification of economic activities.
- It feels geographically isolated in the territory and not part of mainstream institutional and socio-economic development.⁴
- Its living conditions and livelihoods are fragile because of a lack of revenues, a lack of education and a lack of transportation means. Note here that these elements tend to be seen as the main drivers of vulnerability. Here we shall consider them as one amongst other factors of vulnerability. Within Mauritius Island, for example, much of the economic activity tends to be concentrated in the capital, Port Louis, while the conurbation of Quatre Bornes has kept on expanding. Economic activities tend to be concentrated around these cities, as well as in the narrow areas where tourism is developed (west, north-west, north-east, and, more recently, south). This polarization of the development areas has emerged over the last four decades (Magnan, 2005), as the sugar cane industry weakened due to international competition. This explains why living standards tend to be better around urban and tourism areas than inland. Nevertheless, social inequalities tend to be higher in urban than in rural areas.

3.2 Vulnerability mapping and scenarios

At the moment, no exhaustive study of vulnerability in the Republic of Mauritius has yet been completed. However, initiatives to fill this gap have been launched recently, both by the Government in the context of the AAP (see section 2, part IV) and by the Indian Ocean Commission in the context of its *Acclimate* project.⁵

⁴ Statements collected from field visits in July 2010 with communities in Mare Chicose, Tranquebar, Rivière des Galets and Rodrigues, as well as phone conversations with Agalegans, indicate that these communities feel cut off from development occurring in the rest of the country.

⁵ www.acclimate-oi.net

With regard to scenarios, we decided not to include in this report the key conclusions of the next National Communication of Mauritius to the United Nations Framework Convention on Climate Change (UNFCCC),⁶ as this report is not yet officially available.

3.3 Migration and environmental changes

3.3.1 Definition of “environmental migration”

Defining “environmental migration” is a tricky task, hindered by many difficulties. One of the key obstacles is linked to the difficulty of isolating environmental factors from other drivers of migration. To what extent is a migration flow caused solely and principally by environmental change? Is it possible to distinguish whether environmental factors are the primary drivers of migration? The following section attempts to clarify this issue of multi-causality.

This intermingling of migration drivers, however, is far from being the sole obstacle to defining environmental migration. Another major hindrance lies in the confusion between forced migration and voluntary migration. A common assumption is that environmental disruptions trigger only forced – and often brutal – displacements, an assumption emphasized in the term “environmental refugees”. Suhrke (1994) wonders whether there is “something about the nature of environmental degradation that tends to produce refugee-like movement rather than migration.” Many authors stress, however, that environmental factors also induce voluntary migration (Renaud et al., 2007; Suhrke, 1994; Hugo, 1996). The distinction between forced and voluntary migrants is often a fine one in the case of environmental migration.

Finally, a further difficulty arises from the absence of any legal definition of the concept. Unlike refugees or internally displaced persons, no specific legal framework exists to address environmental migration. This can be seen as a catch-22 situation: the development of a legal definition is also impeded by the conceptual fuzziness that prevails.

⁶ Information on the Mauritius implication in the UNFCCC process can be found here: <http://maindb.unfccc.int/public/country.pl?country=MU>

In order to overcome these difficulties, IOM proposed in 2008 a working definition for environmental migration that attempted to capture the complexity of these migration flows:

Environmental migrants are persons or groups of persons who, for reasons of sudden or progressive changes in the environment that adversely affect their lives or living conditions, are obliged to have to leave their habitual homes, or choose to do so, either temporarily or permanently, and who move either within their territory or abroad.

This definition encompasses various types of migration movements:

- those triggered by sudden environmental disruption, and also those induced by gradual changes;
- those taking place within the borders of a country, as well as international movements;
- long-term as well as short-term migration;
- voluntary and forced migration.

In order to account for the diversity of migration behaviours that can be induced in the Mauritian context, this is the definition we shall use throughout this report.

3.3.2. Multi-causality

Most authors stress the multi-causality of migration and the intermingling of factors (Black, 2001; Castles, 2002; Brown, 2008; Boano et al., 2007). Therefore, one can legitimately ask whether isolating environmental drivers is possible, or makes much sense conceptually. Lassailly-Jacob (2006) rightfully questions whether environmental migrants make up an additional category of forced migrants, or are better understood within existing conceptual categories.

The question of causality relates to the relative importance assigned to environmental factors among other drivers: the former are deeply rooted in socio-economic, cultural and political contexts, and are not easy to disentangle. Even though the importance of environmental drivers is widely acknowledged in literature, debate remains regarding the need to conceptualize these drivers as distinct from other migration drivers.

In any case, there is growing consensus that it is impossible to establish a direct, causal relationship between environmental change and migration. On the contrary, environmental changes are embedded in socio-economic structures from which they cannot be separated. Thus it seems that environmental migration should be envisioned as part of global migration dynamics, rather than as a separate category of migration.

This is the reason why we shall not try in this report to establish a distinct category of environmental migrants in the Mauritian context, but rather to assess and understand how environmental changes, associated with other socio-economic changes, can impact migration behaviours.

3.3.3. A failure to adapt?

The number of migrants forced to move by environmental changes will largely depend on the adaptation policies that are developed to cope with these impacts. The relationship between migration and adaptation is dual: it can represent both a failure to adapt and a genuine adaptation strategy implemented by the migrant.

For a given environmental change, the development of adaptation strategies in the regions of origin will be the only way to limit the scale of migration flows. In many cases, migration will be the last resort, only considered if different adaptation strategies have failed. The real impact of environmental change on populations will largely depend on the success of these adaptation strategies. In cases where these strategies fail, adaptation will also be needed in the region of destination, which will often be faced with demographic changes in addition to environmental changes.

But migration itself, far from representing a failure of adaptation, may also in certain cases be developed as an adaptation strategy in its own right. The decision to migrate will then be deliberate and will enable migrants to reduce their vulnerability to environmental changes, while easing demographic pressure in their region of origin. Migration, which is sometimes temporary or seasonal, especially enables families to diversify their income, and thereby constitutes a kind of insurance against environmental risk. To understand migration as a risk prevention and reduction strategy, “climate migration” must be seen not as a specific type

of migration, but as a version of the migration processes that have always existed.

These strategies may be particularly effective in the case of progressive environmental degradation. However, for the time being, this type of migration remains compromised by inappropriate public policies and by migrants' lack of resources: only the more affluent can use migration as a form of adaptation, with the more vulnerable often being forced to stay. The political challenge will therefore be to facilitate and manage migration rather than to try and prevent it from happening.

PART III

ENVIRONMENTAL CHANGES AND MIGRATION





**ROAD LIABLE
TO FLOODING**

Introduction: The Environment-Migration Nexus in the Mauritian Context

Climatic conditions and environmental disruptions have long been drivers of migration in Mauritius, and are intrinsically linked to its history. The Dutch colonization, between 1638 and 1710, was marred by numerous cyclones, droughts and other environmental disruptions. The first Dutch settlement was established by Cornelius Gooyer in 1638. Soon the settlers were faced with cyclones, droughts and bad harvests. They finally decided to flee the island in 1658, ending the first Dutch attempt at colonization. The Dutch made a second attempt in 1664, but eventually gave up in 1710, faced with too many environmental disruptions and other related hardships such as cattle diseases, infestations and bad harvests.

In 1925, many economic and governmental activities, such as meteorological services and other governmental administration functions, were relocated from Pamplemousse after the city was hit by an epidemic of yellow fever and malaria. A few years ago, some residents of Port Louis were displaced by a landslide that took place on a nearby hill.

Mauritius is also the home of Chagossian islanders, victims of one of the most famous cases of development-induced forced displacement, with limited resettlement strategy. The deportation of Chagossians started in 1967, in order to make way for the construction of a UK naval base on the island of Diego Garcia, in the Chagos archipelago. The Chagossians were displaced to Mauritius and the Seychelles. So far, the return of the Chagossians remains a matter of dispute between the Mauritian and UK governments.

Notwithstanding these occasional displacements, environmental conditions, weather patterns in particular, also played a major role in the distribution of population on the island. Before the tourism boom, the wealthy used to live on the central plateau and would go to the shore in the winter, because of the unpleasant cold temperatures on the plateau.

Local micro-climates in Mauritius have also

been a significant factor in population migration within the islands. The release of land near the coast by the sugar industries, in their strategy to consolidate their holdings, also greatly facilitated and accelerated the proliferation of houses on the coast, many of them secondary residences. From then on, beaches would face a very important and ever-increasing demographic pressure. This pressure is a real threat for local ecosystems. Drainage systems remain inadequate in coastal areas. As a result of this, heavy rainfall often results in serious flooding in residential areas, most of which are built on land that is prone to flooding, wetlands in particular.

More recently, the 2004 tsunami acted as a wake-up call. Though the damages sustained by coastal infrastructure were not really important, many coastal residents realized how vulnerable they were to sea-level rise, storm surges and coastal erosion. This has been a significant concern for hoteliers, and some of them have moved their bungalows farther away from the sea. As will be shown in subsequent sections of this report, in particular in part III, section 2.1, many coastal residents have been living in fear of another tsunami since then.

I. Methodology

The field mission was conducted over a period of two weeks in July 2010. It included three different components: expert interviews, direct observation through field visits, and focus groups. Much of the time was spent in Mauritius, with a three-day visit to Rodrigues.

I.1 Expert interviews

Expert interviews were conducted with about 30 key informants in Mauritius, Rodrigues and Agalega, with interviews in the latter conducted by phone.

Expert informants included representatives from key governmental agencies and ministries, as well as community organizers and representatives from international organizations present in Mauritius. The full list is provided in the Appendix. Each interview was conducted face-to-face, with the frequent presence of an IOM collaborator, Ms Preeta Heeralall, who arranged for and facilitated the interviews. In a few exceptional cases, the interview was conducted over the phone rather than face-to-face.

Interviewees had been made aware in advance of the overall nature of the project, and some of them were actually members of the Project Implementation Committee (PIC). Each interviewee was met only once and the average length of the interview was about 30–45 minutes. The interviews were not taped.

1.2 Field visits

Field visits were another major component of the study, as they allowed not only for direct observation of environmental changes at play, but also of habitats, infrastructure and social attitudes in reaction to these environmental changes. The choice of sites relied on the criteria of accessibility, regional balance and

environmental diversity. The selection of sites does not pretend to cover all environmental changes in Mauritius, but should be seen as a direct observation of some key policymakers.

In four sites, it was possible to conduct focus groups (see part III, section 1.3). These sites have thus become the priority research areas for the study. The other sites (referred to in Maps 2 and 3 as “secondary sites”) have also been identified as equally important, though no focus groups were conducted at these sites. It is of utmost importance to stress that the distinction between the former and the latter is solely related to the practicalities of the study, and does not presume any vulnerability ranking.

Map 2: Location of study sites in Mauritius



Map 3: Location of study sites in Rodrigues⁷

Sites where focus groups have been conducted include:

Rivière des Galets

The site of Rivière des Galets, in the south of Mauritius, was chosen because of its high vulnerability to sea-level rise and storm surges. The village has been flooded numerous times in recent years, and beach erosion is particularly visible, despite the building of a dike.

Petit Sable

This site presents an interesting combination of non-climatic environmental changes and the impacts of global warming. Located in the south-east of the island and home to small planters, Petit Sable often faces landslides and flooding. Floodwaters often carry silt and pesticides from the nearby sugar cane plantations, which they deposit on the fields. The soil is also exposed to saline conditions from the nearby sea.

Tranquebar

Tranquebar is a slum on the outskirts of Port Louis, inhabited primarily by migrants from Rodrigues. Located on a hill, the slum is often flooded and threatened by mudslides. Unlike the two previous sites, Tranquebar is both a destination point for migrants and a place threatened by environmental disruptions. It is also the only primary site that is located inland.

South East Marine Protected Area (SEMPA), Rodrigues

SEMPA is the largest marine park in the Republic of Mauritius and the first in Rodrigues. The project *Partnership for Marine Protected Areas in Mauritius and Rodrigues* was initiated in 2005. Within this project, SEMPA was set up and gazetted in 2009. The choice of this site, located in the south-east of Rodrigues, aims to address the concerns of fishers who are forbidden to fish in some parts of the lagoon area following the establishment of the marine park.

In addition to these sites, other sites were also chosen in order to expand the coverage of the study. The latter sites complement the former in that they either represent a different issue or address an environmental issue considered in

⁷ Note that SEMPA is spread over 43 km² – the red dot simply indicates the location where the study was conducted, in the office of the marine park.

previous sites, but in a different area. No focus group was organized in these sites. Instead, the study was conducted through targeted interviews of affected residents.

These sites include:

Cité Lumière, Grand Baie area

Cité Lumière is a slum established on a swamp. Its location makes it highly vulnerable to flooding. The government is currently planning to relocate the residents in another area, in order to reclaim the land for a real estate project.

Mare Chicose

Mare Chicose is a small village located inland, north of Rose Belle. It is also the site of a government-managed landfill. The government is currently implementing a resettlement scheme in order to relocate residents in Rose Belle.

Agalega Islands

Agalega is an archipelago of two islands, lying 700 miles north of Mauritius. The islands are

populated by just 350 inhabitants, and are very small (24 km²) and low-lying, which make them especially vulnerable to sea-level rise. Other environmental issues such as droughts and cyclones are also major concerns.

Plaine Corail, Rodrigues

Plaine Corail is the site of an important sand mining activity. The activity, however, induced significant coastal erosion, and will soon be phased out. This case study aims to look at the impact of environmental protection measures on the livelihoods of the sand miners.

Overall, the combination of different sites aims to cover a broad diversity of environmental changes in diverse regions of the country, including coastal and inland areas, in Mauritius, Rodrigues and Agalega. Case studies also look at the impact of environmental protection measures on livelihoods, as well as at resettlement schemes aiming to relocate residents to safer areas. Table 3 summarizes these characteristics:

Table 3: Characteristics of study sites

	Rivière Galets	Petit Sable	Tranquebar	SEMPA	Cité Lumière	Mare Chicose	Agalega	Plaine Corail
Island	Mauritius	Mauritius	Mauritius	Rodrigues	Mauritius	Mauritius	Agalega	Rodrigues
Location	Coastal	Coastal	Inland	Coastal	Inland	Inland	Coastal	Coastal
Floods	Yes	Yes	Yes	No	Yes	No	Yes	No
Cyclones	Yes	No	Yes	No	No	No	Yes	No
Pollution	No	Yes	No	No	No	Yes	No	Yes
Measures of environmental protection	No	No	No	Yes	No	No	No	Yes
Resettlement considered	Possibly	No	Possibly	No	Yes	Yes	No	No
Key economic sectors	Fishing	Farming	Low-skill jobs	Fishing	Low-skill jobs	Diverse	Farming (coconut)	Sand mining

Statistical limitations made it extremely difficult to know the exact number of people living in the affected sites. The only data available were the number of people living in each administrative zone. The delimitation of these zones, however, did not match the limits of the sites. The electoral register contains data broken down by addresses, but this information could not be used because of confidentiality issues. For the same reason, it has been impossible to conduct a quantitative analysis of the socio-economic profiles of the sites, and only qualitative information could be obtained from field visits. The lack of usable

statistical data has been a major limitation of the work.

1.3 Focus groups

Information in primary sites was essentially collected through the use of focus groups. The focus group method is a technique of qualitative sociological research, where a small group of participants (about 10 to 15) are asked to discuss their ideas, perceptions and reactions to a particular topic. The setting of the group is interactive and participative, and participants can react freely to each other's opinions. Moderation

is limited. The focus group discussions organized for this study were attended by the IOM collaborator in charge of the project, Ms Preeta Heeralall, as well as by a community organizer. The latter was a reassuring presence for the participants, who were thus more inclined to provide truthful answers to questions.

The choice of the focus group technique was justified for several reasons:

- Statistical data on the regions under study could not be used, as it would have required a laborious manipulation of census surveys (not readily available to the public), which was not possible. It was therefore impossible to conduct quantitative surveys, which would have required a sampling exercise.
- Given the time constraints and the number of sites studied, focus groups were the only way to meet a significant number of people from the affected regions.
- The technique also allowed the participants to interact, rather than just respond to a set of questions. Therefore, it allowed for greater nuance and precision. It was also a way to test the strength of some beliefs and the robustness of some perceptions.
- Finally, focus groups allow for the emergence of a collective opinion, rather than just an addition of individual opinions. Migration

research has shown the importance of group dynamics in the migration decision (Castles and Miller, 2003); it was therefore particularly important to assess these collective dynamics. The focus group allowed the collection of data on the perceptions and beliefs of the community, and not just of individuals.

Focus groups were videotaped for the purpose of the research. Participants were told that nothing they say would be used in the press. The focus groups were always preceded or followed up by a couple of personal, in-length interviews with some members of the community.

2. Empirical evidence

2.1 Rivière des galets

2.1.1 Geographical and socio-economic profile of the site

Rivière des Galets is a coastal area located south of the village of Chemin Grenier. As shown on the aerial photograph, the village is located along the coast, and is traversed by a road. Waves tend to be particularly high in the area, which is one of the very few places in Mauritius where surfing is possible.



Aerial photograph of Rivière des Galets

Credit: Google Earth.



Protection wall and gabions in Rivière des Galets

© IOM, July 2010, Francois Gemenne



Gabions on the beach of Rivière des Galets

© IOM, July 2010, Francois Gemenne

Inhabitants have noticed significant environmental degradation in the last few years: in particular, they point to regular floods (the most significant occurred in 1987, 2001, 2004 and 2006), coastal erosion and a decline in fish stocks.

Historically, the south of the island has always been the part that was the least developed, and Rivière des Galets is no exception. Most of the inhabitants live in small and fragile one-level houses. A significant proportion of them are fishers. The demographic composition of the village reveals that many inhabitants are middle-aged, having spent all of their lives in the village. There are about 20 children though, and a school is located in the village.

2.1.2 Results of the focus group

All 15 participants have experienced environmental changes. Many have had their houses flooded on numerous occasions, and note that the sea is coming closer. A turning point seems to have been the 2004 tsunami, which triggered panic in the region. Since then, inhabitants have been afraid of a new tsunami, which they often mistake for an impact of climate change.

The perceptions of the inhabitants about environmental change are obviously dominated by fear. Many state that they often think about rising waters, especially at night, since they believe that floods happen most often at night. They force themselves to forget about the floods afterwards, given that they have nowhere else to go. A major difference between floods and tsunamis is related to the noise: though inhabitants can hear the noise of rising waters, tsunamis and storm surges are judged to be less predictable and inaudible. The 2004 tsunami has definitely sparked much fear and panic, which remain present six years after the event.

Participants are very conscious of the vulnerability of their village. They acknowledge that this region is the most vulnerable region of Mauritius with regard to tsunamis and floods. This is due to the absence of reef barrier, as well as due to the river, which is judged by some as a factor of vulnerability and by others as a protection against floods.

Fishers experience a significant decline in fish stocks, as well as an increase in non-fishing

days due to rough sea. This decline appears to be due primarily to overfishing, but some fishers also blame the rough sea. Though fishers receive government compensation on the days they cannot go to sea, it is not sufficient to compensate for loss of income. Overall, their economic situation has greatly declined in recent years, and they do not expect it to get better in the future.

Many judge that protection walls and gabions are inefficient against floods, and these people do not feel safe. Most of them settled in the region a long time ago, unaware of its environmental vulnerability. Though social development has been significant, it has been counterbalanced by the degradation of the environment. Environmental degradation has impacted social life: fear has spread through the village, to the point that women are now afraid to wash their laundry in the river. Tourists have also deserted the area, and parties are no longer held on the beach. Overall, the sea has reclaimed what used to be a space of socialization. Many resent the nearby presence of luxury resorts, with one participant pointing out that “[they] are no longer free to go [to the beach] in our own country.” They complain that the government warns hotels and resorts in case of a tsunami or storm surge by placing phone calls, but not the inhabitants, who need to rely on radio bulletins. Most residents, the elderly in particular, are unwilling to leave the area. They would be ready to do so, however, should the government provide compensation. They also think that the government should forbid the construction of new houses in the area. They have heard of new houses that were being built by the government for relocation, but they have never been contacted directly about it. They have heard that the houses were too small. In any case, they share the opinion that the government should organize a public meeting to inform the residents and discuss resettlement options with them. In their view, each family should get its own house. The refugee centre for cyclones is also perceived as insufficient and ill-adapted, as many point out that cyclones are different from tsunamis and that the refugee centre would be inefficient in case of a tsunami. They have not received any specific training for evacuation in case of a tsunami, but are entitled to financial aid. This aid, however, is difficult to get, and inhabitants have to ask for it, which is something they find unfair.

Though residents are unwilling to leave, they are resigned to do so, and believe they do not have any other choice. In case they could choose where to go, they would go to Chemin Grenier or elsewhere along the coast, but not too far from their working place. Though they own their houses, they do not own their land, which is state land. In case of relocation, the price of land would be a major issue, as many consider it unaffordable. A schoolteacher, who does not live in the area, stated that she dreads another tsunami hitting while she is teaching the children, and that she would personally be unable to live in Rivière des Galets.

2.1.3 Comments

A major feature of Rivière des Galets is the omnipresence of fear amongst its inhabitants. The tsunami and other floods have deeply affected the social life of the village and created significant trauma. Residents have assimilated the fact that relocation is unavoidable, but they remain unsure about the conditions of this relocation. If a resettlement process is indeed being considered, better information should be provided to the residents. In any case, better safety information could be provided, especially with regard to tsunami and cyclone evacuations. Overall, the inhabitants lack information about environmental changes, and this does not allow them to adapt anticipatively. This lack of information can sometimes result in maladaptation, as is the case with indents that have been made in walls, which hinder the recession of flood waters.

2.2 Petit sable

2.2.1 Geographical and socio-economic profile of the site

The region of Petit Sable is located in the south-east of Mauritius, on the coast, north of Mahebourg. It is home to about 200 small planters, and is the principal locus of onion production in Mauritius.

Most of the inhabitants of the area are small planters, organized in small family businesses. Because of the degradation of environmental conditions, some planters have been forced to change their livelihoods and have become carpenters, masons, taxi drivers or fishers. Most of the planters do not own their land, which

belongs to the government. Crop plantations are the only source of income for the area. The region is quite marginalized within Mauritius: transportation is difficult, and governmental interventions are scarce. Women also work in plantations, as transportation does not really allow them to go to work in Mahebourg or Port Louis.

Environmental conditions induce severe difficulties for farming. Coastal regions are regularly flooded during the flooding season, especially in February and March, making the land impossible to cultivate. Because of the floods, sugar cane plantations have often replaced onion plantations. Planters often cultivate both onions and sugar cane. This, in turn, has had dramatic consequences for the local environment:

- Canes have replaced trees, which are used to stabilize the land. Though cane provides solid soil cover except at the time of planting, some planters perceive that a result of this is that heavy rains often induce mudslides that wipe out onion crops and damage the homes of planters.
- Fertilizers from sugar cane plantations are carried down the hill onto the sea, and planters feel that these fertilizers kill onions and fish, though the reality of this perception is challenged by both the Mauritius Sugar Industry Research Institute (MSIRI) and the Agricultural Research and Extension Unit (AREU). In addition, onion seeds are often washed away by heavy rains and flash floods. Planters need to restart their plantations from scratch afterwards.

Due to the drop in sugar prices and the high cost of sugar cane production on mountain slopes, some of these areas have gradually been abandoned or converted to other agricultural use, as planters no longer find it profitable to continue to grow sugar cane. This has also resulted in increased soil erosion.



Flood sign in the region of Petit Sable

© IOM, July 2010, Francois Gemenne

A possible solution to these problems could be the setting up of drains. Thanks to a governmental grant, the Mouvement pour l'Autosuffisance Alimentaire (MAA) has been able to install a couple of drains. These drains, however, remain insufficient, and the MAA association has made repeated pleas to the government to have more drains installed.



Drains through onion fields, Petit Sable

© IOM, July 2010, Francois Gemenne

Finally, the local economy has been badly hit by the importation of hybrid seeds. Reproductive flowers have also been damaged by heavy rains and hotter temperatures.

Due to cross-fertilization, yielding has considerably decreased in recent years and seeds have become an increasingly scarce commodity, though they are crucial for production. Heavy precipitation and high temperatures have also damaged seed crops.



Damaged reproductive flowers
© IOM, July 2010, Francois Gemenne

2.2.2. Results of the focus groups

All planters have experienced significant environmental changes in recent years. The observed changes include:

- an increase in heavy rainfall, which altered the timing of the rainy season;
- birds eating seeds;
- coastal erosion, which carries fertile soil to the sea;
- contamination of crops by fertilizers, though AREU insists that such contamination is primarily the result of saltwater use and saltwater intrusion;
- an increase in the number of mosquitoes, grasshoppers and other insects, which makes the use of pesticides necessary;
- contamination of fertile soil by saltwater from the sea.

In addition to onions, planters also grow carrots, garlic and chillies. Many of the crops are attacked by insects, and it is now necessary to use pesticides.

All planters describe their economic situation as very difficult; their income has declined, and they do not have the resources to hire employees. Hence, all the work has to be done by the family. In addition to a decline in their income, farmers also suffer from an increase in production costs – especially those related to the purchase of pesticides.

Though planting is now a family business, children and young persons are not interested in pursuing planting activity. Most planters are over 40 years old, and youths have chosen careers in masonry, hospitality and tourism, or education instead. Very few have become fishers. Current planters

have no intention of changing their activity, and have never thought of doing so. Some of them received their parcel of land from their parents; they say they might have abandoned their activity if they had had to pay for land. They believe that their land will be abandoned when they cease activity. Greenhouses are not affordable and too vulnerable to cyclones.

All planters feel that their community is neglected by the government. They are under the impression that the government is more interested in fishers than in them. As an example of this, they mention the fact that they do not receive any governmental compensation on the days when they cannot work, unlike fishers. They also claim that the government should launch an initiative to lower the prices of pesticides and seeds. The AREU has initiated several tests for more resistant seeds, including drought-tolerant crop varieties, but the tests have been inconclusive. Planters say that they would rather receive financial rather than material aid from AREU.

There is little outmigration from the region. Most planters believe that their children will continue to live in the area, even though some of them intend to move to urban areas.

2.2.3. Comments

Economic hardships combine with environmental problems. These environmental problems themselves are associated with climatic and non-climatic factors. Planters share a certain sense of abandonment by the government and would like to receive more help, which could include funding for more drains. It is unlikely that planters would abandon their job though; most of them are already quite elderly, and it is likely that their activity will not be pursued by their children. Land rights play an important role in their decision not to move; except for one who was already cultivating in higher grounds, all planters had no option to plant elsewhere.

2.3 Tranquebar

2.3.1. Geographical and socio-economic profile of the site

Tranquebar is a slum located on a hill on the outskirts of Port Louis (see Map 4 for more details). It is mostly inhabited by migrants from Rodrigues, most of whom are below 30 years old. While some are unemployed, others work in low-skill jobs such as masonry. All residents are poor, though many would define themselves as richer than those in Rodrigues.

Map 4: Map of Tranquebar



Credit: Google Maps.

Housing conditions are very poor. Tranquebar is often affected by mudslides and heavy winds, which can badly damage houses.



Houses in Tranquebar

© IOM, July 2010, Francois Gemenne

2.3.2 Results of the focus group

Most of the migrants came to Mauritius because there were no jobs in Rodrigues, or, if there were, these jobs were badly paid ones. Some of the migrants were fishers who suffered from a decline in fish stocks as well as the phasing out of the government's allocation for non-fishing days. Many of the migrants had changed or lost their jobs in the last few years. They had to save money for about three to four months in order to be able to afford a plane ticket to Mauritius.

Despite living in a slum, most of the migrants state that their economic situation is significantly better in Mauritius than in Rodrigues. They continue to visit their families in Rodrigues quite frequently, and send them remittances throughout the year, via the post or the bank. They tend to consider that it is easier to work in Mauritius than in Rodrigues, even though their work is often irregular.

If they had been able to, all would have preferred to stay in Rodrigues though. Some of them would

like to go back to Rodrigues, and many save money in order to build a house for themselves in Rodrigues. They point out that there are significant cultural differences in Rodrigues and Mauritius – in particular, there are more crimes in Mauritius.

The slum faces many environmental issues, most notably with the rain and wind, which often induce mudslides. There is no electricity in the slum. The road is hardly practicable, and does not allow for ambulances to go through. In case of rain, the slum is invaded by mosquitoes that bring along different diseases. Participants seem little informed about the impacts of climate change.

Because of the planned construction of a ring road around Port Louis, the government is planning to relocate the slum. All of its inhabitants, however, resent the absence of any contact with the government. The resettlement is scheduled for May 2011. Most of the residents are unwilling to move, but feel they will have no other choice eventually. They are, however,

informed very little about the conditions of a possible future resettlement.

2.3.3. Comments

Though economic factors and unemployment, in particular, seem to be the key drivers of migrants from Rodrigues to Mauritius, environmental factors cannot be completely ruled out. Indeed, a key reason for unemployment in Rodrigues has been the decline of fish stocks. Despite living in a slum with neither electricity nor asphalt road, migrants seem to agree that their living conditions are better in Mauritius than in Rodrigues. This also corresponds to an attempt of self-justification of the migration process, often conceived as an investment. In any case, it underlines the importance of perceptions and representations in the migration process.

Many plan to return to Rodrigues eventually, and save money to build a house. Rodrigues has certainly not been abandoned by the migrants, and their relationships and attachment with their home island remains very strong. Migrants feel marginalized in Mauritius, and this marginalization is further compounded by the possibility of further resettlement associated with the ring road. This prospect of resettlement is met with anxiety and resignation by the residents of Tranquebar.

2.4 South East Marine Park Area (SEMPA), Rodrigues

2.4.1. Geographical and socio-economic profile of the site

The creation of SEMPA was set up and gazetted in 2009, as a joint project of the Global Environment Facility (GEF) implemented by UNDP and the Government of Mauritius.⁸ Also supported by the Regional Assembly of Rodrigues, the Rodrigues Marine Protected Area is a part of a wider project that also includes the Blue Bay and Balaclava marine parks (Mauritius Island). Covering 43 km², Rodrigues Marine Park is the largest marine park in the Republic of Mauritius. As indicated in Map 5, it comprises the lagoon area in the south-

east part of the island, between Anse Quito and Anse Bouteille.

The park was established after extensive consultations with fishers operating in the area. There are about 950 fishers concerned with the park, and they participate in its management. Fishers are allowed to continue fishing in certain zones of the park, while other areas have been designed as conservation zones and are forbidden to fishing. Given that fishers have been experiencing significant fish stock decline, the project aims to protect fish stocks and marine resources.

The lagoon has suffered from legal and illegal overfishing. Fishers, in turn, have suffered not only from declining fish stocks, but also from an important cut in allocations for bad weather. More than two years of consultations have been necessary to get their involvement with the management of the area. It is upon their proposal and approval that certain zones, declared critical by an ecological monitoring assessment, have been zoned. However, because of this zoning, some fishers have seen their resources drastically decrease, resulting in an economic problem. Some livelihood alternatives should now be fostered in order to support the success of the marine park, with a view to helping fishers find other revenues. For now, fishers from the lagoon are also encouraged to venture out to the high sea for fishing.

⁸ The framework is the *Partnership for Marine Protected Areas in Mauritius and Rodrigues*.

Map 5: Map of SEMPA



Source: SEMPA.

2.4.2. Results of the focus group

Fishers have all noticed important environmental changes in recent years. In particular, they single out the fact that the sea is now rougher than ever, especially since the tsunami; they state that the sea is now impossible to sail at least one day per week. Fish stocks have also considerably declined, not only in the lagoon, but also in the high sea. They blame different factors for this situation: overfishing by some fishers, the rougher sea, the destruction of coral reefs, and the pollution of the lagoon by soil that is washed away at sea in times of torrential rain. They acknowledge that some traditional fishing techniques, in particular those related to the fishing of octopus, are very damaging to coral reefs.

All fishers qualify their economic situation as very difficult. Many have already thought about

changing jobs, but this does not seem to be a possible option; there are no other employment possibilities in other regions, and they do not have a house in other regions. The only other employment opportunity on the coast seems to lie with the possible creation of saline. Some of the fishers intend to stop fishing and work in saline production.

They claim to be satisfied with the creation of the marine park, though other fishers met outside of the focus group context did not share the same opinion. There is a strong agreement to acknowledge that tides are much higher than what they used to be, and are destructive for ecosystems. Most fishers have heard about climate change, and they have personally experienced a change in the seasons, which impacted fish migratory routes. They believe the situation is going to get worse, and tides will become even higher. Eventually, they believe that all islands are doomed to disappear because

of the melting of ice sheets. There seems to be strong argument about this belief.

There are many complaints about the new government's policy to revise the allocation of financial aid to compensate for days of bad weather. Whereas aid was previously granted when winds were above 55 km/h, it is now only granted when winds are above 75 km/h. Not all fishers receive aid, as one needs to be registered with the government in order to be entitled to it. Fishers also complain that weather forecasting is made in Mauritius and sometimes does not take into account the specificities of Rodrigues climate.

Some have already given some thought about immigrating to Mauritius, but many remain attached to their land. One fisherman declares that it is his intention to migrate to Mauritius, a statement that sparks railing and scepticism amongst the others. They point out that

migration to Mauritius is a risky endeavour, and that this cannot be considered a solution. Most see migration to Mauritius as a forced choice made by some, a choice which they would rather avoid. They point out the difficulty of bringing along one's family, as well as the numerous difficulties facing new immigrants. All have family members who have migrated to Mauritius, and all agree that their mentality has considerably changed. Overall, they seem to have a rather negative perception of migration to Mauritius, which is associated with social problems, economic hardships, and a change of lifestyle. Oddly enough, they think that people in Mauritius are happier than those in Rodrigues, and that employment opportunities are more numerous. However, they also think that they would be unhappy in Mauritius, because of the different culture, the lack of proper housing, and the abandonment of their families and their lands.



SEMPA viewed from the road
© IOM, July 2010, Francois Gemenne

2.4.3. Comments

The perception of migration to Mauritius is a rather negative one, which mixes resentment and possibly envy towards those who have gone. Fishers in Rodrigues seem to have a sense of fatality with regard to their situation. A major concern is clearly the lack of employment opportunities, which makes them accept the degradation of their situation without any real possibility of reversing the trend. With the degradation of environmental conditions and the decline in fish stocks, financial aid from the government represents an essential additional income, to which many do not have access because of recently implemented rules.

2.5 Other sites of concern

2.5.1 Cité Lumière (Grand Baie area)

Cité Lumière is a slum established on a wetland area. As of August 2010, it was inhabited by 19 families. Because of its location on a wetland, the slum is regularly flooded, with water levels that can rise up to 60 cm. The water typically stays stagnant for several days, posing serious health risks. Families live in very dire conditions and precarious housing.



The Cité Lumière slum in Grand Baie
© IOM, July 2010, Francois Gemenne

The government is currently in the process of implementing a resettlement scheme for these families. The National Empowerment Foundation (NEF) is building houses in Sottise, a few kilometres away, where the families would be resettled. Construction work is already well under way.

Families claim that they have not been consulted about this resettlement, and they complain that the scheme is being imposed upon them. The price they would need to pay to occupy and ultimately own their new house seems unaffordable to them, as the instalments for repayment rise sharply after the first few instalments. At present, families are unwilling to move to Sottise and would rather endure the constant flooding of their slum. Below is a copy of the standard contract offered by the NEF to the families living in Cité Lumière; though the monthly instalment is only 800 rupees in the first year, this amount increases to 3,000 rupees starting in 2021, for the next 13 years. Families argue that the increase is too sharp and amounts to a price that is too expensive; many are unwilling to move because they claim they cannot afford the repayments.

FRATERNITE DE GRAND BAY (N.G.O.)
Regd. No. 5327
Tel. No. 945 3088
Tere suggestion de La NEF

Année	Mensuel	Annuel
2010	800	9600
2011	1000	12000
2012	1200	14400
2013	1400	16800
2014	1600	19200
2015	1800	21600
2016	2000	24000
2017	2200	26400
2018	2400	28800
2019	2600	31200
2020	2800	33600
2021	3000	36000
TOTAL		379,600
2022 à 2034	3000 x13x12	468,000

Paiement total pendant 25 ans (2010 à 2034) :-
Somme Totale :- 8279,600+
8668,000.
8743,600.
Chairman

Copy of the contract offered by NEF to families living in Cité Lumière for the resettlement scheme.

2.5.2. Mare Chicose

The Mare Chicose landfill site was inaugurated in the late 1990s, next to the small rural village of Mare Chicose. Immediately after the opening of the site, nearby residents started to experience major inconveniences such as odours and a proliferation of flees, as well as fever, skin infections and other health problems.

Following numerous complaints, the government made the decision to resettle the whole village in the town of Rose-Belle. Villagers will be provided with land and a significant amount of money to build a new house. The amount of money will match the value of their previous house, which will be reclaimed by the government. The villagers have been consulted regarding the choice of Rose-Belle as their resettlement location.

It appears that villagers welcome the decision of the government to relocate them, as well as the way the whole process has been handled, even though they regret that it took so long for a decision to be made. The villagers seem satisfied with the choice of Rose-Belle and find the compensation they will receive adequate. Some of them had considered moving before, but had delayed their decision as soon as they heard of a possible resettlement scheme years ago.

Overall, the resettlement process of Mare Chicose appears as a model to follow: all key principles recommended by the World Bank and the International Finance Corporation (IFC) have been respected, such as prior consultation with the residents and the provision of adequate compensation, and the residents seem perfectly satisfied with the scheme and are looking forward to being resettled (IFC, 2002).



The Mare Chicose landfill site

© IOM, July 2010, Francois Gemenne

2.5.3. Agalega islands

For material reasons, it was not possible to conduct a field study in Agalega. Indeed, there was no regular boat service between Mauritius and Agalega, and planes were either too expensive or reserved for medical emergencies. The following section is thus based on testimonies of previous residents, as well as on telephone interviews with current residents.

The archipelago of Agalega appears as the part of the Republic of Mauritius that is the most vulnerable to the impacts of climate change. The archipelago is comprised of two islands, where three villages are located. It is home to about 350 inhabitants. The main economic activity is the production of coconut oil. What makes the islands particularly vulnerable to climate change is their small size (24 km² in total) and, most of all, their very low elevation, due to the fact that they are coral atolls.

A major exodus happened following cyclone André in 1983. The cyclone flooded the South Island completely, causing one casualty. Massive migration towards Mauritius ensued, with 75 per cent of the inhabitants leaving the archipelago, and people have been afraid of cyclones since then.

Another major turning point was the 2004 tsunami. Though Agalega was relatively spared by the waves, people now live in fear of another tsunami. Since the 2004 tsunami, residents have observed major changes in the sea: waves have become much higher, and the sea much rougher. As a result, coastal erosion has become an important issue, affecting coconut trees.

Residents feel increasingly concerned by sea-level rise.⁹ They get much of their information about climate change through satellite television and compare their situation with the people of Bangladesh, since the broadcast of a documentary on sea-level rise in Bangladesh on the French television channel M6.

At the moment, people are not really considering the option to move to Mauritius, but it is likely that they would should the government offer the possibility of leaving. This is especially true for the youth. For now however, there does not seem to be an alternative to staying. People travel regularly to Mauritius though (once a year or once every two years), either to visit family members, shop, or show the island to their children.

2.5.4. Plaine Corail, Rodrigues

Plaine Corail is the site of sand mining, an economic activity¹⁰ that provides jobs to about 50 miners. The activity induces major environmental damage, however, as it accelerates coastal erosion, in particular on the islets of Ile aux Crabes and Ile aux Cocos. Sand miners extract about 180 tons of sand a day, and are very aware that their activity is doomed to be phased out in the near future, because of the extensive damage it causes to the lagoon.

Miners have noticed that the sea has been much rougher since the tsunami of 2004. The sea can now be rough up to two weeks per month, and tides have changed.

⁹ Based on a phone conversation with Agalegans on July 2010.

¹⁰ Sand mining has been banned in Mauritius since 2001, with former sand miners getting financial compensation.



Sand mining in Plaine Corail

© IOM, July 2010, Francois Gemenne

Miners describe their economic situation as difficult, because of both the recurrent bad weather and the cost of fuel for their boats. They earn little and they also have no means to save part of their earnings. They feel that they are given less consideration than fishers, and complain that they do not receive any help from the government, even for some basic items like life-saving jackets.

They all know that they will soon need to look for a new livelihood, as sand mining is soon to be forbidden. If they could choose a new livelihood, they think they would prefer a livelihood inland, less exposed to environmental changes. There are no other possible livelihoods for the moment, except for the saline production that should open soon.

Migration does not seem to be an option either, primarily because of family and housing reasons. They state that they would rather avoid migration, but would consider it as an operation of last resort. They would only go to Mauritius when it is no longer possible to find a new job in Rodrigues, as they think that people are less happy and poorer in Mauritius.

3. Interim conclusion: a mix of migration drivers

- Despite its relatively high elevation, Mauritius is greatly vulnerable to the impacts of climate change. The whole coastal zone is particularly at risk, because of a combination of environmental disruptions (sea-level rise, cyclones, coastal erosion, tsunamis). Key economic activities could be affected, and economic operators have only timidly started to adapt.
- Environmental changes already cause economic hardships and psychological suffering. Too many environmental issues are not addressed and need to be mitigated. If they cannot be mitigated, alternative livelihood options or resettlement options need to be provided to affected populations, over time and gradually. This justifies the focus of this report on the provision of alternative sustainable livelihoods for affected communities.
- Many of those affected by environmental changes do not have the resources or land that would allow them to relocate their activity.

- Not all vulnerable populations enjoy the same level of attention and assistance from the government. Some of those amongst the most vulnerable feel neglected and abandoned to their fate.
- Environmental changes are neither expected to massively drive people out of the country nor to create cohorts of internally displaced people. They could, however, result in significant internal migration/relocation linked to the impacts of environmental changes on some economic sectors. Internal migration is thus likely to increase as a result of these changes. Inter-island migration, in particular, is likely to increase considerably, especially from Rodrigues and Agalega to Mauritius. Cities in Mauritius will need to adapt to these demographic changes and provide new resources (housing, jobs, etc.).
- Very little information, however, is available on inter-island migration. Though there are more Rodriguans living on Mauritius Island than in Rodrigues, very little is known about their socio-economic profile.
- Though environmental factors could play a major role on migration behaviours, these factors will be mediated by their impacts on economic activities. It is therefore important to acknowledge the environmental dimension of internal migration associated with the search for new livelihoods.
- Overall, and despite information campaigns, people remain little informed about the likely impacts of climate change and the time frame of these changes. Climate change appears rather as a theoretical concept than as an actual experience. More research should be undertaken about the local impacts of climate change, and this information should be made widely available to the population.
- Mauritius is not really used to environmental risks other than cyclones. More preparation is needed, as well as appropriate information for the population, about a wider variety of environmental risks.
- Economic activities in the country could undergo major changes and reshuffling due to environmental changes. This is primarily because key economic sectors are linked to environmental conditions. This could result in major changes to the population distribution across the country, as the distribution of the population has always followed economic developments.
- In some places, populations will need to be moved out for their own safety. Resettlement processes have already started in some areas. Populations will need to be systematically consulted.
- Current resettlement schemes are disparate and do not apply the same standards. They would need to be harmonized.
- Support policies will be needed for those whose activities are phased out because of measures related to environmental protection.
- The 2004 tsunami was a turning point in the perception of environmental risks in the country. Since then, many coastal residents have been living in fear of another tsunami.
- Many islanders adopt a resigned or frightened attitude with regard to environmental changes. These attitudes should be transformed into more proactive attitudes, as they could greatly hinder adaptation strategies. A significant number of people live in permanent fear of brutal environmental disruption. This fact needs to be acknowledged and addressed.

4. Interim policy recommendations

Environmental monitoring and information

Overall, despite the dynamism of the Mauritius Meteorological Services, information on the impacts of climate change remains partial and poorly scaled to the context of Mauritius. The population is confused about the impacts of climate change and therefore needs to be better informed. Climate data and projections need to be more robust, and better environmental information could be provided to the populations. This could be done through the following:

- Revisit the cyclone warning system. If the intensity of tropical cyclones continues to rise in the near future, the time frame to warn the population will become inadequate.
- Better monitor sea-level rise. However, it should be noted that the setting up of a warning system for storm surges and other extreme events is being considered under the *Adaptation Fund Board project entitled Adapting Coastal Zone Management to Address the Impacts of Climate Change* for submission before the Adaptation Fund Board.

- Improve climate impacts information. In particular, make flood maps public. Overall, information regarding extreme events could be improved, both in terms of monitoring and population warning.
- Study the impacts of climate change on different key economic sectors.
- Improve meteorological services in Rodrigues. Possibly, a meteorological forecasting station could be set up on the island.
- These last three items are currently being considered under the AAP at the level of the Ministry of Environment and Sustainable Development.
- Organization of some training sessions with regard to tsunami evacuation. Though the population is relatively well-informed about cyclone evacuation, tsunamis have some specific characteristics that need be addressed in training sessions. Best practices should be replicated, using a template that could first be developed in Rivière des Galets.
- Setting up of a welfare fund and board supporting vulnerable groups affected by gradual and sudden environmental changes, as determined by a set of criteria.
- Addressing and recognizing the mental health impacts of environmental change and/or degradation. High levels of fear have been observed in Rivière des Galets, in particular.
- Establishing adequate empowerment programmes, especially for women, in light of the fact that the gender dimension of vulnerability is insufficiently taken into account. Such programmes could greatly reduce the vulnerability of affected communities.

Documenting migration

Very few quantitative data exist on intranational migration flows in the Republic of Mauritius. There is a real need to improve statistical information on migration, as it would greatly facilitate the design of social policies aimed at migrant communities. Some suggestions for improvement include:

- Systematic data collection of intranational migration patterns through the census. This information could be supported by maps produced by the Mauritius Statistical Office. A specific focus should be put on Rodriguans living in Mauritius.
- Data collection should also aim to capture information on the inter-island migration processes.

Addressing the concerns of the affected populations

Many of the most vulnerable populations feel that they do not receive enough attention from the government. This situation could be improved through:

- Early consultations and organization of public meetings of information about relocation options or professional re-conversions. Many communities feel poorly informed about their possibilities of relocation. It would also be useful to designate a community focal point for each of the affected communities. Overall, focus should be put on the empowerment of local communities, aiming at developing pragmatic and realistic approaches that address environmental changes.

Better migration policies

Inter-island migration flows could be better managed. At the moment, these migration flows have not yet unleashed their full potential. The following could be undertaken in order to improve migration policies:

- Develop a comprehensive adaptation strategy that enables people to remain where they currently live and work.
- Migration flows between the islands of Rodrigues and Mauritius should be better planned and managed. There are more people from Rodrigues living in Mauritius (about 70,000) than in Rodrigues (about 30,000). Very little is known about Rodriguans living on Mauritius Island; hence, there is an urgent need to conduct a socio-economic mapping of this population in order to improve social policies.
- Harmonize resettlement/relocation schemes, using the Mare Chicose example as standard practice, so as to prevent social inequalities. A set of guidelines should be set forward, such as the importance of the proximity of resettlement sites.
- Existing and future migration policies should be better integrated. For instance, people whose livelihoods are affected by environmental changes ought to take more

take advantage of existing labour migration schemes. International labour migration schemes could be further developed, modelled after the agreement that exists between Columbia and Spain. Members of the Mauritian diaspora could also be mobilized to send, for example, remittances aimed at providing alternative livelihoods to those who are most at risk of environmental disruptions.

- Finally, further cooperation should be engaged on a regional scale with neighbouring countries, in order to allow for better management and apprehension of the environment-migration nexus in the region, as well as the mutual sharing of practical experiences.

Implementing adaptation strategies

- As intranational migration related to environmental changes will most likely be forced migration movements, adaptation in situ should be prioritized. Adaptation needs to be mainstreamed into different areas of public policy, most importantly in land-use planning. Land-use planning policies should also take into account the dynamics of internal migration processes.
- Include populations affected by environmental changes in the agenda of the NEF and the portfolio of the Ministry of Social Integration as vulnerable groups, so that they

can benefit from incentives (professional training, reintegration, integrated villages, etc.)

- Focus on the importance of food security and autonomy for vulnerable communities in the context of finding alternative sustainable livelihoods. Communities need to be given the skills to cater for their basic food from multiple sources, with the objective of making them less vulnerable to climate change, and the associated means of livelihood. Kitchen gardening and backyard poultry pens are some of the ways to strengthen communities.
- Enhance communities' capacity to manage the impacts of environmental changes through education, awareness and networking.
- The tourism strategy could also be revisited, so that it does not focus solely on beach tourism and touristic activities are diversified. Ecotourism, for example, should be further developed – this point is addressed in part IV.
- Vulnerable populations should be thoroughly analysed and mapped as per the defining criteria of vulnerability, in order to include even the less visible vulnerable communities. In this regard, it should be stressed that the communities studied in this report are examples of different vulnerability settings, but they do not offer a comprehensive overview of vulnerability in Mauritius.

PART IV



A FRAMEWORK FOR PILOT PROJECTS FOSTERING ADAPTATION TO CURRENT AND FUTURE ENVIRONMENTAL CHANGES

With a special focus on environmentally based businesses



Introduction

As discussed in the previous section, environmental changes are not expected to massively drive people out of the country nor create cohorts of internal migrants. They could, however, result in significant internal migration or relocation linked to the impacts of environmental changes on some economic sectors. Consequently, the pressure on internal lands is likely to increase and local communities will need to adapt and find new resources and livelihoods. Nevertheless, as most of the climate impacts have not yet occurred and current types of environmental degradation are known, adaptation policies should aim at avoiding forced migration.

We decided to focus our efforts on vulnerable communities on a local scale. These communities will experience higher migratory pressure, and need to be made a priority in terms of support in order to avoid potential displacement. Consequently, pilot projects should:

- seek to prevent forced migration;
- focus on adaptation to climate change;¹¹
- be innovative and relevant to local communities, in order to enable them to adapt to environmental degradation and climate change;
- be consistent with the MID new vision and the on-going Programme on Sustainable and Consumption Production for Mauritius.

There are two ways to fight climate change: mitigation, which is about reducing greenhouse gases emissions, and adaptation, which aims at preparing societies to deal with future environmental changes. A key goal of this project is to prevent forced migration and promote sustainable livelihoods; the report has thus focused on adaptation actions that can already be implemented on a local scale. These options do not include actions that focus solely on mitigation challenges, however important these challenges may be.

This section presents an innovative framework for the development of such pilot projects. The framework seeks to ensure that the pilot projects are consistent with adaptation to both current

environmental degradation and future climate impacts. It provides a first list of potentially relevant pilot projects, and discusses the conditions of transferability of these experiences in other areas and sectors.

I. Methodological aspects

A key challenge of adaptation is its actual translation into concrete projects – for now, only a few examples of adaptation exist on a local scale. A key challenge of this study was therefore to move forward and fill in this gap through the identification of some pilot projects that could be implemented in the local context. This is the reason why it is important to first build a general framework for pilot projects and make sure they are consistent with adaptation challenges. This framework is a key innovation of the study.

A first draft of this framework had been initially developed before conducting the field missions in October 2010. This first draft was based on the team's experience with regard to both the implementation of adaptation strategies¹² and the geographical context of the Indian Ocean.¹³ This initial phase of the work also benefited from a very wide literature review. The draft was consolidated during the field mission in Mauritius and Rodrigues, through interviews and meetings. These interviews and meetings provided a great opportunity to discuss with local institutions and stakeholders and receive their feedback about:

- their definition(s) of an “adaptation to climate change strategy”, or at least what they consider an “environmentally friendly action”;
- the challenges and the barriers to adaptation to current and future environmental changes (in general and in the context of Mauritius);
- the communities they identify as being the most vulnerable.

¹² In particular, Dr. A. Magnan has conducted work on resilience and anticipation mechanisms, as well as on the “maladaptation” issue. According to Barnett and O'Neill (2010), “maladaptations” are actions taken ostensibly to avoid or reduce vulnerability to climate change that impacts adversely on, or increases the vulnerability of other systems, sectors or social groups.

¹³ Dr. A. Magnan's PhD (2002–2005) dealt with the links between coastal tourism and development in Mauritius and the Maldives, two hotspots of island tourism in the western part of the Indian Ocean. Furthermore, Dr Magnan has conducted work in the Seychelles (2003–2006) and he has been living for a long time in La Réunion.

¹¹ Though mitigation can also be part of the pilot projects, it should not be their prime focus.

Discussions with institutions and international cooperation agencies also emphasized the relevance of such a conceptual approach before starting the implementation of concrete actions. Building on this framework, the project identified some pilot projects, including their feasibility and potential outputs. Initially, the project was focused on actions that had an economic component, either to consolidate the existing activities of poor and vulnerable local communities or to favour the emergence of new activities. Some projects, however, could help a community adapt to current and future environmental changes without immediately generating economic revenues. One example could be the creation of a local association dedicated to environmental awareness. We argue that such actions, though they do not create immediate economic benefits, participate in a larger community's project of economic development. According to this conception, non-economic options have also been considered, and instead of talking about "green jobs", it was decided to talk about "green or environmentally based businesses".

A definition of what should be a relevant action from an adaptation perspective is provided in section 3.1, as it is a basis for the framework that is developed in section 3.2. The list of pilot projects is provided in section 3.3. A key goal of this list is to demonstrate the diversity of options that are available in the Republic of Mauritius. It also emphasizes the fact that some of these actions could be implemented both in Mauritius and Rodrigues, and subsequently create necessary synergies. Actions have also been identified for Agalega, but since the experts could not visit the islands, the relevance of these actions relies on their experience of atoll contexts.¹⁴

All the actions listed in section 3.2 should be seen as trigger experiences in order to foster pragmatic strategies for adaptation in the country.

2. Short overview of the Mauritius context

This section attempts to provide a short overview of the opportunities for adaptation

projects in the Mauritius context. Government and international organizations have indeed put in place and supported national strategies and policies that aim to facilitate the shift towards a low-carbon growth model. They have also started addressing the conditions for enhancing adaptation to climate change strategies and options. Some major initiatives are presented here.

Maurice Île Durable

Launched in 2008 and supported by the Agence Française de Développement (AFD), the *Maurice Île Durable* (MID) project consists of a number of policies and initiatives that promote sustainable development. The long-term vision is to make Mauritius a model of sustainability – one key goal is to render Mauritius less dependent on fossil fuels – by enhancing energy efficiency and increasing the use of renewable energy sources. The MID Fund (1.3 billion Mauritian rupees) was specifically created in June 2008 in order to fund a number of schemes, studies, projects (notably solar water heaters and compact fluorescent lamps) and awareness campaigns.

In December 2009, a process was initiated to develop a National Policy for Maurice Île Durable that aims to provide clear guiding principles and mechanisms for a sustainable economic and social development model. The process started with national consultations in February 2010.

The Ministry of Environment and Sustainable Development is the principal leader of the implementation of the MID programme. In addition, a National Programme on Sustainable Consumption and Production (SCP) was launched for the period 2008–2013. The key goal of this programme is to facilitate the transition of the Mauritian economy towards a more sustainable model of consumption and production.

The Africa Adaptation Programme (AAP)

The AAP is funded by the Government of Japan¹⁵ (USD 92 million) and administered by UNDP. Its goal is to enhance the adaptive capacity of 21 countries across Africa, to promote early adaptation action and to guarantee long-

¹⁴ In the Maldives (Indian Ocean) and Kiribati (Central Pacific) coral archipelagos, as well as in Tuvalu (Central Pacific).

¹⁵ Japan International Cooperation Agency.

term investments to increase resilience to climate change across the African continent. It will notably: (i) enhance dynamic long-term planning mechanisms to manage climate change uncertainties; (ii) build leadership and develop institutional frameworks to manage climate change risks and opportunities; (iii) implement climate-resilient policies and measures in priority sectors; (iv) finance options to meet national adaptation costs; and (v) mainstream climate change risks and opportunities into national development processes.

Complementing the AAP, *The Other Migrants* project aims to go one step further by designing and implementing pilot projects that would enable vulnerable communities to deal with climate change. It is thus in line with the key AAP objectives of identifying best practices and experiences for the implementation of climate-resilient policies in key sectors.

CSR (Corporate social responsibility)

Corporate social responsibility (CSR) is a concept developed by the Government of Mauritius in order to favour the connections between economic development and environmental preservation. Under the CSR framework, companies have “to pay 2 per cent of their book profit towards programmes that contribute to the social and environmental development of the country.” CSR encourages economic sectors and activities to be aware of their impacts on social aspects and the environment. The collected funds are used to support national programmes, agencies and non-governmental organizations (NGOs) dedicated to social and environmental issues. Finally, “a company performing highly in CSR is one that goes beyond compliance with the legal framework to actively pursue positive impacts on local communities and its environmental footprint.” The NEF has established CSR guidelines¹⁶ that help people to better fit in with the official expected business standards.

By gathering economic and environmental issues and trying to make them compatible, CSR represents an operational context for the

development of pilot projects that reduce communities’ vulnerability and improve their economic situation or develop alternative livelihoods. Thus, synergies between the pilot project framework and the CSR guidelines should be fostered – for example, CSR guidelines could be incorporated into pilot projects.

3. Conditions for the implementation of pilot projects

3.1 Definition of a pilot project in the context of this study

The main objectives of the pilot projects are as follows:

- To support vulnerable local communities to cope with current and future environmental degradation.
- To limit potential forced migration movements that could be induced by these changes.

Beyond this, it is important to have a clear definition of what we call a “local-scale environmentally based pilot project for adaptation to climate change”. Such a project should therefore incorporate three key-elements:

- The local-scale dimension: In the IOM study, pilot projects should primarily be designed for vulnerable local communities in Mauritius, Rodrigues and Agalega.
- The adaptation perspective: In order to prevent forced migration movements and better prepare for voluntary migration, pilot projects should reduce the vulnerability of local communities to current and future environmental perturbations. Schematically, addressing current threats refers to the ability of communities to be resilient¹⁷ when a disruption occurs or when progressive environmental degradation starts causing tangible problems. On the other hand, addressing future threats refers more to the anticipation of events that have not yet occurred. This means that a pilot project should fit into the current environmental

¹⁶ Available at : <http://www.nef.mu/csr/guidelines.php>

¹⁷ Resilience is usually defined as the ability of a system to absorb external stresses and disturbances as a result of social, political and environmental change (Adger, 2000).

context, taking into account cyclone and landslide risks but also considering the potential evolution of current conditions, keeping some options for adjustment open. Solutions that solely consider the short-term dimension (here the resilience goal) could lead to maladaptations that will not solve the problem on a longer time frame, and could even worsen it. Adapting to climate change means finding a compromise between current challenges and future ones (even if they are uncertain). Adaptation thus requires both resilience and long-term anticipation.

- An environmentally based philosophy: Here, the hypothesis is that the closer a community is to its neighbouring environment, the better it will be able to deal with environmental changes. This hypothesis fits within a general current of thought in the international arena that deals with “ecosystem-based adaptation” and relies on the idea that healthy ecosystems favour healthy communities. According to this, communities that care about their environment both preserve their subsistence and economic means and prevent disruptions. Strong linkages with the environment also allow communities to find the most sustainable solutions, because environmental features are then considered as important and as valuable as economic ones.

The combination of these three key features suggests that a pilot project would be considered as relevant for a local community if and only if it addresses at least the majority of the community’s key components of vulnerability (see part II, section 3.1). This implies that the relevance of a pilot project can only be assessed in a local context.

A relevant pilot project should reduce current vulnerability without having collateral effects, that is, without moving vulnerability to another location and/or to another community, or shifting it to longer term. This means that a pilot project should favour:

- the consolidation of environmental features (both in terms of spatial configuration and ecosystems sensitivity);
- the consolidation or rebuilding of social cohesion (solidarity between individuals);
- the diversification of livelihoods and/or economic model (by changing current practices and/or introducing new ones);

- the integration of the community into regional and national dynamics of adaptation to climate change (AAP, MID, etc.);
- the progressive improvement of living conditions.

3.2 A framework for pilot projects

3.2.1 Why is a framework needed?

There is currently a lack of adaptation projects implemented on a local scale. Thus the possibility for this project to replicate other initiatives is limited. This is the reason why it was deemed important to develop a general framework prior to the identification of pilot projects. The framework makes sure that a project is relevant for adaptation and avoids maladaptation. Furthermore, though it is not its primary purpose in the context of this study, the framework could also be used by donor agencies in order to identify the projects that are most relevant for adaptation.

Such a framework therefore appears to be of major importance in building adaptive and resilient communities by providing guidelines both (i) for communities and local NGOs to design actions, and (ii) for authorities and international cooperation agencies to identify which projects to support and fund.

3.2.2. The general background of the framework

As a major prerequisite, a pilot project necessarily needs to be realistic and feasible. “Feasibility” means that the project should imperatively be in line with the community’s key components of vulnerability.

Adopting a comprehensive approach and affirming that consolidating the links between local communities and their direct environment is a crucial goal for enhancing adaptation to climate change. The framework relies on the following elements:

In terms of its general objectives (supporting actions that are feasible in terms of their implementation), the framework should prioritize actions that are:

- Appropriate: The action (i) should be in line with the social and cultural values of vulnerable local communities and (ii) should be based on individual and collective current knowledge and skills. The aim is for vulnerable local communities to develop and manage the pilot project according to their needs so as to gain ownership of it;
- Appropriate: The action should not move or reinforce existing vulnerabilities, neither in space (from one community to another and/or from one ecosystem to another) nor sector (from one economic sector to another) nor time (from present to near or far future). Pilot projects should not result in maladaptations (which are short-term instead of long-term adaptation solutions).
- Adjustable: Ideally, the experimentation of one specific project should encourage vulnerable local communities (i) to reproduce it elsewhere and/or (ii) to develop new projects based on previous experiences.

3.2.3. Detailed features of the framework: Which guidelines?

The aim of the following section is to provide an overview of the main guidelines that constitute the framework (see Table 4 for a synthetic overview). These guidelines should be seen as formal elements in order to help identify what is a relevant “local-scale environmentally based pilot project for adaptation to climate change” (though this makes for a long expression, all the words are important in order to define the relevance of the action). According to this framework, a pilot project could be judged as relevant in terms of adaptation if and only if it addresses at least a majority of the following guidelines.

Guideline description

These guidelines can be divided into four main categories dealing with sociocultural, environmental, economic and institutional/administrative aspects.

(1) The sociocultural dimension

Pilot projects should be in line with the social features and the cultural values of people from vulnerable local communities. An exogenous action that does not take into account the social

structure of the community, its living conditions and its cultural references, to cite a few, could indeed very likely overlook its initial goal.

- (1.1) On the one hand, the project should not be in contradiction with basic cultural features and should respect cultural traditions, for example, with regard to eating habits.
- (1.2) On the other hand, it should also not weaken the social structure of the community, for example, by forcing young workers to move very far and be separated from the village and their families.¹⁸

Pilot projects should also correspond to communities’ capabilities and should be based on existing knowledge and skills.

- (1.3) Existing skills are indeed consistent with the local context of a community and its history, environment and cultural values. They also reflect the current capabilities of people from this community and thus the kind of projects they are able to carry out.
- (1.4) This does not mean that new skills could not be developed within the project, but rather that the action should appear feasible to the community. Yet, in most situations, this feeling of feasibility always relies on acknowledged capabilities.

Here again, one major underlying condition for the success of a pilot project is its capacity for appropriation. Ideally, the community should take ownership of the project.

(2) The environmental dimension

- (2.1) Pilot projects should be consistent with the nature and the dynamics of local ecosystems. As we previously mentioned, ecosystems provide numerous kinds of services (supply of fresh water, productive soil conservation, resistance to invasive pests, plants pollination, fish resources reproduction, moderation of coastal erosion, micro-climate regulation). Preserving them constitutes a prerequisite for reducing current vulnerability, and this goal emphasizes the importance of preserving current environmental conditions.

¹⁸ This is, for example, the case in the tourism industry in the Maldives.

- (2.2) Pilot projects should also be consistent with the nature and the dynamics of neighbouring ecosystems. This means they should not transfer pressure on the ecosystems of neighbouring areas and communities.
- (2.3) Pilot projects should favour the protection function of the ecosystems regarding current natural hazards and, consequently, climate change threats. For example, the levelling of coastal dunes (e.g. for building hotels or houses, or for creating a new agricultural area) exacerbates the consequences of storm surges, as the sea can then submerge previously sheltered inland zones. In this case, actions that favour the replanting of dunes with original or at least adapted vegetation could greatly help reduce vulnerability both to current natural hazards (short-term) and to climate change impacts (long-term). Mangrove areas and coral reefs are also extraordinary buffer zones, and mangrove or coral replanting can be seen as adaptation actions.
- (2.4) Pilot projects should take into account climate change threats on environmental conditions. Even though there are many uncertainties regarding the future impacts of climate change on a local scale, the global nature of the risks is known (submersion of low-lying coastal areas, marine erosion, salinization of soils and groundwater, etc.). The relative gap in knowledge on the magnitude of these impacts should not be an excuse to do nothing and wait for more scientific studies. Some “no regret” options can already be taken, integrating the risk dimension. For example, building new houses or developing new agricultural activities on areas that are too close to the sea entails dangers that can be avoided by moving the houses or agricultural fields back from the shore. Another example concerns freshwater supply. A too-heavy dependence on groundwater can represent a source of vulnerability in case of salinization; one way to reduce this vulnerability consists of providing households with water tanks for the collection of rain water. This reduces the pressure on groundwater, as well as the potential consequences of salinization.
- (2.5) Finally, one more element should be emphasized: the adaptation goal should

take precedence over the mitigation goal (which is optional in this study’s context). The fight against climate change is often reduced to greenhouse gases emission reduction. This means that mitigation actions are often presented as “adaptation to climate change” options. However, adaptation represents another path: it is not dedicated to limiting greenhouse gases emissions, but rather to helping communities be resilient to the unavoidable effects of climate change (some of the impacts are indeed already unavoidable). This is why adaptation could be clearly linked to migration issues.

Adaptation should thus be the main goal of the pilot project. It does not exclude the possibility that the project also tries to reduce greenhouse gases emissions, but this mitigation aspect should not be a priority. For example, a project dealing with crop diversification could also include the development of renewable energies. Synergies between adaptation and mitigation should of course be emphasized, but the crop diversification goal should be put above the pollution reduction goal. It is really crucial that both national and international funders as well as local entrepreneurs are aware of the importance of funding/developing projects that are relevant to the foundations of the targeted framework.

(3) The economic dimension

Pilot projects should be economically viable. This means that they should take into account businesses opportunities according to market features, notably when one of the objectives of the project is to create jobs.

- (3.1) The project has targeted poor communities¹⁹ as relevant ones. According to this choice, one of the major initial goals of the study was to favour the emergence of “green jobs”, in order to maintain or increase communities’ wealth. This is why in this framework, the economic dimension plays an important role. Thus, in order to fit with the guidelines,

¹⁹ As previously said (see part I, section 3.1), the economic dimension is not the main determinant of vulnerability, but, obviously, paying particular attention to poor communities constitutes a no-regret strategy.

a pilot action should allow vulnerable local communities to improve or at least maintain their revenues.

- (3.2) Uncertainties about climate impacts on a local scale impose it upon communities to keep options for adjustment. In economic terms, as we saw previously (see part I, section 3.1), this means ensuring a certain level of diversification of activities and sources of revenues. Here, though we specifically refer to economic activities, we also need to be aware of the importance of subsistence activities. Maintaining and/or developing gardening on household properties could prove to be of major importance both in times of environmental crisis (as it allows for partial self-sufficiency) as well as for providing supplementary incomes.
- (3.3) Finally, relevant pilot projects should take into account future environmental change projections, particularly climate change. The objective here is to avoid the development of activities that require proportionally important investments but will prove obsolete with regard to future changes in environmental conditions. For example, crop production is very sensitive to salt (groundwater salinization and marine spindrifts). Proper attention should be given here to the possibility of maladaptation, as avoiding this problem is at least as important as developing environmentally friendly actions.

(4) The institutional, legal and administrative dimension

Pilot projects should be consistent with the national legal, administrative and institutional framework.

- (4.1) Pilot projects should fit into the national entrepreneurship framework, particularly into the Mauritius context of the CSR framework (see part IV, section 2)
- (4.2) Pilot projects should also fit into the national legal framework. Though this might seem obvious, it is important that pilot projects do not breach existing rules, in particular those with regard to land-use planning.
- (4.3) Vulnerable local communities are usually marginalized, from both an economic and geographic viewpoint. This also

induces a form of social marginalization that explains why such communities are often not comfortable with official and administrative procedures, rules and forms. Despite this situation, it is important that pilot projects respect administrative procedures. Doing so will also enable local communities to be eligible for diverse national and international funding schemes. However, depending on the community's context, the envisaged pilot action should ideally be relatively easy to formalize, or at least would benefit from administrative support. In Mauritius, some agencies already exist that help small entrepreneurs build their project (for instance, SMEDA²⁰).

A synthetic view of the framework

Table 4: Synthesis of the guidelines for the adaptation to climate change framework

(1) Sociocultural dimension
Pilot projects should be consistent with the social and cultural values of people and should correspond to the capabilities/competencies/knowledge of communities.
(1.1) Pilot projects are consistent with social features and cultural values (what people expect from the present and for the future).
(1.2) They are located near the family/community's living place, and do not induce displacements of the community (or a part of it) for long periods of time.
(1.3) They are based on existing knowledge and competencies (in order to avoid sociocultural maladaptation).
(1.4) They do not require too complicated new skills to be developed.

²⁰ Small and Medium Enterprises Development Authority.

(2) Environmental dimension

Pilot projects should be consistent with the nature and the dynamics of local ecosystems and should take into account potential climate change threats to environmental conditions.

- (2.1) Pilot projects do not degrade the direct environment (through overexploitation, degradation of resources, destruction of habitats, etc. - idea of avoiding environmental maladaptation).
- (2.2) They do not degrade the indirect environment either.
- (2.3) They favour the protection function of ecosystems with regard to current natural hazards and climate change threats (such as buffer zones on the coasts).
- (2.4) They take into account the range of uncertainties concerning the impacts of climate change on a local scale, thus preserving some possibilities for adjustment.
- (2.5) They are not focused on reducing greenhouse gases emissions, but rather on adapting to environmental changes.

(3) Economic dimension

Pilot projects should be economically viable.

- (3.1) Pilot projects allow vulnerable local communities to improve or at least maintain their revenues
- (3.2) They ensure a certain level of diversification of activities and sources of revenues
- (3.3) They are consistent with future environmental change projections (in order to avoid economic maladaptation).

(4) Institutional, legal and administrative dimension

Pilot projects should be consistent with the national legal, administrative and institutional framework.

- (4.1) Pilot projects should fit into the national entrepreneurship framework
- (4.2) They should fit into the national legal framework.
- (4.3.) Ideally, they should be relatively easy to formalize, or at least would benefit from administrative support.

3.3 Examples of potentially interesting pilot projects

This part is organized into two sections. First, a list of pilot projects that could fit into the framework for adaptation to current and future environmental changes is provided (descriptive table). Then a synthetic table provides an overview of the way these different examples could fit into the general framework.

3.3.1 A list of possible pilot projects

Table 5 provides an extended list of 13 pilot projects that could fit into the framework. In

order to be relevant for adaptation, a project needs to address the majority of the guidelines provided.

For each pilot project, the following information is provided:

- the context to which it corresponds (Mauritius and/or Rodrigues and/or Agalega);
- its income-generation potential;
- a brief description;
- insights about potential support;
- the main expected outputs.

Pilot projects 1 to 6 deal directly with the reduction of vulnerability to natural hazards and adaptation to climate change issues, whereas pilot projects 7 to 12 deal indirectly with them. These indirect contributors to adaptation to current and future environmental changes refer, for example, to the sectors of waste recycling (manufacturing), food self-production (roof gardening) and handicraft production. These sectors are primarily neither designed for preserving neighbouring ecosystems or increasing their resilience, nor for increasing local population awareness about natural hazards and climate change threats. They even participate towards achieving the adaptation goal in a way that favours the reinforcement or the emergence of a relationship between local communities and their environment, and, in some cases, between individuals within the community itself. Waste recycling indeed encourages people to be conscious about the environmental impact of their lifestyles. Developing roof gardening also encourages people to use organic products that have strong long-term effects on the environment (biodiversity and ecosystem services). Finally, developing a handicraft activity based on local products (such as pandanus leaves) also encourages people to maintain a link with the environment and be aware of their role in preserving it. Pilot projects 7 to 13 could also generate incomes in the short term, a key objective of the project.

Finally, note here that the following pilot projects do not represent a one-size-fits-all solution. They should be seen as simple examples of the types of projects that could both help vulnerable local communities develop environmentally based businesses and start adapting to climate change. Each project needs to be envisioned in a context-specific framework.

Table 5: A list of potential pilot projects

Pilot project		Short description
Direct linkages with climate threats		
1	MAURITIUS, RODRIGUES and AGALEGA Coral planting and restoration ^a	<p>Background: Developing easily appropriable techniques for replanting corals in order to rehabilitate degraded coral reef areas. The idea is to regenerate life back on reefs that have been severely affected by recent cyclones, exogenous species, coral bleaching, pollution from inland sediments, etc.</p> <p>Objectives: To restore a natural buffer zone and many vital resources. Attention should be paid to local coral species that are potentially resistant both to current and future climate stresses. Local people could be involved in making regular assessments of the health of coral reefs in order to monitor the global functioning of the whole coral area. People could then help scientists as “subcontractors”, both upstream and downstream from the laboratory phase.</p> <p>Time frame: Some actions have already^b been launched in Mauritius. This option requires several years (laboratory phase, replanting in natural environments, and waiting for coral growth).</p> <p>Outcomes:</p> <ul style="list-style-type: none"> - Preserving the environment (biodiversity and buffer zone) with the possible transplantation of corals onto the affected areas of the reef where live coral cover is at a minimum; - Awareness of local populations about the importance of maintaining the health of corals; - Ecotourism opportunities (job creation subsequently). <p>Support from:</p> <ul style="list-style-type: none"> - Coral ecosystems experts with experience in coral planting (such as ECOMAR, Marine Ecology Laboratory of the university of La Réunion) ; - Several experiences in different parts of the world; - Albion Fisheries Research Centre (AFRC), Ministry of Fisheries and Rodrigues - Ministry of Environment and Sustainable Development of Mauritius; - Local NGOs: Reef Conservation in Mauritius, Shoals in Rodrigues; - Mauritian Wildlife Foundation (MWF).
2	MAURITIUS, RODRIGUES and AGALEGA Marine park rangers ^c Income- generating	<p>Background: In collaboration with marine park authorities, local rangers could be responsible for the day-to-day management of the protected area and could be progressively being recognized as “local wardens”. This has already started in Rodrigues (four persons in the south-east protected area).</p> <p>Objectives:</p> <ul style="list-style-type: none"> - To carry out upstream assessments and monitoring (of species evolution, of people’s practices and frequenting of climate change impacts on biodiversity and landscapes). - To help enforce marine park regulations in their areas. <p>Time frame: Rangers will need a broad range of skills, some of which they already partly have (knowledge of the ecosystem’s functioning and of diverse species) and some they will have to acquire (assessment and monitoring methods, climate change impacts and signals). However, these skills could be rapidly acquired. Several months are necessary for rangers’ training, but they could be operational after one year.</p> <p>Outputs:</p> <ul style="list-style-type: none"> - Protecting and preserving ecosystems (vegetation and wildlife); - Maintaining a cultural link between communities and the coastal environment, and encouraging awareness of natural history; - Ensuring that the park remains a diverse, resilient and productive ecological system while allowing people (fishers, tourists) access to its resources; - Ecotourism perspectives. <p>Support from:</p> <ul style="list-style-type: none"> - Local specialists (scientists and others) on the ecosystem; local NGOs like Reef Conservation in Mauritius and Shoals in Rodrigues could be relevant; - Local specialists (scientists and others) on the traditional management of the resources; - AFRC, Ministry of Fisheries and Rodrigues; - UNDP office in Mauritius.

^a Meetings were organized with Reef Conservation, AFRC and Shoals Conservation and Mr Alexandre Magnan (October 2010).

^b The Ministry of Fisheries and Rodrigues (Fisheries Division) embarked on a pilot project on coral farming jointly with the Mauritius Oceanography Institute (MOI) in 2008, with the MOI experimenting with land-based farming in culture tanks and the Fisheries Division working on ocean-based farming. Coral farming involves the use of small coral fragments sampled from the wild. Following promising results, the Fisheries Division will soon embark on this project on a larger scale at different sites, with the possibility of involving fishermen communities in the future, for the rehabilitation of reefs.

^c Meetings were organized with SEMPA coordinators and Shoals Conservation and Mr Alexandre Magnan (October 2010).

3	<p>MAURITIUS, RODRIGUES and AGALEGA</p> <p>Climate change ambassadors or Creation of a climate change association (“People for the environment and the society”)</p> <p>(mitigation goals included)</p> <p>Income-generating</p>	<p>Background: Adaptation to climate change requires strong social and cultural links, in order to: (i) guarantee the identification of relevant and realistic adaptation options, and (ii) guarantee that the whole population is in accordance with the adaptation strategy (ready to make the effort needed for future well-being).</p> <p>Objectives: Three kinds of missions could be developed:</p> <ul style="list-style-type: none"> - Organizing school visits; - Promoting local community participation; - Informing Mauritian citizens about the threats and the opportunities presented by climate change (on livelihoods, on natural resources, on spatial planning); <p>These “climate change ambassadors” could be of major importance for several stakeholders: the government (in order to communicate with people about new policies), international environmental and humanitarian NGOs, local and international scientist conducting field work, etc.</p> <p>Time frame: In the beginning, we can expect the creation of one to three jobs per district. Only several months are needed to create the association and find first core funding.</p> <p>Support from:</p> <ul style="list-style-type: none"> - The Government of Mauritius; - Local and international NGOs such as the MWF; - International agencies (such as AFD, UNDP); - Adaptation funds. <p>Outputs:</p> <ul style="list-style-type: none"> - Developing awareness of climate change threats among populations; - Creating a major link in the chain of environmental and climate change challenge dissemination (adaptation and mitigation); - Reinforcing the links between local communities and their neighbouring environments (key for adapting to climate change); - Maintaining sociocultural cohesion among the population. This activity could lead, with the support of the government and NGOs, to the creation of an eco-museum dedicated to “the changing environment in Mauritius: people and the islands, people and climate change”. In this case, it could have income-generating benefits (such as ecotourism).
4	<p>RODRIGUES</p> <p>Natural sea salt production^d</p> <p>Income-generating</p>	<p>Background: This activity is already in the pipeline in Rodrigues, on the initiative of the sand miner community. Ancient salt ponds exist in Rodrigues. They could be repaired and put back to use for the manufacture of sea salt. Like Rodrigues’ honey, it could lead to an “authentic product” with real economic value, and then help the miners’ community (currently nearly 50 persons) to develop another activity. Such an activity has been carried out and has proved fruitful in Ré island,^e on the Atlantic coast of France. Sea salt is also produced in La Réunion^f (an eco-museum also). Rodrigues workers could benefit from the experiences of Ré island and La Réunion.</p> <p>The tourism industry (first in Mauritius, but maybe also elsewhere) could serve as the main market for Rodrigues natural salt. According to this perspective, there are several challenges that should be met:</p> <ul style="list-style-type: none"> - Ensuring that Rodrigues sea salt is in line with the quality and hygiene standards required by the tourism industry; - Adding a marketing component to the initial project of salt production. Sea salt production should find buyers in order to allow job creation. This implies developing marketing procedures. In this view, Rodrigues sea salt producers could benefit from the experience of Rodrigues honey producers, and maybe could become part of the marketing component of the honey activity; - Ensuring that sea salt production areas will not be severely threatened by sea-level rise. In this case, solutions could be thought of and implemented upstream before problems occur. <p>Time frame: Several years are needed to start producing salt and to structure the activity (in terms of marketing and economic efficiency).</p> <p>Outputs:</p> <ul style="list-style-type: none"> - Activity transformation (from sand mining to salt production) that could avoid loss of revenues due to the banning of the commercial use of sand; - Valorization of rare resources (Rodrigues sea salt as an “authentic product”) - Maintaining a strong link with the sea (also an opportunity for fishers); - Participation in the promotion of Rodrigues culture and savoir faire. <p>Support from:</p> <ul style="list-style-type: none"> - Local and national authorities (labour, trade, agriculture, tourism); - Experienced people in La Réunion and Ré island; - The Conservatoire du Littoral (a French agency that manages the Pointe au Sel in La Réunion)

^d Suggestion provided by resource persons at the Rodrigues Regional Assembly.

^e www.sel-de-re.tm.fr

^f www.selreunion.com

5	MAURITIUS Mangrove replanting and restoration ^g	<p>Background: Along the same lines as coral replanting, mangrove replanting should provide many benefits: the availability of a buffer zone against the waves, stabilization of the shores (sediment fixing), fish nursery, etc. Mangrove ecosystems are indeed an important asset for fisheries and the marine environment, and they are protected species under the Fisheries and Marine Resources Act 2007. Two species of mangrove, <i>Rhizophora mucronata</i> and <i>Bruguiera gymnorhiza</i>, grow around Mauritius. Over the years, the extent of mangrove cover around the island has decreased. This is because mangroves are cut for firewood, for construction purposes and for providing boat passage. In light of the constant pressure exerted on this ecosystem, a mangrove propagation programme was started in 1992 by the Fisheries Division; to date, a total of around 220,000 mangrove seedlings have been successfully planted on an area of more than 130,000 m² (13 hectares) of the coastal strip, with a survival rate exceeding 80 per cent. The total mangrove cover around the island has significantly increased and presently stands at some 145 hectares (ESA Classification Report, June 2009).^h</p> <p>Time frame: Techniques could be easily learned with the support of scientists (training during several months), but they solely constitute a preliminary phase in the whole programme, which requires investigations over several years. Such an experience had been developed, for example, in Kiribati (Central Pacific) and in many other places around the world. Here again, local people could be involved both upstream and downstream from the laboratory phase in making regular assessments for the monitoring of the global functioning of mangroves areas that this step requires. In Mauritius, technical advice on propagation is already given to NGOs, fishermen, local communities and the private sector.ⁱ</p> <p>Outputs:</p> <ul style="list-style-type: none"> - Preserving the environment (biodiversity and buffer zone); - Generating awareness among local populations about the importance of maintaining the health of mangroves; - Ecotourism opportunities. <p>Support from:</p> <ul style="list-style-type: none"> - Mangrove ecosystems experts; - Several experiences in different parts of the world; - AFRC, Ministry of Fisheries and Rodrigues; - Ministry of Environment and Sustainable Development of Mauritius; - MWF.
6	RODRIGUES, MAURITIUS and AGALEGA Eco-guides ^j Income-generating	<p>Background: Tourism is an important economic activity for Mauritius and Rodrigues. In addition, at the international level, the environmental sensitivity of tourists is growing, and tourists are paying more and more attention to the environmental dimension of their holidays. A market is thus emerging for ecotourism. However, specialized eco-guides in coastal fauna, flora, or even geomorphology are lacking in Mauritius. Interesting information about landscape origins and evolution, as well as coastal marine ecosystems and landscapes (seeing the shore from the sea), could be provided.</p> <p>Objectives:</p> <ul style="list-style-type: none"> - To develop tourists' awareness of coastal issues. - To promote local-based tourism (presenting the specificities of the islands). <p>Time frame: Only a few months are necessary for training. Afterwards, it depends on whether tourism operators would volunteer to include eco-visits into their panel of activities.</p> <p>Outputs:</p> <ul style="list-style-type: none"> - Creation of jobs (alternative to sea-related job loss); - Environmental awareness (among tourists, but also indirectly among the local community); - Diversification of Mauritian tourism activity. <p>Support from:</p> <ul style="list-style-type: none"> - Ministry of Tourism; - SMEDA; - Tourism operators associations; - UNDP, AFD.

^g Meetings were organized with Reef Conservation, AFRC and Shoals Conservation and Mr Alexandre Magnan (October 2010)

^h Elements provided by the AFRC, Ministry of Fisheries and Rodrigues.

ⁱ Information provided by the AFRC, Ministry of Fisheries and Rodrigues.

^j Meetings were held between IOM and local ecotourism companies such as Incentive Partners – Chazal Ecotourisme.

7	MAURITIUS and RODRIGUES Changes in crop production ^k Income-generating	<p>Background: Climate change will certainly have serious impacts on precipitation volumes and air temperatures and moisture. Changing conditions will also probably favour the expansion or emergence of insects that could devastate crops. According to these threats, some currently cultivated crops could prove maladapted to future conditions. On the other hand, some crops that are not cultivated today could prove very resistant and adaptable. Then the idea could be to initiate some changes in crop production.</p> <p>Many examples of crop changes are already implemented worldwide, for example, in Thailand, with rice species. Rice is probably not the most relevant crop to develop in Mauritius and Rodrigues, but these experiences could provide very useful information, notably concerning the time frames needed for change and the leverages (and barriers) for getting the support of populations. In Mauritius, an interesting experience is a crop diversification project undertaken in Petit Sable and supported by the NGO Mouvement pour l'Autosuffisance Alimentaire.</p> <p>In the specific case of Rodrigues, this option could also constitute an opportunity both to involve some youths who do not have jobs in an economic project and to fight the major problem of soil erosion (which threatens lagoon life) due to a massive decline in agricultural practices over past decades. This point concerns the whole island.</p> <p>Objectives: - To fight the future adverse effects of climate change on agriculture (returns and gross production). - To limit the economic effects of climate change (on revenues and on jobs).</p> <p>Time frame: Such an option requires time (not only for identifying new crops and cultural techniques, but also for the appropriation of new practices by local farmers). Expert advice and monitoring systems are also needed, and could be vital from a long-term perspective.</p> <p>Outputs: - Possibly creating new jobs, or at least avoiding long-term loss of revenues for existing farmers; - Maintaining the long-term competitiveness of the Mauritius crop industry; - In Rodrigues: fighting unemployment, soil erosion and marine ecosystems degradation.</p> <p>Support from: - AREU, Ministry of Agriculture; - MSIRI; - Experts from the scientific "community-based adaptation" community.</p>
Indirect links with climate change threats		
8	RODRIGUES and MAURITIUS Local house-building and upkeep ^l Income-generating	<p>Background: The creation of a Marine Protected Area in Rodrigues and Mauritius (SEMPA project, in cooperation with UNDP-Mauritius) led to the definition of restricted areas where fishing will be forbidden. If some of the Rodriguan fishers had been involved as "marine park rangers", most of them will lose an important source of subsistence and revenue. One crucial challenge thus consists of defining alternative livelihoods for fishers in SEMPA regions.</p> <p>One possibility could be to involve fishers in the building and upkeep of local houses, by using local materials in order to partly avoid cement and concrete imports (external dependency). Using wood could also help limit the pressure on sand resources, and indirectly contribute to the success of the shift from sand mining to salt production (see pilot project 4). Wood houses are the main type of housing in many islands worldwide, and wood could prove very resistant to cyclone winds and rains, for instance.</p> <p>Objectives: - To support a local-based architectural style. - To limit cement and concrete imports and enhance the sustainable use of local resources.</p> <p>Time frame: Fishers already have the main skills for such a business; what they need are some tools and transportation means (small trucks). Nevertheless, the sustainability of this activity relies in the rational use of existing wood, as well as support from the government to create new plots for wood production, as well as management plans for this resource. This option could take several years to be fully implemented.</p> <p>Outputs: - Creation of jobs (alternative to sea-related job loss); - Environmental protection (replanting plots will limit soils erosion and lagoon pollution); - Improvement of local housing (could concern the whole population).</p> <p>Support from: - AREU, Ministry of Agriculture; - Ministry of Housing and Lands of Mauritius; - UNDP.</p>

^k Meetings were organized with AREU, AFRC and Mr Alexandre Magnan (October 2010).

^l Meetings were organized with AREU, UNDP and Ministry of Housing and Lands and Mr Alexandre Magnan (October 2010).

9	<p>AGALEGA, MAURITIUS and RODRIGUES</p> <p>Sea cucumber farming^m</p> <p>Income-generating</p>	<p>Background:</p> <p>This activity is developed worldwide and provides numerous island communities with significant revenues (such as in Abemama, Kiribati). Sea cucumber live on coral reef areas and can be collected, cleaned, dried and sold to Asian markets (notably China), where they have a good reputation (they are said to favour longevity) and can command a high value.</p> <p>In Mauritius, sea cucumber fishing for export purposes started in 2006 and the total catch of sea cucumbers amounted to 493 tons live weight. A two-year moratorium has been imposed on fishing sea cucumbers from October 2009 in order to conserve the stock. In addition, under the Fisheries and Marine Resources (fishing of sea cucumbers) Regulation 2009, GN 110 of 2009, no person shall fish any sea cucumber from 1 October 2009 to 30 September 2011.</p> <p>The Mauritius Fisheries Division is also in the phase of implementing a project on the development/establishment of hatchery techniques for seed production and farming of sea cucumber for two species (<i>Holothuria scabra</i> and <i>Stichopus chloronotus</i>). Once the techniques are successfully acquired, sea ranching of baby sea cucumbers would be undertaken to help towards the sustainable exploitation of this resource.</p> <p>Sea cucumber exploitation presents an important potential for the redeployment of vulnerable local communities, as it does not require complex skills and expensive tools. This business can provide a certain number of jobs, but as is the case for sea salt production (pilot project 4), it needs to be included in a commercial project and it needs to fit with marketing processes and standards (quality of the product, hygiene, etc.). This activity's challenges are the same as those for sea salt production. In addition, several questions should be answered in a previous stage:</p> <ul style="list-style-type: none"> - Which are the speciesⁿ already developed in Agalega, Rodrigues and Mauritius lagoons? Are these species valuable in terms of consumption? Are their stocks sufficient to support a business? - Which new valuable species could be implanted without damaging the existing ecosystem? - Where are the most promising areas in the Republic of Mauritius? (maybe Agalega and probably Rodrigues, due to the extraordinary extension of its lagoon) - Are these species threatened by the expected elevation in sea temperatures, or are these species perfectly adaptable to these expected temperatures (then they could support a more sustainable production)? <p>Time frame:</p> <p>Training people and organizing the activity (infrastructure and market) requires time, maybe several months to years. However, as mentioned previously, Mauritius had already initiated some actions (with the support of the Fishing Division).</p> <p>Outputs:</p> <ul style="list-style-type: none"> - Creation of jobs; - Developing national exportation; - Forcing local communities to take care of the marine environment (because sea cucumbers are sensitive to pollution, for instance). <p>Support from:</p> <ul style="list-style-type: none"> - Experiences elsewhere in the world; - Local NGOs specialized in marine and coastal ecosystems.
10	<p>MAURITIUS</p> <p>Textile recycling^o</p> <p>(mitigation goals included)</p> <p>Income-generating</p>	<p>Background:</p> <p>Industries (notably in textiles) generate a massive amount of waste such as cuttings. Some of this raw material could be reused in patchwork. One very interesting activity has been in existence in Mauritius for several years. Women from the "Magic Fingers" (Rose Hill) association salvage pieces of fabric that are thrown out by textile factories, pick them over, and reuse them for making sheets, blankets, tablecloths, curtains, toys for kids, etc.</p> <p>This activity does not require expensive tools, and skills can be relatively purchased. Women very often already have some basic sewing skills, and unlike food production (such as sea salt and sea cucumbers), patchwork does not need to fit with international quality standards. Manufactured work could even reach a special value in the market, especially among international tourists who live in countries where very few things are hand-made.</p> <p>One market opportunity in Mauritius is the open day for local artisans that some hotels hold, allowing artisans to directly meet customers (without any intermediary) and sell their products.</p> <p>Finally, such activities seriously contribute to the emergence of both environmental consciousness and community consciousness. Here, the main benefit of an adaptation to climate change perspective is not direct, as patchwork does not reduce environmental vulnerability to natural hazards or reinforce resistance to environmental disruptions. However, patchwork favours the gathering of people from vulnerable and poor local communities and the progressive establishment of links between them. These community links are of extreme importance both in case of natural hazards (solidarity favours recovery) and when considering the necessity to develop an adaptation strategy (which requires efforts from the current generation for the benefit of the next generation).</p>

^m Activity suggested by the AFRC, Ministry of Fisheries and Rodrigues.

ⁿ Species of sea cucumber that currently exist in Mauritius are: *Actinopyga echinites*, *Actinopyga mauritiana*, *Actinopyga milaris*, *Bohadschia marmorata*, *Holothuria atra*, *H. leucospilota*, *H. pervicax*, *H. scabra*, *Stichopus chloronotus*, *S. variegates*, *Thelotrema ananas* and *H. nobilis*.

^o Meetings were organized, thanks to SMEDA with Magic Fingers and Mr Alexandre Magnan (October 2010).

		<p>Objectives:</p> <ul style="list-style-type: none"> - To support income-generation by households. - To support community links. - To participate in waste reduction (reuse). <p>Outputs:</p> <ul style="list-style-type: none"> - Revenue-generation; - Waste recycling (free access to raw material); - Favours the emergence of an environmental consciousness; - Favours social and cultural links in communities; these links help people avoid social isolation, which in turn contributes to solidarity in the community. <p>Support from:</p> <ul style="list-style-type: none"> - "Magic Fingers"; - SMEDA; - The tourism sector, particularly Association Hôtelières et Restaurateurs de l'Île Maurice (AHRIM).
11	<p>MAURITIUS and RODRIGUES</p> <p>Local handicraft</p> <p>Income-generating</p>	<p>Background:</p> <p><u>Example No. 1</u></p> <p>Like local food production (pilot project 4) and patchwork (pilot project 10), local handicraft could provide interesting revenues to local communities, or at least contribute to the diversification of the sources of revenues of households. The best situation occurs when the community that develops this activity has open access to raw materials. If this is not the case, the community can also cultivate the plants needed for handicraft-making. This has been the experience in Petit Sable over the past 15 years with the support of the local NGO Mouvement pour l'Autosuffisance Alimentaire and UNDP/GEF funds.</p> <p>Petit Sable was marginalized and very poor. Originally, the main economic activity was onion farming, with very specific Mauritian endemic species. Over time, living conditions tended to deteriorate, threatening the sustainability of onion production. In parallel, the slopes that dominate the thin coastal plain where the village and onion fields were located were progressively cleared, leading to environmental problems (erosion and landslides) and threatening onion production. After gaining the support of scientists, and in order to find a solution to this major problem, the community decided to replant the slopes with pandanus, allowing stabilization of the slopes and supplying the community with raw material for handicraft (leaves). As the local NGO involved in this project said, local people already had the skills for making handicraft; they simply lacked raw materials.</p> <p>Objectives:</p> <p>In the Petit Sable example, the project allowed the community to:</p> <ul style="list-style-type: none"> - start diversifying its activities and revenues; - find a sustainable manner to protect onion fields from inland natural hazards; - support local identity: onion is indeed an important component of the community's identity. <p>This example shows that protecting and developing economic means could fit into an environmental perspective, in what is maybe the key challenge in adaptation to current and future environmental changes. In this way, favouring handicraft could be labelled as an adaptation project.</p> <p>Concerning the Petit Sable project, one crucial point is now to get a more precise idea of the potential impacts of climate change both on onion fields (because of sea-level rise, storm surges and soil salinization) and on pandanus slopes (because of possible changes in the rainfall regime). However, as the community is already involved in an environmentally based economic model, it is in a good position to understand future environmental threats and define relevant solutions for countering future problems. A virtuous cycle has been engaged.</p> <p>Time frame:</p> <p>The Petit Sable example is a good one as it shows that the in-depth transformation of the functioning of the community and its relationships to the environment requires several years of effort, but the benefits are long term.</p> <p>Outputs:</p> <ul style="list-style-type: none"> - Revenue-generation and diversification of the economic scheme; - Environmental preservation (on the slopes, in the plain, in the sea); - Development of a strong link between the community and its neighbouring environment; - Strengthening of the resilience and adaptive capacity of the community. <p>Support from:</p> <ul style="list-style-type: none"> - Ministry of Agriculture, Ministry of Environment and Sustainable Development, Ministry of Tourism; - International organizations (UNDP, AFD); - Local NGOs like Mouvement pour l'Autosuffisance Alimentaire

		<p>Example No. 2 Making leaf plates from areca palm sheaths This is another example of income-generation and diversification through handicraft. Areca palm is a family of palms common around Mauritius and especially grown on plantations as royal palms or white plants. The sheaths used are those that are shed by mature trees. The sheaths are collected, washed, and moulded into plates by a simple manually operated machine, and are left to dry before marketing. The know-how comes from India, where the production originated. Leaf plates cost around 3 rupees each. Beneficiaries from Rivière des Galets will be provided with basic training by experts from India; this training does not require special aptitude or a high level of education. A feasibility study will be finalized but it seems that this project proposal will fit the needs of such a community, especially the spouses of fishermen.</p> <p>Objectives:</p> <ul style="list-style-type: none"> - To start diversifying activities and revenues in new innovative income-generating activities that do not require much investment. - To develop an activity in line with environmental concerns. - To strengthen the resilience and adaptive capacity of the community <p>This example shows how protecting and developing economic means could fit into an environmental perspective, in what is maybe the key challenge in adaptation to current and future environmental changes. In this way, favouring handicraft could be labelled as an adaptation project.</p> <p>Time frame: The activity can be operational within two months. However, in the context of this project, the objective is also to assist in creating operationally sustainable activities. Thus, several months will be required to stabilize the activity.</p> <p>Support from:</p> <ul style="list-style-type: none"> - Ministry of Environment and Sustainable Development; - CSR departments and foundations; - Local NGOs like Mouvement pour l'Autosuffisance Alimentaire, APEDED and Fondation Bel Ombre; - Savannah and Riche en Eau Sugar Estate (free supply of palm sheaths).
12	<p>MAURITIUS</p> <p>Rooftop gardening/ container gardening^p</p> <p>(mitigation goals included)</p> <p>Income-generating</p>	<p>Background: In Mauritius, a large majority of people live in individual houses with flat rooftops. This could constitute an opportunity for developing "rooftop gardening", allowing people to produce all or a part of the vegetables they eat. Rooftop gardening could contribute to household welfare by enabling a household to avoid some food expenditures. It could also contribute towards efforts to solve the food security issue, which is a crucial challenge for Mauritius. In terms of adaptation to current and future environmental changes, this option could partly contribute to offset decreases in industrial food production due to natural hazards occurring in Mauritius or in an exportation country. Furthermore, rooftop gardening could strongly encourage people to use organic fertilizers and thus contribute to the long-term reduction of the Mauritian society's environmental footprint. We saw previously that preserving biodiversity and ecosystem services is a key strategy both for limiting the impacts of climate change and for making room for future manoeuvring. Domestic containers can also be (re)used for rooftop gardening, contributing to the limitation of domestic waste.</p> <p>Time frame: Depending on people's level of involvement, only a few months would be necessary to launch this activity.</p> <p>Outputs: In terms of adaptation to current environmental changes:</p> <ul style="list-style-type: none"> - Indirect preservation of the environment (soil and coastal waters); - Avoiding household expenditures; - Participation in efforts to meet the national challenge of food security. <p>Support from:</p> <ul style="list-style-type: none"> - Ministry of Agriculture, Food Technology and Natural Resources; - International agencies focused on food security; - Local NGOs like Mouvement pour l'Autosuffisance Alimentaire.

^p This suggestion was provided by AREU (Mr Bisnauthsing), October 2010.

13	MAURITIUS, RODRIGUES and AGALEGA Composting ^q (mitigation goals included) Income- generating	<p>Background: Individual composting is feasible in Mauritius, since local researchers have developed a special machine for this purpose (University of Mauritius, School of Engineering^r). As elsewhere in the world, the great majority of domestic waste in Mauritius is organic and can thus be composted. This option, like the previous one, contributes to the greening of industrial and individual systems of food production. It also indirectly contributes to the reduction of pressures on the environment. Composting thus acts in favour of the natural resilience of the environment; this should be acknowledged as one of the major components of the adaptation to climate change toolkit.</p> <p>Objectives: - To produce environment-friendly fertilizers at the household level. - To avoid chemical inputs into the soil.</p> <p>Timeframe: A compost machine could be bought (an individual machine costs approximately 1,500 rupees) and small training is necessary. Making compost only takes a few weeks or months, so this option could be very rapidly implemented.</p> <p>Outputs: - Food industry production process; - Waste minimization.</p> <p>Supports from: - Ministries of Agro-Industry and Food Security and Ministry of Environment and Sustainable Development; - University of Mauritius, School of Engineering; - Local farmers.</p>
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^q Meetings were organized with Dr Mohee from the University of Mauritius, Dr Bhokoree from the University of Technology, Mauritius and the consultants, Dr Francois Gemenne and Mr Alexandre Magnan.

^r This suggestion was provided by Mrs Molee.

3.3.2. How pilot projects fit into the framework

Table 6 proposes a synthetic overview of the above-mentioned pilot projects, and assesses each of them in light of the adaptation framework. The objective is not to rank the pilot projects in order to emphasize which ones should be prioritized, but rather to show that various types of projects could fit into the adaptation to current and future environmental changes perspective.

Each pilot project is assessed against each of the guidelines presented in Table 4. Different colours correspond to different situations:

- When the pilot project fully fits with the guideline, the corresponding square is coloured in green.
- When it fits with the guideline under specific conditions only (how the project is designed, implemented and managed), the square is orange.
- When the pilot project is not related to the guideline, the square remains blank.
- Finally, when the pilot project is at odds with the guideline, the square is red.

It is possible to set up a points system, where green = 1; orange = 0.5; blank = 0; and red = -1. Each pilot project could then be allocated a score

that reflects the compatibility of the project with the adaptation goal of the community.

It is important to note here that this scoring exercise had solely been conducted with the aim of showing how pilot projects could fit into the framework, rather than to compare them with each other. Indeed, for many projects, the design, implementation and management will vary from one community to another, depending on each community's specificities. A serious scoring exercise could only be proposed on the basis of concrete examples and after a rigorous assessment process.

Table 6 shows that the majority of pilot projects fit well into the framework. Roof gardening (pilot project 11) and composting (pilot project 12) do not score very well, reflecting the fact that they are on the verge of the adaptation to environmental changes dimension. Some examples of pure mitigation projects are also provided in order to emphasize the difference between adaptation projects and mitigation projects.

Table 6: How well do the pilot projects fit with guidelines?

	1. Sociocultural dimension				2. Environmental dimension					3. Economic dimension			4. Institutional, legal and administrative dimension			Eligibility of the project *
	1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	4.1	4.2	4.3	The number indicates the total score allocated to the project in the first round of assessment **
Pilot projects listed in Table 5																
Pilot projects with direct links with climate change threats																
1. Coral planting and restoration																10.0
2. Marine park rangers																13.5
3. Climate change ambassadors/association																12.5
4. Natural sea salt production																12.0
5. Mangrove planting and restoration																10.0
6. Eco-guides																12.0
7. Changes in crop production																13.0
Pilot projects with indirect links with climate change threats																
8. Local house-building and upkeep																13.0
9. Seaweed farming (sea cucumber)																11.0
10. Patchwork																12.0
11. Local handicraft																11.0
12. Rooftop gardening																6.5
13. Composting																6.0
Some examples of climate change mitigation pilot projects (which do not fit into the adaptation framework)																
Solar water heater installation enterprise																3.5
Organic fertilizer production enterprise																3.5
Plastic recycling employers																4.0

Notes:

* Regarding adaptation to current and future environmental changes.

** These scores are just indicatives and can roughly change from one evaluator to another.

Legend:

The pilot project fits with the guidelines		Points equivalence
	Sure	1
	Potentially, depending on how it is designed, implemented and managed	0.5
	No specific relation between the pilot project and the guideline	0
	Counterproductive effect : the pilot project acts against the guideline	- 1

Reminder of the guidelines:

(1) Sociocultural dimension

- (1.1) Is consistent with social features and cultural values (what people expect from the present and for the future)
- (1.2) Is located near the family/ community's living place, so as not to induce displacement of the community (or a part of it) for long periods of time
- (1.3) Is based on existing knowledge and competences (in order to avoid sociocultural maladaptation)
- (1.4) Does not require too complicated new skills to be developed

(2) Environmental dimension

- (2.1) Does not degrade the direct environment (through overexploitation, degradation of resources, destruction of habitats, etc.)
- (2.2) Does not degrade the indirect environment
- (2.3) Favours the protection function of ecosystems regarding current natural hazards and, consequently, climate change threats (e.g. buffer zones on the coast)
- (2.4) Takes into account the range of uncertainties concerning the impacts of climate change on a local scale (i.e. preserves a certain "room of manoeuvre")
- (2.5) Is focused on adaptation rather than on mitigation

(3) Economic dimension

- (3.1) Allows vulnerable local communities to improve or at least maintain their revenues
- (3.2) Ensures a certain diversification of activities and sources of revenue

- (3.3) Is consistent with future environmental change projections (idea of avoiding economic maladaptation)

(4) Institutional, legal and administrative dimension

- (4.1) Fits into the national entrepreneurship framework
- (4.2) Fits into the national legal framework
- (4.3) Is ideally relatively easy to formalize, or at least would benefit from administrative support.

3.4. The way forward

3.4.1 Using "good practices": Some recommendations about replication

The interest in a pilot project that is appropriable, appropriate and adjustable consists in making it replicable to another community or to another sector within the same community. These three features should ensure the progressive building up of a community's experience in adaptation to current and future environmental changes. However, replication is a complex process. Local features indeed vary from one place to another, from one community to another, and from one sector to another. The experience of a pilot project that is designed for one particular context could not necessarily be replicated as is, that is, without modifications in order to better fit with the new context.

One recent paper from Billé (2010) offers a concise view of what is at stake in the replication hypothesis underlying the approach. Some of his conclusions that could benefit the project are reproduced in the text box.

Replicability: the myth of the “ripple effect”

Extract from:

Billé, R. (2010) Action without change? On the use and usefulness of pilot experiment in environmental management. S.A.P.I.E.N.S., 3 (1). Available from: <http://sapiens.revues.org/index979.html>

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The bibliography has been deleted here in order to ease reading of the text. For the original version, please refer to Billé (2010).

In his paper, Billé emphasizes four main explicative reasons for the difficulty of replicating pilot projects:

- Stimulation of collective action

The hope for a “proximity contamination of the change process”, which is the foundation of the concept of pilot experiments, relies on a heavy assumption in the field of collective action: that the combination of an objective benefit of a given change and of an external impulse brings a human group to move towards this change.

However, research in the general field of collective action, and in the environmental field in particular, does not support the hypothesis that “good practices” are bound to spread. The claim that the “objective” and collective interest of a group of humans, or even that of its individual members, to adopt a particular mode of environmental management is a sufficient condition for them to do so, ignores most theories on collective action. For instance, (...) “... even if all of the individuals in a large group are rational and self-interested, and would gain if, as a group, they acted to achieve their common interest or objective, they will still not voluntarily act to achieve that common or group interest,” except in specific conditions, such as with a small group of individuals, coercion or “some other special device”. This of course also ignores a large body of work on the phenomenon of the spread of changes and innovation mentioned above. Different coastal zone management projects which we studied, for example in Madagascar, demonstrate the heaviness of the “common interest” hypothesis of collective action, as a look at the management of fisheries worldwide also reveals. Ostrom gives a specific set of

conditions under which this type of collective action becomes possible. In another domain and at a different scale, the difficulty the international community experiences in organizing itself in order to reduce its greenhouse gas emissions despite the collective economic interest clearly demonstrated by the Stern report, speaks volumes.

- The Hawthorne effect

What is more, the simple presence of an observer, an advisor or a facilitator in a human group modifies its behaviour, through the presence of an external view. Not only does it modify it, but the direction of the modification of the group’s behaviour generally goes in the sense which the group perceives as being favoured by the external agent, regardless of whether his intervention is appropriate or not. This phenomenon, by which “people react positively to the fact that they are being taken care of in order to improve their situation, particularly when they are in a position of weakness” is called the “Hawthorne effect”, in reference to workshops of the Western Electric Company (Chicago, USA). During the 1920s and 1930s, a series of experiments on work productivity were performed under the supervision of Elton Mayo, professor at the Harvard Business School. Those experiments showed that the productivity of the workers increased as soon as they were aware of participating in a pilot experiment, regardless of whether their work conditions improved or deteriorated. The results of the experiments were therefore not due to experimental factors, but to the fact that workers were conscious of participating in an experiment. This is why (...) “so many initiatives of reorganization have brilliantly started only to quickly lose their initial momentum”. Although this effect was initially reported in an industrial context, it can be presumed to accurately describe the behaviour of a human group (village, fishers or farmers association, etc.) in which an external agent momentarily intervenes with the objective of inducing a change towards a more sustainable environmental management. Whatever the pertinence of the intervention of the external agent and regardless of the support it receives from the group, there is a high probability that the group will temporarily adopt “good practices”, at least in appearance, in order to please him. This can severely bias the conclusions drawn with respect to the pertinence of an

intervention or the reproducibility of a new mode of management.

- From exceptional conditions, exceptional results

The cases we have studied or in which we have participated clearly show that as “pilot” results are all the more easily obtained, the more exceptionally favourable conditions are chosen. Therefore the first step in setting up a pilot experiment is usually to identify a space (territory, community, sub-basin, administrative unit, etc.) in which the conditions before the intervention seem favourable enough to offer the best promise of success. One of the fundamental parameters often taken into account is the presence of key individuals, talented and charismatic leaders thriving towards innovation (Saunders, 2003). Later on, the anticipated up scaling of the experience is hindered by personalities less driven by innovation, less motivated and less prone to change, be it out of lack of conviction, for reasons of personal agenda (such as career opportunities), because of decisions on the allocation of available resources, or others. In the “pilot operation Menabe” lead by the regional environmental program of the Indian Ocean Commission, the pilot region was chosen amongst other reasons because of the existence of a regional development committee (“Comité régional de développement”), unique in Madagascar and without any official existence in the national politico-administrative system, considered reliable, energetic and with strong leadership under the authority of a motivated local dignitary.

- Decreasing resources applied to increasing difficulties

Not only are pilot experiments conducted in exceptional and well chosen conditions, they also benefit from exceptional financial, human and technical means. Depending on the case, these can be specifically devoted financial resources, technical assistance, the presence of mediators, or particular political support. The presence of local mediators or the availability of financial resources (travel expenses and per diem) to support stakeholder participation in the various consultative processes of development aid projects are examples of such exceptional resources. What is more, this concentration of resources is employed in a context where

resistance to change is weak. As we have already seen, pilot experiments that promote cultural change, change of practices and innovative organization modes tend to be tolerated by stakeholders who are the bearers of the “traditional” and dominant modus operandi as long as they remain pilot ventures. Therefore, they do not have to face the opposition that usually appears in the latter stages, at least not at its full strength or diversity. The resistance to change on behalf of those who have a real or perceived interest in maintaining the status quo only begins in the phase of replication and up scaling. At that stage, studies have identified (...) “innovation enclaves”, around which the management systems remain essentially unaltered. The existence of such enclaves is accepted by the majority of stakeholders as long as they are not destined to become spearheads of change. The Kerouallon experiment is an archetype for all three of those factors (Hawthorne effect, exceptional conditions, and decreasing resources). “An elected representative of the urban community of Brest met them [the involved farmers] individually in order to explain to them the objectives of the study and sign the cooperation convention”. One easily imagines – and this was the intent – how this could favour the rest of the project, since each farmer felt acknowledged or even favoured. The project leaders moreover add that “the teams in the field pledged to employ only permanent agents in order to avoid having the farmers repeatedly give the same information to several persons”. This appears to be another factor likely to favourably influence the course of the project. One could even suppose that due to regular contact, farmers and project agents will begin to develop a relationship, which would further benefit the quality of information exchanges, the mutual trust and the motivation of the farmers. The question is to what extent favourable conditions for the implementation of a pilot experiment can be created without invalidating its reproducibility? What value as an example can an experiment in intensive agriculture have, that presents all the conditions of trust, dialogue, information and implication of farmers, which to say the least, is not the typical situation?

- An evaluation challenge

We already mentioned the seduction power of pilot experiments as modes or organization

of action. This often leads to pilot experiments being accompanied by an exaggerated sense of optimism or even euphoria on the part of the stakeholders. Many of them, and in particular the operators of public action, derive great satisfaction from focusing the discussion on successful local operations, or even better, on promising fledgling operations. As we have already pointed out, they absorb all energies and convey the unverifiable impression that “one is going in the right direction”, to the point of inducing a global optimism far beyond the actual scope of the experiment. The Hawthorne effect and the distortions related to the observation that “every experiment begins by succeeding” are generally ignored. Furthermore, the mere fact of participating in an experiment conveys to the stakeholders the exhilarating, but often mistaken feeling of innovating, even where the same recipes have been used time and again without any real success for decades. Pilot experiments also have a tendency to invalidate evaluation processes, for two sets of reasons. First, the stated objective is often to mobilize and create a new dynamic more than to directly change the performance of an environmental management system. The problem is that the emergence of a mobilization or action dynamics is difficult to measure in ‘abstracto’: it is only in the light of the future behaviour of the concerned human groups that it is possible to know whether a durable dynamic has been created. In addition, there is the problem of scale. It is difficult to evaluate micro-experiences with regard to their impact on the way in which the environment is managed. Moreover, pilot experiments are often associated with the concept of adaptive management, itself akin to the method of learning by doing. Even though the usefulness of those concepts for the general case is in no doubt and they are often justified in practice, they can through gradual drifting lead to an understanding of action, in which mistakes and failures become an integral part of the process. In such a context, an evaluation is fundamentally invalidated, including cases in which those errors equate to severe and largely predictable failures. Finally, we saw before that pilot projects, and in a larger sense pilot experiments, contribute to a fragmentation of public action. This phenomenon leads to an “illegibility” of environmental management systems, which makes it extremely difficult to discern the web of responsibilities, to assign effects to practices or to identify trends. Exaggerated optimism, invalidation of evaluation

and illegibility of environmental management systems all seriously hinder efforts to evaluate pilot experiments, and thereby to capitalize on them, despite this being an essential condition for any kind of collective learning.

3.4.2. Next steps: Towards the implementation of pilot projects

This report paves the way for the selection of some pilot projects to be implemented. The implementation shall follow a four-step process:

- The first step consists of the actual implementation of the project, conducted by local communities with the support of the IOM team.
- Training workshops will be organized in order to foster the implementation of the selected projects.
- An awareness-raising campaign will be launched, in order to inform Mauritians and Rodriguans about the importance of environmental degradation on migration flows and the employment opportunities in the environment sector on the islands.
- Finally, dialogue and information sharing between the different ministries and institutions involved, and between the different regions and islands, will be encouraged.

PART V

GENERAL RECOMMENDATIONS



The following are some general recommendations common to the two clusters of the report.

I. Improving knowledge of current and future environmental pressures, as well as their social consequences

More in-depth scientific studies on the consequences of current and future natural hazards are necessary. They should address not only environmental pressures, but also the way these pressures impact communities. Two avenues for future research appear relevant:

- Better knowledge of current natural hazards and their impacts. Two components can be highlighted:

- (i) An upstream approach: vulnerability studies should be undertaken at various spatial scales before events occur. They should lead to an in-depth analysis of the risks induced by territorial organization, environmental degradation and natural hazard management practices, as well as the ability of local communities to cope with a crisis (perceptions and knowledge about hazards and emergency skills in case such hazards occur, etc.).

This should lead to better mapping of vulnerabilities throughout the islands and the country, as these maps will be a major support both for decision makers and for local NGOs to improve public awareness.

- (ii) A downstream approach: when events occur, resilience and adaptation studies should be carried out in order to assess emergency management practices and communities' resilience. Gathering vulnerability and resilience studies should allow for better anticipation of natural hazards and associated catastrophes. In doing so, scientific studies could also provide information and knowledge on how to protect small communities from forced migration.
- The future impacts of climate change on a local scale: these impacts will neither be

exactly the same in Mauritius, Rodrigues and Agalega, nor within Mauritius and Rodrigues themselves. Even though we cannot wait for more precise scientific knowledge on impacts before launching adaptation processes, better knowledge of these local impacts remains a major goal for the next decade. There are two relevant ways to achieve this:

- (i) Develop regional and local scale-based modelling simulations.
- (ii) Go further in identifying the induced consequences of the evolution of the context of natural hazards (impacts on agriculture, fishing, tourism, livelihoods, etc.).

Reaching this double goal will require both the development of better methodological frameworks for data collection and environmental monitoring, as well as the improvement of basic data availability. This aspect concerns both environmental and social data.

2. Favouring a coherent approach to pilot projects

As mentioned previously, the list of pilot projects provided in this report does not seek to present the whole range of possible actions, but rather to call readers' attention to the wide range of possibilities for adaptation. In some cases, when strong degradation of the environment has already occurred, or when environmental protection measures have been taken, the main goal of the pilot project will be to identify and implement alternative livelihood options. In other cases, more anticipative approaches should be developed.

According to these two dimensions (reactive and anticipative), two points can be emphasized:

- The framework and the guidelines developed and presented in this report could be of major usefulness as they allow for the design of actions that are both relevant for coping with current environmental changes and addressing the impacts of future natural hazards, climate impacts in particular. This framework could be more systematically applied and used as a common basis: (i) between different institutions (national, regional and international); (ii) between different project-holders; and (iii) between funding institutions and project-holders.

- Attention should also be paid to the transferability of “good practices”.
- As the “pilot project framework” has been primarily designed in this project to help vulnerable local communities define relevant environmental projects, it could be interesting to also adjust its guidelines for funders’ needs.

3. Mainstreaming adaptation to climate change into national policies and frameworks

- Stronger linkages could be developed between the pilot project framework and the frameworks of CSR, AAP and MID. Which synergies/conflicts could be identified and how to favour/mitigate them?
- The National Adaptation Programme of Action (NAPA) should be revised in order to:
 - include the migration dimension;
 - use the above framework and guidelines as tools for designing adaptation strategies.

4. Moving towards an adaptation to climate change pathway

Thoroughly informing the population is necessary. This information should address environmental degradation, climate change and the wider associated risks for settlements, economic and

subsistence activities, etc. Awareness campaigns should focus on:

- (i) the threats induced by current natural hazards and environmental degradation;
- (ii) the means of reducing communities’ vulnerability to natural hazards, including migration options.

5. Fostering regional cooperation

There are very strong possible avenues of regional cooperation on the issues of migration and adaptation to climate change. This report showed that from this perspective, the Republic of Mauritius could be seen as a showcase, a country whose experiences could be extended to the context of neighbouring islands. Being international agencies, IOM, the Indian Ocean Commission and the UNDP could play a key role in fostering cooperation.

The recommended framework and strategies could indeed greatly benefit from enhanced regional cooperation. In particular, the management of migration movements could benefit from a regional exchange of information and good practices. This study could easily be replicated, and could also be improved, in neighbouring countries. It is recommended that the results of this study are also discussed in a regional context.

BIBLIOGRAPHY



- Adger, N.
2000 Social and ecological resilience: are they related? *Progress in Human Geography*, 24(3): 347–364.
- Barnett, J. and S. O’Neil
2010 Maladaptation. *Global Environmental Change*, 20: 211–213.
- Billé, R.
2010 Action without change? On the use and usefulness of pilot experiment in environmental management. *S.A.P.I.E.N.S.*, 3(1). Available from: <http://sapiens.revues.org/index979.html>
- Black, R.
2001 Environmental refugees: myth or reality? In: *New Issues in Refugee Research*. UNHCR, Geneva.
- Boano, C. et al.
2007 Environmentally displaced people: Understanding the linkages between environmental change, livelihoods and forced migration. Refugee Studies Centre, Oxford.
- Brown, O.
2008 *Migration and Climate Change*. IOM Migration Research Series. IOM, Geneva.
- Castles, S.
2002 Environmental change and forced migration: making sense of the debate. *New Issues in Refugee Research*. UNHCR, Geneva.
2003 Towards a sociology of forced migration and social transformation. *Sociology* 77(1): 13–34.
- Castles, S. and M. Miller
2003 *The Age of Migration: International Population Movements in the Modern World*. 3rd ed. Palgrave MacMillan, Basingstoke, UK.
- Church, J.A. et al.
2004 Estimates of the regional distribution of sea-level rise over the 1950–2000 period. *Journal of Climate* 17(13): 2609–25.
- Deloitte, ECNL.
2008 *Review of CSR Policies and Actions in Mauritius and Rodrigues*.
- Duvat, V.
2005 Les archipels de l’ouest de l’océan indien face à l’érosion côtière (Mascareignes, Seychelles, Maldives). *Annales de Géographie*, 644: 342–361.
- European Commission
2007 *A Wealth of Ideas for a Greener Europe*. Report produced by the CIP (Competitiveness and Innovation Framework Programme 2007–2011).
2010 *A Strategy for Smart, Sustainable and Inclusive Growth*. COM (2010) 2020.
- Economic Commission for Latin America and the Caribbean (ECLAC)
2006 *SMEs in the Environmental Goods and Services Market: Identifying Areas of Opportunity, Policies and Instruments*. United Nations Publications, Santiago, Chile.

Food Security Fund (FSF)

n.d. *Strategic Plan 2008 – 2011*. Ministry of Agriculture, Government of Mauritius.

Hugo, G.

1996 Environmental Concerns and International Migration. *International Migration Review* 30(1): 105–131.

Intergovernmental Panel on Climate Change (IPCC)

2007 *Climate Change 2007*. Synthesis report. IPCC, Geneva.

International Centre for Trade and Sustainable Development (ICTSD) and International Institute for Sustainable Development (IISD)

2008 *Liberalization of Trade in Environmental Goods for Climate Change Mitigation: The Sustainable Development Context*. Geneva.

International Finance Corporation (IFC)

2002 *Handbook for Preparing a Resettlement Action Plan*. IFC, Washington, D.C.

Jäger, J. et al.

2009 *EACH-FOR Synthesis Report*. EACH-FOR, Budapest.

Jonsson, G.

2010 *The Environmental Factor in Migration Dynamics –A Review of African Case Studies*. Working papers of the International Migration Institute, Oxford.

Kniveton, D. et al.

2008 *Climate Change and Migration: Improving Methodologies to Estimate Flows*. IOM Migration Research Series, IOM, Geneva.

Lassailly-Jacob, V.

2006 Une nouvelle catégorie de réfugiés en débat. *Revue Européenne de Droit de l'Environnement*, 4: 374–380.

Magnan, A.

2005 *Tourisme, développement et dynamique territoriale dans l'archipel des Maldives et à l'île Maurice*. Thèse de doctorat, Université Paul Valéry de Montpellier III, 462 p.

2007 Tourisme et réserves d'espaces sur les littoraux de l'île Maurice. *Les Cahiers d'Outre-Mer*, 240: 341–372.

2009a La vulnérabilité des territoires littoraux au changement climatique : mise au point conceptuelle et facteurs d'influence. Iddri, coll. *Analyses*, 1, Paris, 30 p.

2009b La vulnérabilité des territoires littoraux au changement climatique : mise au point conceptuelle et facteurs d'influence. Iddri, coll. *Analyses*, 01/2009, 30 p.

2010a Two key concepts of the society/climate change interface: vulnerability and adaptation. Iddri, coll. *Syntheses*, 02/10, Paris, 4 p.

2010b For a better understanding of adaptive capacity to climate change: a research framework. Iddri, coll. *Analyses*, 02/10, Paris, 26 p.

Mauritius Commerical Bank (MCB)

2010 *Annuaire de l'Environnement de Maurice*. Published as part of MCB's Initiative 175.

- Ministry of Energy and Renewable Energy
2009 *Framework of the Long-Term Energy Strategy and Action Plan*. Government of Mauritius.
- Ministry of Environment and NDU
2007 *National Environment Policy*. Government of Mauritius.
- Mimura, N. et al.
2007 Small islands. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (M. L. Parry et al., eds). Cambridge University Press, Cambridge.
- Mauritius Meteorological Services
2009 *Climate Change Impacts on Mauritius*. Meteorological Services, Vacoas.
- Mauritius Sugar Industry Research Institute (MSIRI)
2009 Annual report. Mauritius Sugar Industry Research Institute, Reduit.
- National Economic and Social Council
2009 *A Blueprint for the Energy Sector in Mauritius*.
- National Productivity and Competitiveness Council
2007 *Guidance Manual on Green Productivity Opportunity Assessment for Local Green Productivity Practitioners*.
- Nigel, R. and S.D.D.V. Rughooputh
2010 *A landslide potentiality mapping on Muaritus Island*. The Geospatial Resource Portal 2009. Available from http://www.gisdevelopment.net/application/natural_hazards/landslides/mwf09_rody.htm (accessed on 2 October 2010).
- Parry, M.L. et al. (eds)
2007 *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Renaud, F. et al.
2007 *Control, Adapt or Flee. How to Face Environmental Migration?* InterSecTions (Interdisciplinary Security Connections) Publication Series of the United Nations University Institute for Environment and Human Security. UNU-EHS, Bonn.
- Suhrke, A.
1994 Environmental degradation and population flows. *Journal of International Affairs*, 47(2): 473–496.
- United Nations Development Programme (UNDP)
2009a *Sustainable Integrated Development Plan for Rodrigues*. Report Prepared by KPMG.
2009b *Supporting Integrated and Comprehensive Approaches to Climate Change Adaptation in Africa: Inter- Regional Technical Support Component 1*. Project Document available at <http://www.undp-adaptation.org/africaprogramme/>
- United Nations Environment Programme (UNEP)
2008 *Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World*. Report produced by Worldwatch Institute, Washington D.C.

APPENDIX



List of key people consulted

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