

# Etude des risques et vulnérabilités au changement climatique dans les pays de la COI

et ébauche d'un plan d'action régional d'adaptation- PARA dans le cadre du programme ACCLIMATE de la COI



Groupement ASCONIT Consultants- PARETO



## ATELIER NATIONAL MAURICE

VULNERABILITE ET ADAPTATION AU CHANGEMENT CLIMATIQUE

14 janvier 2011

Etude co-financée par FFEM, MAEE, Région Réunion



## Factors Hazards Considered for report (findings and projection)

- Temperature increasing: Mean maxi by about 1.1 and mean minimum by about 2 deg celcius
- Model projection : 1.86 to 3.28 deg
- Rainfall decreasing trend: 12% between 1930 and present
- Longer dry spells
- Increase in frequency of heavy rain
- Sea-level rising up to half a metre
- Increase in the number of strong cyclones
- Wind: no data but in accordance with cyclone numbers
- Model projection of CO<sub>2</sub> increase up to 995 ppm by 2100 (acidification)

## Health sensitivity

- Increasing frequency of heat spells, giving rise to cardiovascular and pulmonary complications.
- Decreasing supply of freshwater, result in gastroenteritis, dehydration and lack of sanitation.
- Recurrent floods, lead in to food spoilage, propagation of vector borne and infectious diseases.
- Rising temperatures and variable precipitation are likely to affect the production of staple foods leading to malnutrition.
- Rise in temperature, result in the lengthening of the transmission period of important vector-borne diseases

## Health adaptation

- Monitoring/surveillance at port and harbour
- Cleaning of environment
- Sensitisation of population
- New laboratory planned
- Identification of flood-prone areas

# Health regulation

- *The Country Paper and the Health sector, 2006* does not specifically address the issue of climate change with regard to the health sector. However, some of the identified measures will help to cope with these issues such as further strengthening the on-going surveillance system for the control of communicable diseases. The on-going intensive island-wide vector control programme will be maintained and strengthened. Surveillance programmes at the port and airport will be consolidated.

# Water resources

- Decreasing trend: 12% between 1930 and present
- Longer dry spells (Sept to Dec instead of Sept -Oct)
- Shift (later) in onset of summer rains
- Change in ground water and river-flow regimes. Water-levels in rivers during each dry season lower than during previous ones as result of lengthening of dry spell?
- Management of reservoirs has become more challenging and requires closer monitoring
- Intrusion of salt water in coastal aquifers –monitoring ongoing.(Certain boreholes have been abandoned as salty)
- While availability of fresh global water is decreasing, demand is increasing (domestic, industrial, tourism, services)

# Water Resources Adaptation

- Reduction of losses in distribution system
- Identification of new water sources (underground)
- Construction of new dams (Bagatelle and R des Anguilles)
- Water treatment for reuse (hotels with more than 75 rooms must recycle)
- Desalination?



# Water Regulation

- An assessment of the impacts of climate change on the water sector has been conducted and measures for a more efficient use of this finite resource have been drawn up. Cost–benefit analyses will be made for appropriate adaptation measures by the end of 2011 under AAP. A *Master Plan Study* for the development of water resources is being drawn up. This will take into consideration impact of climate change on the sector. Legal framework will follow.



# Agriculture

- Heat stress which causes flower drop and loss in crop productivity e.g., tomato crop productivity has at times been severely affected by stress.
- It affects livestock production.
- Temperature increase which favours faster growth rate of insect, pest and vectors, increase disease transmission rate and expansion of the geographical ranges of agricultural pests and disease as well as the duration that they are prevalent.
- Higher temperatures result in increased evapo-transpiration rates and reduction in soil moisture.
- Changes in cropping pattern and crop cycle.
- Shift in agricultural zone.
- Loss of top fertile soil due to soil erosion particularly on the slopes.
- Inundation of low lying areas during extreme weather events.

# Agriculture Adaptation

- New varieties (more heat resistant and requiring less water ) of cultivars
- Shift in regions? (limited land)
- Pest control more intensive
- Sensitisation of vegetable growers on timeliness of activities
- Increase in irrigation ? (limited water availability)
- Identification of inundable zones and better preparedness against floods
- Control of soil erosion
- Maintain forest varieties and extent- reforestation

# Agriculture regulation

- A *Blueprint for a Sustainable Diversified Agri-food Strategy for Mauritius, 2008-2015* – addresses the food security through improving self-sufficiency status of a number of strategic crops in the short to medium term.
- A *Food Security Fund* has been set up to increase the resilience of Mauritius towards food self-sufficiency and to face subsequent global food and feed crunches by increasing production of foodstuff locally and at the regional level by partnering with neighbouring countries. This will also help to curtail the adverse effects of climate change. The Fund also provides funds for adaptation such as the *Food Crop Insurance Scheme and Sheltered Farming*.

# Environment / Coastal Zone

- Beach erosion
- Coral bleaching and acidification impacts on coral reef ecosystem (Outer islands), including weakening of coral barriers, and impacts on sea-grass
- Coral reef health (appearance of coral diseases)
- Change in mangrove extent and location with rising sea-level and sedimentation
- Increase of land-based pollution with increase of rainfall intensities and flood water
- Intrusion of sea water (in wetlands-extant and locations)
- Increase in invasive species
- Change in habitat and reproduction zones and feeding zones and migration of pelagic fish, marine mammals, birds turtles...

# Coastal Zone /Environment- adaptation

- Control of artificial passes (in barrier reefs)
- Control of illegal constructions which were modifying lagoonal currents and erosion
- Beach nourishment and preservation
- Beach rehabilitation ( by planting )??
- Marine protected areas and fish control
- Transplantation of corals and mangroves
- Control of flood discharges

# Coastal zone/Environment - adaptation

- Wetlands zones control and protection??  
(adherence to Ramsar Convention etc)



# Coastal zone/Environment Regulation

- The ***Environment Protection Act 2002*** has been amended to provide, *inter alia*, for the setting up of a ***Multilateral Environmental Agreement (MEAs) Coordinating Committee*** to ensure better mainstreaming of all MEAs into sectoral and national policies. In some cases, the legislations do provide for the necessary framework to deal with climate change but they are very often not enforced due to inadequate means. Government has planned to amend these to better address climate change and its impacts.
- The ***National Environment Policy, 2007*** highlighted the importance of climate change to Mauritius. The objective of Government is to enhance preparedness of the country so as to address the impacts of extreme weather events, climate change and sea level rise and other environmental disasters. The national targets are to improve national and regional coordination for early warning systems, enhance the preparedness of the local population, prepare an integrated action plan to better respond and adapt to disasters and to set up a panel of experts for disaster management.



## Coastal zone/Environment Regulation

- The *National Biodiversity Strategy and Action Plan, 2006-2016* recommends the development of an ICZM plan and the study of Environment Sensitive Areas towards protecting biodiversity. Additional measures include increasing the area of coastal wetlands and mangroves, and to include 10% of Mauritian terrestrial area within the Protected Area Project.
- The Ministry of Environment and Sustainable Development has developed a framework for the Environment Sensitive Areas which has been adopted by Government.

# Forestry

- CC affects the biological pattern of plants (Forests are heavily dependent on water cycle and air temperature)
- If induce the migration of species to cooler areas the naturally occurring fauna and flora will be displaced in the new areas while the indigenous and endemic plants in the cooler areas of the island will be seriously affected.
- Decrease in rainfall will exacerbate the situation.
- Increase fire outbreaks

# Forestry - adaptation

- Replace all felled trees
- Maintain reserves
- Control disease
- Control fire outbreaks (cleaning of forest)
- Remove invasive species

# Forestry regulation

- *The National Forest Policy, 2006* spells out key activities to counter the major cause of climate change. The strategy includes measures to enhance sink capacity through better management of existing forests while reducing timber exploitation.
- *The Forest Land Information System (FLIS)* was developed under the GEF Sustainable Land Management Project.
- In addition, Mauritius is currently implementing the *Land Administration, Valuation and Information Management System (LAVIMS)* to address a number of disciplines, ranging from law, valuation, surveying, land registration and land planning.

# Fisheries

- Rise in *sea surface temperature and acidification*: will cause coral mortality and decrease of reef fish biomass
- CC has an effect on the distribution pattern of species. Movement of tuna stocks may disrupt fish based industries.
- Changes in fish stock distribution and fluctuations in abundance of conventionally fished and “new” species may disrupt existing allocation arrangements.
- Changes in migration patterns and depth of fish stocks are the main factors affecting the distribution availability of tuna and others

# Fisheries - adaptation

- Control of fishing (quota, specie, season, fish gear, MPAs, lagoonal and high sea)
- Research and monitoring (lagoonal and high sea)
- Shift target fish specie for high sea fishing (Indian Ocean Tuna Commission).
- Change in fishing gear and tools
- Recycling of fishermen (incentives to lagoonal fishermen)

# Fisheries regulation

- The *Fisheries Development Plan, 1998* highlighted the precarious status of artisanal fishery as a result of direct and indirect adverse effects of climate change on the marine ecosystems of the lagoon. An Aquaculture Master Plan has been prepared in addition to encouraging bank fishing as well as promoting exploitation of pelagic fishes as alternatives.



# Land Use / Buildings

- Damage to coastal roads and other infrastructures a result of sea-level rise (hotels, port....)
- Displacement of population
- Inland damages and impacts as a result of flooding and cyclones
- Other infrastructures (communication, electricity )
- Heat Stress in buildings

# Buildings - adaptation

- More energy-efficient buildings (Energy Efficient Bill)
- Appropriate Building Materials?
- Elevated construction ???
- Identification of inundable areas

# Energy –including adaptation

- Increase in demands
- Renewable energy
- Incentive to produce and sell by individuals to CEB
- Energy efficient bulbs given free of charge to consumers
- Replacement of old generators at CEB
- Co-generation (coal and bagasse) by Independent Power Generators

# Infrastructure/Buildings Energy Regulation

- The *Long Term Energy Strategy 2009 - 2025* was adopted in October 2009 with the target of meeting 35% of the energy demand through renewable energy sources by the year 2025. Concurrently, multitude options have been identified to improve energy efficiency at both the demand and supply side ends and the adoption of cleaner technologies with lower emission standards for fossil fuels utilised.
- Revision of Building Codes to make buildings more energy efficient

# Industry and Services

- Water consumption
- Infrastructure degradation
- Increase of costs of provision of services
- Recycling of water (see water resources and land-use..)

# Tourism

- Degradation of the environment (diminish attractiveness)
- Effluent discharge
- Limitation of tourist arrivals & accommodation (sea-level rise, extreme weather)
- Water availability
- Heat stress
- Disease
- Food availability

# Tourism-adaptation

- Linked with other sectors- health, water, agriculture, environment, land-use and building, energy, services, fisheries



# Tourism regulation

- The *Hotel Development Strategy* aims at developing guidelines for adherence to Planning Policy Guidance (PPG) and for giving due consideration to eco-friendly and energy-saving practices by hotel promoters. The *Tourism Development Plan, 2000* sets as objective the establishment of Mauritius as a “Green Destination” by 2020.
- A study for the Development of an *Integrated Coastal Zone Management* Framework has been completed with the objectives of:
  - Developing an ICZM Strategy for Mauritius;
  - Reviewing and Preparing a National Policy and Comprehensive Legislative Framework; and
  - Preparing ICZM Area Plans for Pressure Zones in Mauritius.

1. ENJEUX			2. EXPOSITION		3. SENSIBILITE	4. CAPACITE d'ADAPTATION		5. VULNERABILITE
Secteurs / Sous secteurs			Aléas à prendre en compte	Sites générés	Appréciation	Capacité intrinsèque (résilience)	Capacité externe au système, opportunités	Appréciation
			1 Température, 2 Niveau de la mer, 3 Précipitations, 4 Vagues, 5 Modification des fondements environnementaux (saison), 6 Cyclone, 7 Acidification des océans, 8 effets indirects (pollution) peut atténuer avec une action	effet direct et ampleur	Selon 3 degrés : faible, moyenne, forte			
<b>Secteur 3 Santé publique</b>								
X	Sous sect 2	Maladies infectieuses à vecteur (paludisme, chikungunya, dengue, Zika)	1, 3, 5, 6	Augmentation	élevée	variable	Moyenne	Moyenne ?
X	Sous sect 3	Mortalité cardio-vasculaire, maladies respiratoires, brûlures, coups de chaleur, coups de soleil, allergies, la peau (vagues de chaleur, ozone, pollen)		1 Augmentation	élevée	variable	Moyenne	Moyenne ?
X	autres	Malnutrition (mauvaises récoltes)	1, 3, 5, 6, 8 (mal)	Augmentation	élevée	faible	Moyenne	Moyenne ?

Health

	S	D	A	R	SCORE
<b>Politico-economique</b>	0				0
<b>Environnemental</b>				0	0
<b>Social</b>	0		1		1
<b>Gouvernance</b>	1				1
<b>TOTAL</b>	1		1	0	2

1. ENJEUX		2. EXPOSITION		3. SENSIBILITE	4. CAPACITE d'ADAPTA		5. VULNERABIL	
Secteurs	Sous secteurs	Aléas à prendre en compte	Stress généré	Appréciation	Capacité intrinsèque (resilienc	Capacité extérieure a système, opportunité	Appréciation	
		1 Température, 2 Niveau de mer, 3 Précipitations, 4 V... Modification des fondamen... environnementaux (saison... Cyclone, 7 Acidification des... océans, 8 effets indirects (... peut atténuer avec une act...	effet direct et ampleur	Selon 3 degré <b>faible</b> <b>moyenne</b> <b>forte</b>				
<b>Secteur 4 Gestion intégrée des ressources en eau, cycle de l'eau</b>								
X	Sous sect 1	Gestion de la ressource, quantité et qualité		3 Diminution quant et qualité	élevée	faible	Moyenne	Moyenne
X	Sous sect 2	Production et distribution, gestion intégrée de bassin versant		3 Diminution production	élevée	-	Moyenne	Moyenne
X	Sous sect 3	Assainissement et rejet	3, 6	eaux pluviales et eaux usées	élevée	faible	Moyenne	Moyenne

	S	D	A	R	SCORE
<b>Politico-économique</b>	0				0
<b>Environnemental</b>	0	1	0	1	2
<b>Social</b>			0		0
<b>Gouvernance</b>	1				1
<b>TOTAL</b>	1	1	0	1	3

Water

1. ENJEUX		2. EXPOSITION		3. SENSIBILITE	4. CAPACITE d'ADAPTATI		5. VULNERABILITE
Secteurs	Sous secteurs	Aléas à prendre en compte	Stress générés	Appréciation	Capacité intrinsèque (résilience)	Capacité extérieure au système, opportunité	Appréciation
		1 Température, 2 Niveau de la mer, 3 Précipitations, 4 Vents	effet direct et ampleur	faible moyenne forte			
<b>Secteur 5 Agriculture, sécurité alimentaire et exploitation des forêts</b>							
X	Sous sect 1	Agriculture intensive avec engrais (dont canne à sucre, carburants...)	1,3, 8 (inv, mal, ins) Diminution production	élevée	?	Moyenne	Moyenne
X	Sous sect 2	Agriculture vivrière, maraichage et cueillette	1,3, 8 (inv, mal, ins) Diminution production	élevée	?	Moyenne	Moyenne
X	Sous sect 3	Exploitation forestière	1,3, 8 (mal, inv) Diminution production	élevée	?	Moyenne	Moyenne
X	Sous sect 4	Elevage	1, 3, 8 (mal) Diminution production	élevée	?	Moyenne	Moyenne
X	Sous secteur 5	Gestion des sols, lutte contre érosion et désertification	1,3, 8 (feux, gliss) Désertification	élevée	?	Moyenne	Moyenne
x	Sous secteur 6	Gestion des pestes, espèces invasives ou parasites...	1, 3, 5 Augmentation des inv et mal	élevée	faible	Faible	Forte

Agriculture

	S	D	A	R	SCORE
<b>Politico-économique</b>	0				0
<b>Environnemental</b>	0		1	0	1
<b>Social</b>	0				0
<b>Gouvernance</b>	1				1
<b>TOTAL</b>	1		1	0	3

1. ENJEUX			2. EXPOSITION		3. SENSIBILITE	4. CAPACITE D'ADAPTATION		5. VULNERABILITE
Secteurs	Sous secteurs		Aléas à prendre en compte	Stress générés	Appréciation	Capacité intrinsèque (résilience)	Capacité extérieure au système, opportunité	Appréciation
			1 Température, 2 Niveau de la mer, 3 Précipitations, 4 Vents	effet direct et ampleur	Selon 3 degrés <b>faible</b> <b>moyenne</b> <b>forte</b>			
<b>Secteur 6 Préservation de l'environnement et des milieux naturels terrestres</b> côtiers, marins, milieu aquatiques terrestres)								
x	Sous sect 1	Terrestre : forêts, savanes...	1, 3, 4, 5, 8 (feux, inv)	Diminution couverture et bio	élevée ?		Faible	Forte
x	Sous sect 2	Côtiers ( cote sableuse, mangroves...récifs, herbiers...)	1, 2, 3, 5, 6, 7, 8 (inv, mal)	Diminution couverture et bio	élevée	variable (faible)	Faible	Forte
x	Sous sect 3	Marins atolls lointains et hors récifal...	1, 3, 5, 6, 7, 8 (inv, mal)	Diminution couverture et bio	élevée	variable (faible)	Faible	Forte
X	Sous sect 4	Milieu aquatiques terrestres, cours d'eau, zone humide...	1, 2, 3, 6, 8 (inv, mal)	Diminution couverture et bio	?	?	Faible	Forte (?)
x	Sous sect 5	Biodiversité faune et flore, gestion des espèces invasives, espèces emblématiques (cétacés, tortues)	1, 3, 5, 6, 7, 8	Diminution biodiversité	élevée	faible	Faible	Forte

Environnement

	S	D	A	R	SCORE
<b>Politico-économique</b>	0				0
<b>Environnemental</b>	0	0		0	0
<b>Social</b>	0				0
<b>Gouvernance</b>	1				1
<b>TOTAL</b>	1	0	0	0	1

1. ENJEUX			2. EXPOSITION		3. SENSIBILITE	4. CAPACITE D'ADAPTE		5. VULNERABILITE
Secteurs	Sous secteurs		Aléas à prendre en compte	Stratégie	Appréciation	Capacité intrinsèque (resilience)	Capacité externe (opportunités)	Appréciation
			1 Température, 2 Niveau de la mer, 3 Précipitations, 4 Modification des fondations, 5 Environnementaux (sa), 6 Cyclone, 7 Acidification des océans, 8 effets indirects. peut atténuer avec un	effet direct ampleur	Selon 3 degrés : faible, moyenne, forte			
<b>Secteur Pêche</b>								
x	Sous sect 1	Pêche hauturière	1, 4, 5, 7, 8 (mal)	Diminution production	?	?	Moyenne	Moyenne ?
x	Sous sect 2	Pêche traditionnelle et cueillette	1, 5, 7, 8 (inv, mal)	Diminution production	élevée	Faible	Faible	Forte
x	Sous sect 3	Aquaculture	1, 8 (mal)	Diminution production	?	?	Moyenne	Moyenne ?

Pêche

	S	D	A	R	SCORE
<b>Politico-économique</b>	1				1
<b>Environnemental</b>	0	0	0		0
<b>Social</b>	0				0
<b>Gouvernance</b>	1				1
<b>TOTAL</b>	2	0	0	0	2

1. ENJEUX			2. EXPOSITION		3. SENSIBILITE	4. CAPACITE d'ADAPTA		5. VULNERABIL
Secteurs	Sous secteurs		Aléas à prendre en compte	Effets générés	Appréciation	Capacité intrinsèque (resilienc	Capacité extérieure au système, opportunité	Appréciation
			1 Température, 2 Niveau de mer, 3 Précipitations, 4 Vagues, 5 Modification des fondements environnementaux (saisons), 6 Cyclone, 7 Acidification des océans, 8 effets indirects (qui peut atténuer avec une action)	effet direct et ampleur	Selon 3 degrés <b>faible</b> <b>moyenne</b> <b>forte</b>			
<b>Secteur 8 Planification spatiale, aménagements et infrastructures, gé</b>								
x	Sous sect 1	Habitat et logements, bâtis	2, 3, 6, 8 (gliss)	Endommagement, ndations	élevée	Moyenne	Moyenne	Moyenne
x	Sous sect 2	Déplacement et infrastructures linéaires	2, 3, 6, 8	Augmentation déplacement/Endommagement/inondations	élevée	Moyenne	Moyenne	Moyenne
x	Sous sect 3	Gros aménagements et infrastructures (ports...)	2, 3, 6, 8	Endommagement, ndations	élevée	Moyenne	Moyenne	Moyenne
x	Sous sect 4	Entreprises et commerces	2, 3, 6, 8	Endommagement, ndations	élevée	Moyenne	Moyenne	Moyenne

Infrastructure

	S	D	A	R	SCORE
<b>Politico-économique</b>	0				0
<b>Environnemental</b>	0	1		0	1
<b>Social</b>	0			0	1
<b>Gouvernance</b>	1				1
<b>TOTAL</b>	1	1		0	3



1. ENJEUX		2. EXPOSITION		3. SENSIBILITE	4. CAPACITE d'ADAPT		5. VULNERABIL
Secteurs Sous secteurs		Aléas à prendre en compte	Risques générés	Appréciation	Capacité intrinsèque (résilience)	Capacité externe au système, opportunités	Appréciation
		1 Température, 2 Niveau de mer, 3 Précipitations, 4 Vagues, 5 Modification des fondements environnementaux (saison), 6 Cyclone, 7 Acidification des océans, 8 effets indirects	effet direct et ampleur	Selon 3 degrés de gravité : faible, moyenne, forte			
<b>Secteur 1 Industrie, commerces et services</b>							
X	Sous sect 2	Industrie secondaire transformation et manufacture	3 Manque d'eau	élevée		Moyenne	Moyenne
x	Sous sect 3	Industrie tertiaire et services dont banques et assurances	3 (mal) Augmentation des coûts	élevée		Moyenne	Moyenne

Service

	S	D	A	R	SCORE
<b>Politico-economique</b>	0				0
<b>Environnemental</b>				0	0
<b>Social</b>	1				1
<b>Gouvernance</b>	1				1
<b>TOTAL</b>	2	0	0	0	2

1. ENJEUX		2. EXPOSITION		3. SENSIBILITE	4. CAPACITE D'ADAP		5. VULNERABILITE	
Secteurs	Sous secteurs	Aléas à prendre en compte		Impact général	Appréciation	Capacité intrinsèque (résilience)	Capacité externe (système, opportunités)	Appréciation
		1 Température, 2 Niveau de la mer, 3 Précipitations, 4 Modification des fondations, 5 Modification des écosystèmes, 6 Cyclone, 7 Acidification des océans, 8 effets indirects (qui peut être atténué avec un		effet direct et d'ampleur	Selon 3 degrés de gravité : faible, moyenne, forte			
<b>Secteur Tourisme</b>								
x	Sous sect 1	Tourisme de masse, tourisme hôtelier et déplacements par avion (package vacances)	1, 2, 3, 5, 6, 7, 8 (mal)	Diminution de capacité d'attraction	élevée	faible	Moyenne	Moyenne
x	Sous sect 2	Tourisme vert éco tourisme	1, 2, 3, 5, 6, 7, 8 (infeux)	Diminution attraction	élevée	faible	Moyenne	Moyenne
?	Sous sect 3	Loisirs, sports de nature, eaux vives, sports	1, 3, 5, 8 (mal)	Diminution	élevée	faible	Forte	Forte

Tourism

	S	D	A	R	SCORE
<b>Politico-économique</b>	0				0
<b>Environnemental</b>	1			0	1
<b>Social</b>	0				0
<b>Gouvernance</b>	1				1
<b>TOTAL</b>	2		0	0	2

## Key issues for Mauritius and for COI countries :

- Water management :
- Health (vector diseases and cardiovascular and pulmonary diseases)
- Agriculture
- Fisheries (specifically artisanal fisheries)
- Environment (specifically coral reef, mangroves and wetlands)
- Land use (specifically materials buildings, identifier les zones à risques - soil slide, flood- and sea level rise)
- Tourism (transversal)

## Réflexions, orientations sur

- Gouvernance ;
- Financement ;
- Connaissance et améliorations des prévisions (cf. réseau océan Indien en cours de mise en place)
- Réseau des pays de la COI sur Environment (AMP, invasive species), santé, industrial fisheries (CTOI);
- Formation, information, éducation