CLIMATE CHANGE AND BIODIVERSITY:
RESEARCH FOR A SUSTAINABLE TOMORROW

Regional meeting
September 24th and 25th 2008, Trinidad and Tobago.
Normandie Hotel, St. Ann's, Port of Spain

1 Background

The regional meeting on *Research for a sustainable tomorrow* held on 24th and 25th September 2008 in Trinidad, forms part of a two-year project (2006-2008) entitled *Climate change and biodiversity in the insular Caribbean* (CCBIC). The project is being implemented by the Caribbean Natural Resources Institute (CANARI), with funding from the John D. and Catherine T. MacArthur Foundation (MacArthur) and support from WWF Canada.

The project focuses on increasing understanding and consensus on what is known, and perhaps more importantly what is not known, about predicted climate change trends and their impact on biodiversity in Caribbean small island developing states (SIDS). The aim is to develop a regional research agenda and capacity needs assessment to address identified gaps and to consider how protected area management, biodiversity protection, and conservation policy can best address climate change in the region. The full project concept note is attached at Appendix 1 and the agenda for the meeting at Appendix 2.

2 Objectives

The objectives of the meeting were to:

a) present the findings of the CCBIC project to key regional stakeholders;

b) develop a regional research agenda on climate change and biodiversity in the islands of the Caribbean;

c) identify the research priorities for the next three-five years;

d) to identify the capacities that need to be built or enhanced in order to implement the research agenda;

e) to develop a communication strategy for disseminating the findings of the CCBIC project;

f) to build participants' support for and buy-in to the regional research agenda and capacity building strategy and to discuss potential roles, partnerships and networks.

3 Participants

Invitees to the meeting included:

- all the members of the project steering committee;
- representatives of international and regional research institutions working on climate change;
- representatives of regional and donor agencies involved in climate change monitoring, adaptation and disaster risk reduction;
- communication specialists
- individual consultants and representatives of NGOs and CBOs working in areas related to change adaptation.

A full list of the participants at the meeting is attached at Appendix 3.

4 Meeting report

4.1 Welcome, introductions and conference overview

The Chair, Professor John Agard, welcomed participants and introduced the meeting by noting that the CCBIC assessment of the status of current climate change research in the region and identification of a proposed research agenda was timely. The International Panel on Climate Change (IPCC) had attempted to get more detailed information on the Caribbean for its Fourth Assessment but had found many gaps, even in comparison with the other regions with Small Island Developing States (SIDS). IPCC was about to start the process for its Fifth Assessment and the CCBIC findings would provide early inputs from the Caribbean region.

He also commended MacArthur for seeking to find out the needs of each of its focal regions before initiating its full climate change grant-making programme. There was clearly a need for more applied research to meet needs identified by key stakeholders, such as the relevant government agencies and the communities who would be required to lead climate change adaptation efforts. There was a clear need to find more effective forms of dialogue between scientists, who are often required by their institutions to focus on publishing in peer-reviewed journals, and those engaged in implementation of climate change adaptation, for whom this is unlikely to be the most effective form of communication.

He noted that the there was currently widespread interest in and funding for projects relating to climate change, which meant that the prospects for implementing identified research priorities were good. However, on the basis that he had already been invited to 11 workshops on climate change and biodiversity before the end of the year, he feared there was also a danger of wasted investment and duplication of effort.

Following the Chair's introduction, other participants introduced themselves and their specific interests in climate change and biodiversity, which included:

- the physical science of climate change, modelling and scenarios (Caribbean Institute of Meteorology and Hydrology [CIMH]); Institute of Ecology and

Systematics, Cuba; University of the West Indies [UWI] Mona Climate Studies Group;);

- research into and monitoring of impacts on ecosystems (IMA; Institute of Ecology and Systematics, Cuba; Dept. of Life Sciences, UWI St Augustine);
- a pilot project to reduce carbon emissions through community-implemented reforestation and sale of carbon credits, with the revenue being returned to the community (John Agard, Nariva, Trinidad);
- interpreting and communicating scientific and technical knowledge for non-technical audiences in print and audiovisual formats (Buccoo Reef Trust; Nicole Brown; CANARI; Christian Aid);
- applying scientific and technical knowledge to the policy arena and to implementation of climate change adaptation and mitigation at community level (CANARI;; Christian Aid; Institute of Marine Affairs [IMA]; UNEP; University of the Virgin Islands). Specifically, application of findings on the effects climate change and sea level rise to *land use and coastal planning* (Michelle Mycoo, UWI St Augustine); application to *conservation planning* (WWF); *disaster risk reduction* (Caribbean Disaster Emergency Response Agency [CDERA]); *agriculture* (Caribbean Agricultural Research and Development Institute [CARDI]);
- research into linkages between climate change, biodiversity and livelihoods (CANARI; International Institute for Environment and Development [IIED].

Dr Neville Trotz of the Caribbean Community Climate Change Centre (CCCCC), the CARICOM agency tasked with co-ordinating the region's response to climate change, welcomed the CCBIC initiative and particularly the involvement of Cuban agencies, noting that Cuba is often way ahead of the rest of the region, in terms of research and adaptation planning, and always willing to share its expertise and experience. He highlighted two areas of potential priority focus:

- agro-biodiversity, since food security was now high on the policy agenda; and
- participation in carbon markets, with a focus on understanding and breaking down some of the barriers, for example, to rewards for standing forests.

The Chair concluded the opening session with an overview of the agenda, noting that the value of the discussion would lie in the diversity of perspectives represented at the meeting. This offered the potential both to refine the priorities for research relating to climate change and biodiversity and to expand beyond this into broader aspects of climate change policy and adaptation strategies for the region.

4.2 Global overview of the MacArthur Foundation climate change impact assessments

Sarah McIntosh of CANARI presented an overview of MacArthur's current focus with regard to climate change and biodiversity (see Appendix 4 for full details). It was noted that the Caribbean CCBIC project forms part of Phase 1 of MacArthur's interim strategy for climate change (2006-2010), with similar assessments taking place on a phased basis in:

- Eastern Himalaya
- Lower Mekong

- Melanesia
- Madagascar
- Albertine Rift
- Northern Andes
- Southern Andes

MacArthur is organising a side meeting at the IUCN Congress in Barcelona in October 2008 to

- compare the processes adopted for and the findings from these regional assessments; and
- communicate with and catalyse the broader conservation community on the issue of climate change and adaptation.

Once phase 1 is complete, MacArthur's interim strategy will focus on grant making to respond to the recommendations of the assessments and to mainstream climate change adaptation into all its conservation work. The interim strategy findings and outcomes will then be factored into a comprehensive planning process to define MacArthur conservation grant making after 2010 which might result in changes such as:

- a shift in geographic priorities;
- increased investment in areas that are especially resilient and might qualify as 'Noah's Parks'.

4.3 Overview of CCBIC activities to date

Sarah McIntosh then provided an overview of the project activities to date and the actual and proposed outputs (see Appendix 5). Key elements of the project implementation process had been the formation of a multi-disciplinary Steering Committee and of expert Working Groups to address the current status of research in Caribbean SIDS on:

- trends and scenarios for climate change in the insular Caribbean;
- impacts of climate change on marine and coastal ecosystems; and
- impacts of climate change on tropical forests and other terrestrial ecosystems.

She also noted the influence that the project has had in shaping CANARI's climate change programme, notably in expanding its focus on public education and awareness of climate change to support adaptation and in identifying the need for further policy research on the linkages between climate change and livelihoods.

4.4 Presentation of the Working Group findings

4.4.1 Working Group 1: Trends and scenarios for climate change in the insular Caribbean

Professor Anthony Chen presented a summary of the findings of this group (see Appendix 6 for presentation and http://www.canari.org/macarthurclimatechange.html for full report).

According to IPCC, the following regional trends and scenarios could be predicted with a fairly high level of certainty for the 21st century:

- ***temperature***: (> 90% probability) that Caribbean temperatures will increase but the extent will depend on actual green house gas emissions;
- ***precipitation***: (> 66% probability) drying in the Greater Antilles in June, July and August;
- ***sea level rise****: (>66% probability)* is likely to continue to rise on average around the small islands of the Caribbean, close to the global mean of 0.2 to 0.5m up to 2090s;
- ***hurricanes****:* globally (>66% probability) that the intensity of tropical cyclones will increase in some regions but there is not yet enough information to make a specific statement about the Caribbean.

Among the needs identified to expand the range of models and scenarios and to inform short-term adaptation strategies (for example, in water management, disease control and life stock management) were:

- ***climatology or average weather****:* more information on winds, sea surface temperature, radiation, relative humidity, evapotranspiration etc. to add to existing data on precipitation and temperature;
- ***knowledge of variability in climate****:* for example, effects of El Niño Southern Oscillation (ENSO). and North Atlantic Oscillation and variability in tropical cyclones;
- ***models of the relationship between climate and biodiversity****.*

Some key data gaps were outlined, particularly in relation to modeling the relationship between climate and biodiversity, with the following actions being suggested to rectify these:

- increase the density of monitoring stations and to have daily station data of sufficient temporal length (30 years or more) for scenario generation via statistical means;
- expand the number of climatic variables captured;
- ensure researchers have easy access to existing data stores;
- ensure that data currently being recorded meet adopted global and regional standards;
- capture secondary or derived information (e.g. from non-traditional archives such as records of sugar plantations, agricultural and hydrological bodies); and
- better coordinate region-wide data capture effort, and in particular, digitise hard copy data, much of which is likely to be deteriorating rapidly.

Some of the key capacity constraints that were identified were:

- the small pool of professionals who can combine disciplines (e.g. meteorology and the biosciences);
- the small pool of professionals with the skills to effectively assess and/or examine vulnerability or adaptation; and
- ‘aging’ cadre of professionals in the meteorological institutions of the region.

These constraints result in consultants from outside the region being hired, who leave their results but not their methodologies, so knowledge is not effectively transferred.

These constraints are exacerbated by technical constraints such as:

- the high cost of maintaining and calibrating meteorological instruments, which has resulted in a gradual deterioration of the meteorological network; and
- the lack of sufficient high-performance computers and massive data storage systems to generate useful and high-quality information for forecasting purposes and for the research community.

The following points were made or reinforced during the subsequent discussion:

- not enough is currently known - at the regional, national or local level - to determine in detail what is going to happen with regard to climate change and therefore to develop informed adaptation strategies;
- the governments of Caribbean SIDS should continue to pressure other governments to reduce their emissions of greenhouse gas. In order to be successful, they need to develop an effective, collaborative regional voice and to develop alliances with other SIDS sand SIDS regions.

Other key points noted during the discussion were:

- CCCCC is increasing the number of models to which the region has access, drawing on the ensemble of 16 global models from the UK's Hadley Centre. Relevant data will be passed on to Mona Climate Studies Group (CSG);
- CCCCC noted that the regional monitoring needs are yet to be agreed and suggested this be determined by a small group including Mona CSG and CIHM;
- regional modelling of sea level rise needs to be improved but CCCCC estimates that with the modelling inputs that are currently available, models could be produced for each Caribbean island;
- a considerable amount of relevant data exists but is not in the digital format needed for modelling (e.g. data collected by sugar plantations). CIHM has started a process of digitising such data by going to the source of the data and photographing it, which eliminates the complexities of sending hard copy data from one country to another. CIHM has put together a proposal for digitising the information it is aware of, at a cost of US$150,000. It was agreed that this should be recommended as a priority but that the data should then be made freely available to others. It was noted that access to CIMH data has become easier for researchers, though not for commercial entities.
- there needs to be a better mechanism for disseminating information about who is holding what data, as well as improving accessibility. Capacity to analyse data and provide it in a useful form also needs to be improved.
- biodiversity models at the regional and national level are lagging behind, mainly because available biodiversity models, such as the UNEP-WCMC GLOBIO model, and FAO's IMPACT model for food and crops, are too coarse. It was suggested that collaborations should be developed between climate change and

biodiversity modellers to soft-link the models. It was also noted that, for sea level rise, fine resolution may not be necessary since the wider global model is applicable to the Caribbean.

4.4.2 Working Group 2: Impacts of climate change on marine and coastal biodiversity

Dr Rahanna Juman presented a summary of the findings of this group (see Appendix 7 for presentation and http://www.canari.org/macarthurclimatechange.html for full report).

Gaps were identified in and recommendations made in ten key areas as noted in the table below.

Area	Gaps	Recommendations
1 Long-term monitoring of changes in coastal and marine ecosystems	o Large variation from island to island in existence of data relating to spatial extent of ecosystems, inventories of flora and fauna, and monitoring of ecosystem changes o Accessibility of data o Analysis of results	o Compile and analyze existing data and prepare a regional baseline against which future changes can be compared o Establish an effective data management and data sharing mechanisms
2 Connectivity between systems in the insular Caribbean	o Connectivity and interrelationships between species and systems in the Caribbean large marine ecosystem o Recruitment and retention of coral larvae	o Research to better understand interrelationships in the Caribbean large marine ecosystem o Predictive models on how climate change will affect key species, and predator/prey relationships o Analyze potential changes in environmental services and economic benefits
3. Circulation changes in the Caribbean Sea & adjacent water bodies	o How temperature change will affect water circulation in the Caribbean Sea and adjacent water bodies, sites of upwellingand downwelling, and marine flora and fauna	o Predictive models to show horizontal and vertical water movements likely to result from climate change and their effects on dispersal, productivity, migration and habitats of marine flora and fauna
4. Sea level and sea surface temperature data	o Accurate sea level change data o Sea surface temperature data	o Establish a representative network of tide gauge stations o Establish an effective temperature data collection system including nearshore waters
5. Ocean acidification	o Calcification response to increased CO2 in key species	o Select key species and conduct research into calcification rates,

	o Changes in calcification rates o Mechanisms of calcification o Diurnal and seasonal cycles of the carbonate system	responses and mechanisms o Establish baseline and long-term monitoring of pH and calcification rates on corals
6.Diseases and invasive species	o Coral diseases and how they respond to temperature changes o Diseases affecting Caribbean marine mammals and turtles o Distribution and abundance of marine invasive species o	o Develop a database of diseases affecting marine species and determine their present and future trends o Prepare a database of marine invasive species o Select key diseases for further research in relation to climate change
7. Algal blooms and plankton	o Current trends in algal blooms and plankton distribution, and how these are impacted by changes in climatic parameters o	o Baseline survey and long term monitoring of algal blooms and plankton distribution patterns in the region and the effects of changes in climatic indicators
8. Remediation techniques and ecosystem resilience	o Incomplete knowledge on ecosystem remediation techniques suitable for national and regional situations and their efficacy o	o Compile information on ecosystem remediation techniques o Involve the wider community in monitoring selected sites and implementing measures that strengthen the resilience of the ecosystem to change
• 9. Biological research and assessments	o Information on basic biology, behaviour, distribution, abundance, migration and habitats of smaller odontocetes, seabirds and waterfowl, in particular o	o Determination of biology, status assessments, life histories and impacts of climate change on selected species
10. Species responses to changes in temperature •	• Uncertainties about future fish stocks, including spawning times, in the light of climate change	o Select key species for detailed research on tolerance levels and increased temperatures

Key messages emerging from the presentation and subsequent discussion were the need to:

- increase the quantity of and access to relevant data and clarify inconsistent data, particularly for the smaller islands. It was noted by CCCCC that the Caribbean Coastal Marine Productivity Programme (CARICOMP) had been established for

some time but many smaller islands had stopped monitoring, so data is mainly from the larger islands.

- enhance collaboration with communities for monitoring and data collection and implementation of measures to strengthen the resilience of the system to climate change. It was noted by CCCCC that, under the Caribbean Planning for Adaptation to Climate Change (CPACC) project, local people had been trained to monitor sea level but this had not worked as a result of equipment failure. The programme was being re-introduced, using a new approach whereby CIMH would take responsibility for the maintenance work in countries that do not have the capacity. Equipment has been bought and sent to countries. The potential exists to monitor additional parameters in future, such as ocean acidification;

Other key points noted during the discussion were the need:

- to analyse the effects of climate change on existing Marine Protected Areas (MPAs) and then review and revise their strategies to become sustainable in the face of climate change. It was noted, however, that relatively few Caribbean MPAs are deemed effective in achieving their current objectives so further analysis is needed to determine the factors that have led to successes, such as those in Saint Lucia and Belize. There is also a need to analyse the contribution that MPAs make to livelihoods and how these could be enhanced.
- for more research on the impacts of climate change on fisheries, which should be facilitated by the fact that fisheries is generally a data-rich sector. It was suggested that it should be easy to correlate FAO fisheries data sets and those in University of British Columbia (UBC) *Seas Around Us* project (see http://www.seaaroundus.org/) and fix any anomalies. UBC also has an Eco-Ocean model for all oceans and can now be queried; and
- to increase research that that links terrestrial and coastal ecosystems (the "ridge-to-reef" approach) with a view to increasing the resilience of ecosystems.

4.4.3 Working Group 3: Impacts of climate change on terrestrial biodiversity

Professor Avelino Suarez presented a summary of the findings of this group (see Appendix 8 for presentation and http://www.canari.org/macarthurclimatechange.html for full report).

Key points made were:

- o reliable data on the expected impacts of climate change on terrestrial biodiversity in Caribbean islands were scarce;
- o most islands have baseline data on their terrestrial biodiversity, such as species lists, vegetation formations and/or ecosystems. Mapping of such data is patchy, with little mapping of species distribution and only Cuba having a national map of vegetation fragmentation;
- o all the islands have declared protected areas but information on the degree of biodiversity protection, or coverage of biodiversity by the established protected areas, was not always available;
- o current management plans of protected areas do not take climate change into account; and

- the main plants and animals that are traditionally used by people have been identified in most countries. However, not all of the species used by people and the genetic resources *are* protected by law or are *in situ* collections and traditional knowledge has often not been recorded. Without action, there is a high risk that the resources and traditional knowledge will be lost, not only due climate change, but as a result of other socio-economic pressures.

Recommendations included:

- completion of species and vegetation databases, especially for taxonomic groups and vegetation that are sensitive to climate change. All new databases should be geo-referenced, including the altitude;
- geo-referencing existing databases;.
- completion of species and vegetation distribution maps at regional and national level;
- completion of habitat fragmentation maps for each island;
- habitat fragmentation assessment and modelling of future status under different climate change scenarios;
- vulnerability assessments (landscapes, ecosystems, habitats, species groups, and species).
- assessment at the regional and national levels of the vulnerability of protected areas to climate change, in order to identify threats, and develop appropriate protected areas systems and adaptation plans.
- completion of the information on traditional knowledge of biodiversity, including agro-biodiversity that is significant to local and indigenous peoples.

The following points were made during the subsequent discussion:

- there is a need for more speculation on the indirect effects of climate change on biodiversity, for example, as a result of increasing frequency of forest fires;
- the need to explore and build on the critical linkages between biodiversity, livelihoods and climate change mitigation and adaptation planning;
- neither climate variability nor climate change is currently included in planning and management of biodiversity. It could be useful to gather information on past events that were perceived as extreme (e.g. hurricanes, drought) and analyse the impacts on biodiversity

4.5 Research agenda and capacity needs assessment.

Dr Owen Day noted then presented a synthesis of reviewers' comments on the working group reports, and a summary of the research and capacity needs identified in the three working groups (see Appendices 9 and 10).

4.5.1 Synthesis of reviewers comments on the three working group reports

Only seven people had provided written feedback on the reports. Some additional materials had been identified and the following highlighted:

- the importance of economic valuation;
- concern that mapping oceanic currents could be duplicating US work;

- the recommendation that corals should be treated as a special case because they are especially vulnerable to temperature change;
- identification of a similar review exercise being carried out in Puerto Rico

4.5.2 Research agenda

Nine main research areas were identified for the **research agenda**, with sub-themes relating to each working group area (see Appendix 10):

i. Data management of existing data
ii. Data collection and monitoring
iii. Maps, trends, connectivity and monitoring
iv. Vulnerability of specific species and ecosystems
v. Remediation techniques and resilience management
vi. Protected Area management
vii. Integrated Coastal Zone Management
viii. Community awareness and involvement
ix. Social Science, policy and economics, including the need for more multi disciplinary research

4.5.3 Criteria for prioritising research agenda

It was suggested that the following might be used as the criteria for identifying the **research priorities:**

A. Is the research likely to lead to tangible benefits in environmental management?
B. Does the research promote a "win-win" approach (i.e. useful with or without climate change)?
C. Is the cost of the research in keeping with the likely environmental and socio-economic benefits?
D. Is the timescale of research-to-implementation in keeping with the urgency of the specific issue?
E. Is the research already being done by other groups from outside the Caribbean?
F. Does it use an ecosystem-based approach?
G. Does the research meet the needs of policy-makers?

It was agreed that the highest priority should be accorded to G (needs of policy-makers) with A (tangible benefits) and D (timescale) also being accorded a high weighting.

4.5.4 Capacity needs

Capacity needs fell into two main categories: human capacity and technical capacity (see Appendices 9 and 10). In terms of human capacity, it was noted that the small populations in SIDS face mean that few countries can develop expertise in all relevant areas so there is a need to develop regional centres of excellence with resources being pooled and shared. This would necessitate a fundamental shift in mindset in terms of sharing of data between institutions as well as greater focus on translating scientific findings into information that is understandable to the wide range of target audiences who need to be engaged in climate change mitigation and adaptation, from politicians and policy-makers to formal and informal natural resource managers, vulnerable communities and the wider public.

4.5.5 *<u>Review of research conceptual framework and discussion of findings to date and research agenda.</u>*

John Agard outlined for participants the conceptual framework (see Figure 1 and Appendix 15).agreed upon by the Steering Committee..

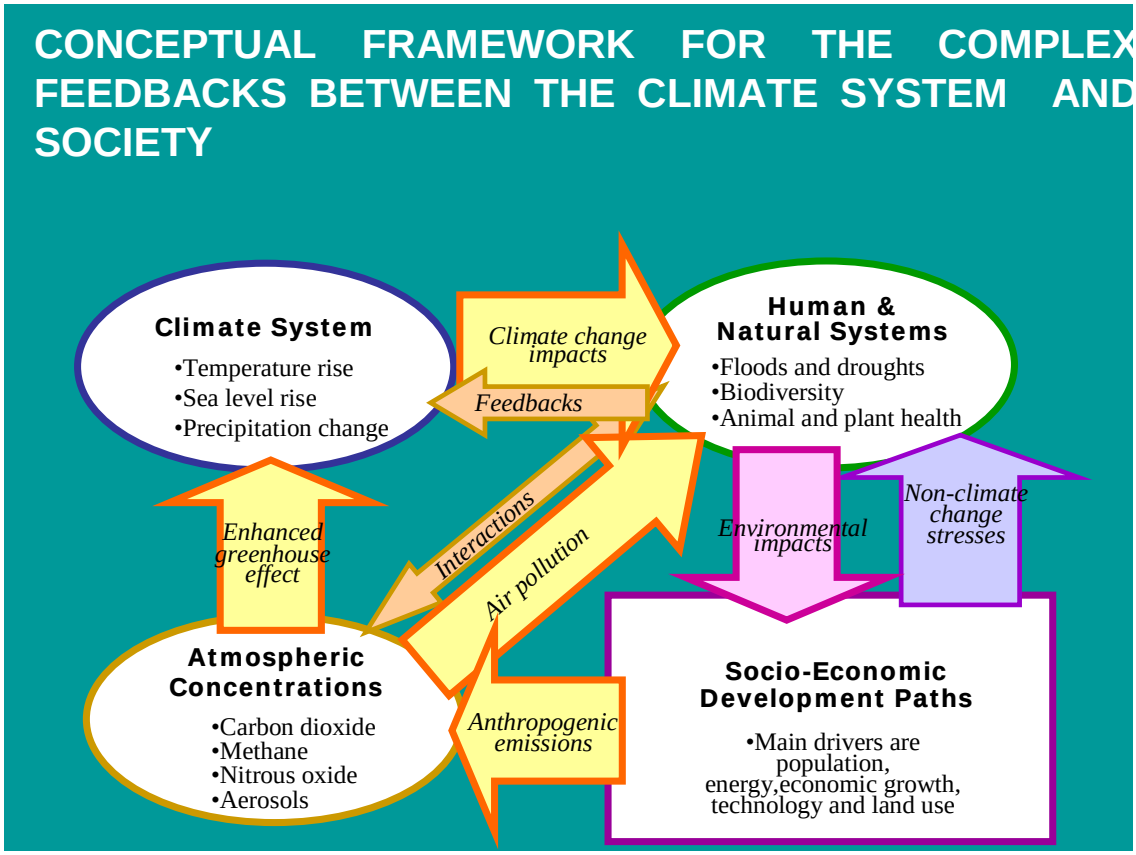


Figure 1

This drew heavily on the conceptual framework for the IPCC and the Millennium Ecosystem Assessement which identified both direct and indirect drivers of change and reviewed ecosystem services in terms of their contribution to human well-being (e.g. the basic material for a good life, health, good social relations, security and freedom of choice and action) and poverty reduction. He noted that the main gaps in the work done under the project to date related to the ***feedback*** and **interactions** elements.

Key points made during the discussion included:

- the potential of both penalties and incentives to influence human behaviour. For levels of and the perception of the need for recycling in northern countries has been influenced by a combination of initial peer pressure from a committed minority and, increasingly, government programmes that provide recycling facilities and sanction those who do not comply;
- the need for communication products targeted to specific objectives and target audiences;
- the need for more multi-disciplinary research on and multi-sectoral approaches to adaptation strategies;

- the need for academics within the region to publish in peer review journals as much of the material currently being published is by outside researchers and of a low quality. Graduate students should be encouraged to publish in time for the Fifth IPCC Assessment, since this only considers peer-reviewed material.

4.5.6 Identifying the priorities for the next three years in terms of research and capacity building

Participants were divided into three groups to discuss and agree on the main priorities for research and other action in the areas of:

i. Climate change models and scenarios
ii. Impacts of climate change on biodiversity
iii. Effective communication of research findings to support mitigation and adaptation

The conclusions of Groups i and ii are outlined in Appendices 11-13 and summarised in the first two tables below:

Key research priorities 2009-2011	
1. TRENDS AND SCENARIOS	
Research area	Detail
1. Enabling activity for research:	• **Data rescue** with CIHM as main repository, going to countries to photograph rather than moving data
2. Monitoring biodiversity-related variables.	• Creation of **regional network of climate data** relevant to understanding biodiversity vulnerability to climate change • **Consultation with biodiversity specialists** about the type of data needed
3. Analysis of model runs	• **Data analysis** of all PRECIS runs, • Massive **data storage** and support for graduate students • Explore possibility of establishing **nodes for storage** in region through the clearing house at CCCCC.
4. Reducing uncertainties in statistical downscaling (SDS)	• PhD project to obtain averages of outputs from 21 IPCC global climate models in format suitable for statistical downscaling for any island in the Caribbean, focusing on rainfall, streamflows and temperature initially
5. Caribbean climate atlas	• Production by Climate Studies Group Mona of GIS-based atlas showing climatology, variability and scenarios
6. Climate and biodiversity - correlation studies	• Impacts of climate variability/extremes on fisheries • Impact of climate extremes in drought on forest fires.
7. Simulating reforestation of Haiti	• Multi-disciplinary project using regional climate models to simulate what would happen in terms of impacts on human well-being and climate if Haiti were reforested. • Development of reforestation and land • use plans which would generate carbon credits and improve human well-being
8. Coupling climate and biodiversity models	• Soft linking of climate change and biodiversity models at regional level

Key research priorities 2009-2011	
2. TERRESTRIAL, COASTAL AND MARINE BIODIVERSITY	
Research area	Objective
1. Compilation of existing data to produce and complete species/ vegetation/habitat maps	• Provide baseline for future research
2. 2. Identification of species/habitat/ natural ecosystems/ agro-ecosystems that are sensitive to climate change impacts as well as species/habitat/ ecosystems that are resilient to impacts of climate change	• Provide indicators • Improve resilience
3. Vulnerability analysis of both terrestrial and marine specific (indicator) species/natural ecosystems/agro-ecosystems as well as of ecosystem assemblages linked to key sustainable economic activities	• Provide indicators • Link to human well-being
4. Development of inventories and of comprehensive monitoring systems for the surveillance of the impact of CC on biodiversity	• Tool for early warning and adaptive management
5. Vulnerability assessment of protected areas and recommendations for adaptation and remediation.	• Guarantee long-term viability of conservation and sustainability of the use of the resources.
6. Research and monitoring on the impacts of CC in the coastal zone	• Development of appropriate co-management tools as a basis for the implementation of ICZM initiatives.
7. Modelling of the impacts of different CC scenarios on biodiversity and associated ecosystem services.	• To propose appropriate adaptation strategies

It was agreed that these broad suggestions should be further refined into project activities, including focusing on

- not just documenting vulnerability but also on how to build resilience;
- multi-disciplinary research needs to be clearer;

Other research ideas proposed were:

- complementary research in the area of Protected Areas (PAs) on a) why so few are currently achieving their objectives and what distinguishes those that are; and b) what are effective alternatives to PAs where these may not be feasible/desirable;
- remediation projects, for example, using heat-resistant coral species resistant to climate change;

- incorporation of relevant elements of a research agenda developed under an earlier CANARI project entitled *Institutional arrangements for coastal management in the Caribbean: A preliminary research agenda (*see Appendix 12)

Group iii: Communications research
The group identified systematic and effective communication about climate change as a gap in the region, with no organisation clearly taking a lead in coordinating this. It was also felt that much of the current communication effort was 'preaching to the choir' so there was a need to widen the scope and type of communications.

The group started the exercise by segmenting its discussion on communications into five areas of focus as follows:

a) Objectives

The group identified the following as the main objectives of communications about climate change:

- to provide information to and build the awareness of all Caribbean people about climate change;
- to 'democratize' science by 'translating' scientific knowledge into a form that is accessible to non-technical audiences;
- to effect behaviour and attitudinal change;
- to empower people to become campaigners and advocates;
- to increase the capacity of key climate change interlocutors to deliver messages effectively to their target audiences.

b) Research agenda

The main focus of the research agenda would be to:

- test and evaluate a range of communication approaches in terms of their effectiveness in modifying behaviour and attitudes;
- analyse how to increase the Caribbean's voice and influence on the international stage (adaptation and mitigation discourse).

The steps involved in fleshing out a research agenda and research projects would be:

1. to identify what data exists and where;
2. to analyse baseline behaviours and attitudes;
3. to develop and test a range of communication and advocacy tools;
4. to evaluate what worked and why; and
5. to disseminate information about what worked.

Specific research questions suggested were:

- How can Caribbean countries collaborate and effectively apply pressure to first world countries to cut back on emissions and commit to greater mitigation efforts?

- How can tourists be sensitised so that they become advocates for changes in their countries?
- How can communication efforts stimulate collaboration between different organisations and sectors in implementing mitigation and adaptation strategies?

c) Target audiences

- Policy makers (technocrats and the political directorate)
- Individuals, with a particular focus on young people, whose future is most at stake
- Communities, with particular focus on those in vulnerable areas
- Researchers
- CCCCC Focal points
- Private Sector
- Regional and international agencies
- Tourists
- Schools
- Media/journalists

d) Messages

The core messages to be communicated about climate change are:

- Getting the facts about climate change empowers you to act (adapt and mitigate)
    - where you can get information
    - what you can do to make a difference
- As a region, there is need for a stronger unified voice advocating for increased mitigation efforts.

Examples of messages to specific audiences were:

Policy makers:

- Climate change poses an immediate threat to the Caribbean and you have a responsibility now.
- There are 'no regrets adaptive strategies that will also achieve wider development goals.
- Collective action could help influence the world stage.

Private sector

- Adaptation offers opportunities to cut costs/save resources.
- Climate change can and should be mainstreamed into corporate social responsibility.

e) Channels of communication

It was agreed that to be effective, communications about climate change must stay on the cutting edge of technology and that marketing/advertising agencies could be approached to develop campaigns. Other suggestions included:

- the identification of champions, particularly those who would appeal to young people;
- use of participatory video

- use of theatre in education
- use of popular 'conscious' performance artists
- use of blogs, Youtube and websites such as Climate Ark

The group's presentation stimulated a lively discussion in which the following points were made:

- participants experience indicated that messages to policy makes about ***mitigation*** should highlight national/regional 'responsibility' and the potential for mitigation to reduce costs (as against adaptation) and save lives;
- CCCCC developed a ***Public Education and Outreach*** (PEO) ***Strategy*** in 2004 which identified several target audiences and messages. This was presented to and accepted by COTED but the next step of developing of national strategies has not happened. CCCCC is now talking to CANARI as a possible vehicle to get messages out;
- ***new approaches to the design and implementation of communication strategies*** are needed, for example by engaging agencies that are used to developing advertising campaigns, using modern technology (web, cable) and greater use of visuals, particularly for young people and students..
- the 2009 Summit of the Americas and Commonwealth Heads of Government meetings in Trinidad provide an opportunity for the ***Caribbean to speak with a united voice on climate change issues.***

4.6 Project communication strategy.

Sarah McIntosh presented the proposed communication strategy for disseminating the findings of the project (see Appendix 14), with the major products being:

i. The three Working group reports
ii. Strategic research agenda
iii. Capacity needs assessment
iv. Summary of findings of the 3 working group reports (approx 25 pages)
v. Policy brief (2-4 pages)

All products would be available electronically in English and items iv and iv would be translated into Spanish and French. All products should be available by the end of 2008 and would be disseminated via CANARI and partner website, list servs and on CD. The summary and policy brief would also be available in hard copy, primarily for distribution to libraries at at conferences and meetings.

It was agreed that CANARI should seek to create a buzz around these publications, by involving members of the steering committee in media interviews and activities.

4.7 Next steps

- The Working group reports will be reviewed and finalised, incorporating and relevant comments received.
- The research agenda would be framed within the framework of the CBD COP 2010 commitment (+SPAW/CITES/Cartagena/UNFCC). It was suggested that this might include a list of the obligations that countries have made commitments to.

- The reports and the research agenda should be considered living documents, with potential for ongoing input of comments;
- Participants with a particular interest in a research agenda item would flesh out the ideas into 2 page concept notes;
- Participants will share project findings at relevant meetings and in initiatives in which they are involved

4.7.1 Areas of interest by participant/participant organisation

Participants then outlined their particular individual/organisational areas of interest in terms of current and future work on climate change:

Owen Day, Buccoo Reef Trust (BRT):
Increasing the effectiveness of marine protected areas in Tobago. Involved in a 1-year project at Speyside, which is earmarked to become a marine park, involving community-based monitoring activity and mapping. BRT is also co-implementing with ICRAN a project to strengthen coral reef management, monitoring, outreach and education programmes in the region, through a grant from the UN Foundation.

LaVerne Ragster, University of the Virgin Islands: will share the project findings at two meetings taking place in the near future – Alliance of Small Island States and UNICA (network of European Universities, at which she will emphasis the need for greater collaboration between the European Overseas Territories and the rest of the region on research and adaptation.

Nicole Brown, independent consultant: is part of the Green Park Consulting team which is involved in facilitating the design of the new IUCN Caribbean programme, due to be launched at the World Conservation Congress in October. As currently conceptualised, this includes a programme of activities on ecosystems, livelihoods, resilience and adaptation as well as a programme on renewable energy.

Rahanna Juman, Institute of Marine Affairs (IMA): the IMA is in transition due to its recent incorporation into University of Trinidad and Tobago but retains an interest in the research agenda identified by WG1.

Anthony Chen and Michael Taylor, Climate Studies Group Mona (CSGM):
strong interest in WG1 research and related communication strategies.

Judy Gobin, Faculty of Agriculture and Natural Sciences UWI St Augustine
anticipated that she would play a role in collaboration with IMA and other UWI departments.

Maurice Anselme, UNEP SPAW RAC: although there is nothing specific on climate change in the SPAW protocol, there is a focus on marine protected areas and there are areas of the work plan where climate change could be included. He could also act as a liaison point with the French-speaking islands.

Sheldon MacDonald, Association of Caribbean States (ACS): again, climate change features strongly in discussion but is not currently formally in the work plan.

There are a few aspects of the project findings that could be incorporated in or disseminated through ACS activities, e.g. its membership of the Caribbean Sea Commission and through the Ministerial Council which next meets in January 2009. He also noted that the ACS has a category called 'social actors' which includes NGOs etc who can then be involved in ACS work. He could request information on how this is done and seek to streamline the relationship with CANARI and others via MOUs etc.

Jose Gerhartz, WWF Cuba: since the hurricanes this year, WWF is reanalysing its conservation strategy – both physical and operational – not just in Cuba but in the Greater Antilles generally. There is potential for WWF to an play important role in implementing several of the proposed projects. In Cuba it is now involved in a very wide effort to geo-reference and digitise species level data and produce a preliminary geo-referenced database. Cuba is also developing a new MPA system plan for next 5 years which should include consideration of the potential impacts of climate change. WWF can also help to reinforce ties between Cuba and other partners in the region.

Michelle Mycoo, Department of Surveying and Land Information, UWI St Augustine: incorporation of climate change in curriculum development (e.g. planning in coastal zone). Also in developing and testing communication products and continuing the linkages made through the CCBIC project..

Judith Turbyne, Christian Aid, Jamaica: Christian Aid is not an implementing agency but supports others so they may be potential to support communication and public education, perhaps focusing on something that would otherwise be difficult to fund.

Avelino Suarez, Institute of Ecology and Systematics, Cuban Environmental Agency: at the agency responsible biodiversity in Cuba, including a climate change interest, there is potential to implement some of the research projects. Welcomes opportunities for regional collaboration but this is not always easy. The Cuban government policy is to integrate climate change into its sectoral policies, with a particular interest in integration of social aspect, e.g. agrobiodiversity etc. The Institute can integrate also integrate the project findings into its programmes and disseminate them to key people in government, and into the second national communication under UNFCC.

David Dodman, IIED UK: since the follow-up steps need to be owned by the region, IIED is necessarily a step removed but would be interested in collaboration and could has expertise in the following areas which could potentially Caribbean projects:

- expertise in forest conservation and livelihoods;
- experience of influencing policy at the global level and training negotiators; and
- communications..

Saudia Rahat, CDERA: CDERA can play a key role in information dissemination. CDERA has a CDM governance mechanism with 6 sector groupings, including education, agriculture and tourism. These include international and local donors, who might be interested in funding research.

Judi Clarke, independent consultant: interested in assisting with the refining of a communication strategy and dissemination of project findings.

Leslie Simpson, CARDI: CARDI has 12 units in the Caribbean and can therefore act as a strategic partner. It wants to create a network of countries storing germoplasm to reduce the vulnerability of any single country. Particularly interested in agro-biodiversity research.

Adrian Trotman, CIHM: CIHM is interested in modelling and particularly biodiversity modelling. The Institute has a hydrologist who is interested in modelling water flow for watersheds. Also establishing a drought monitoring network involving people in different disciplines – e.g. foresters, ecosystem specialists.

Neville Trotz, CCCCC: primary role would be to work with CIMH and CSGM on the identified enabling activities. CCCCC is also in the process of establishing a clearing centre and is at the disposal of projects like CCBIC to facilitate networking, communications etc**.**

Sarah McIntosh, CANARI: CANARI's immediate interest is in the area of communications research and designing and implementing communication strategies to influence policy and practice.

John Agard concluded by noting that the immediate next step would be to circulate the meeting report and associated documents. Participants were also encouraged to develop concept notes to address the research agenda.

APPENDIX 1: Project concept note

CARIBBEAN NATURAL RESOURCES INSTITUTE
CANARI
Fernandes Industrial Centre • Administration Building • Eastern Main Rd. • Laventille • Trinidad W.I.
Tel: (868) 626 6062 • Fax: (868) 626 1788 • Email: info@canari.org • Website: www.canari.org

Climate Change and Biodiversity in the Insular Caribbean

1. Background

Recognizing that global warming is occurring and threatens biodiversity conservation, the John D. and Catherine T. MacArthur Foundation is investing US$5 million over three years to identify and mitigate the threat from global climate change on species in the most diverse ecosystems of the planet.

One of the projects which the Foundation is supporting is being implemented by the Caribbean Natural Resources Institute (CANARI) in the islands of the Caribbean. This two-year project focuses on increasing understanding and consensus on what is known, and perhaps more importantly what is not known, about the predicted climate change trends and their impact on biodiversity in Caribbean small island developing states (SIDS). The aim is to develop a regional research agenda and capacity needs assessment to address identified gaps and to consider how protected area management, biodiversity protection, and conservation policy can best address climate change in the region.

CANARI is also building on this project to develop a programme of activities designed to raise the awareness of Caribbean civil society about climate change and to build the capacity of civil society organisations to play a role in adaptation planning. Once the initial working group reports have been finalised, CANARI intends to explore ways in which this information about the predicted impacts of climate change in the region can be more effectively integrated into development planning and in particular the formulation of national and regional poverty reduction strategies.

2. Project Context

This project comes at a critical time as evidence mounts that dire predictions about climate change are becoming a reality. The impacts of climate change on the ecological systems of Caribbean SIDS are likely to be particularly severe in terms of sea level rise, higher mean temperatures, and changes in rainfall and weather patterns. This has important implications for national and regional socio-economic development strategies, although this is rarely reflected in policy. The livelihoods of Caribbean people, and particularly the rural poor, are closely linked with natural resources, through economic activities such as tourism, craft and agriculture and in terms of their traditional social and cultural value. Additionally, in most islands, the major cities and villages are located in the coastal areas most vulnerable to the effects of climate change.

Research is being conducted by the Caribbean Community Climate Change Centre (CCCCC), the University of the West Indies (UWI), the Caribbean Epidemiological Centre (CAREC) and other institutions in the region to assess the impacts of climate change on the region's resources. This project complements these initiatives and offers a unique opportunity to bring together regional experts to develop a systematic and comprehensive assessment of current research and the implications for Caribbean SIDS.

APPENDIX 1: Project concept note

3. Project Methodology

The project is being guided by a multidisciplinary Steering Committee, coordinated by CANARI and chaired by Professor John Agard, Department of Life Sciences, University of the West Indies, St Augustine Campus and member of the Intergovernmental Panel on Climate Change (IPCC). Other members include climatologists, biodiversity experts, and policy analysts from academia, civil society, government agencies throughout the Caribbean as well as representatives of the inter-governmental institutions and international organisations.

Three working groups have been formed to undertake the assessment of the state of knowledge on the expected impacts of global climate change on Caribbean biodiversity. They are also tasked with identifying gaps and suggesting what research is needed to fill those gaps. Each working group is focusing on a distinct area: coastal and marine biodiversity; terrestrial biodiversity;and the development of climate change scenarios and models.

The working group reports were reviewed at the second meeting of the Steering Committee in January 2008, then finalised and have been circulated to a wide range of stakeholders for comment. Only 7 sets of comments have been received to date but those have provided some useful additional information, which will be included in the final versions of the reports which are due to be completed by 30 November 2008. The working group reports and the comments template are available at http://www.canari.org/macarthurclimatechange.html.

A regional conference was held on 24-25 September 2008, followed by the 3rd Steering Committee meeting, to develop a regional research agenda and discuss the implications for policy. The conference developed an outline communication strategy for distilling and disseminating the project findings to a range of different target audiences, which will include a 25-30 page summary of the main findings of the working group reports.and an 2-4 page policy brief. Both documents will be translated into Spanish and French and circulated widely in electronic format, with hard copies being made available for libraries, workshops and conferences.

4. Outputs

a) A 25-30 page synthesis of the reports from the three working groups
   i. summarising the state of knowledge in relation to:
   - the expected impacts of global climate change on Caribbean on coastal and marine biodiversity (Working Group 1);
   - the development of climate change scenarios and models to underpin the identification and assessment of the expected impacts of global climate change on Caribbean biodiversity (Working Group 2);
   - the expected impacts of global climate change on Caribbean terrestrial biodiversity (Working Group 3).

   ii. identifying key research needs based on the identification of gaps by the Working Groups;
   iii. the development of a Caribbean research agenda to address the identified research needs;
   iv. a review of the capacity building needs required to support the implementation of the proposed research agenda;

b) report of regional conference;

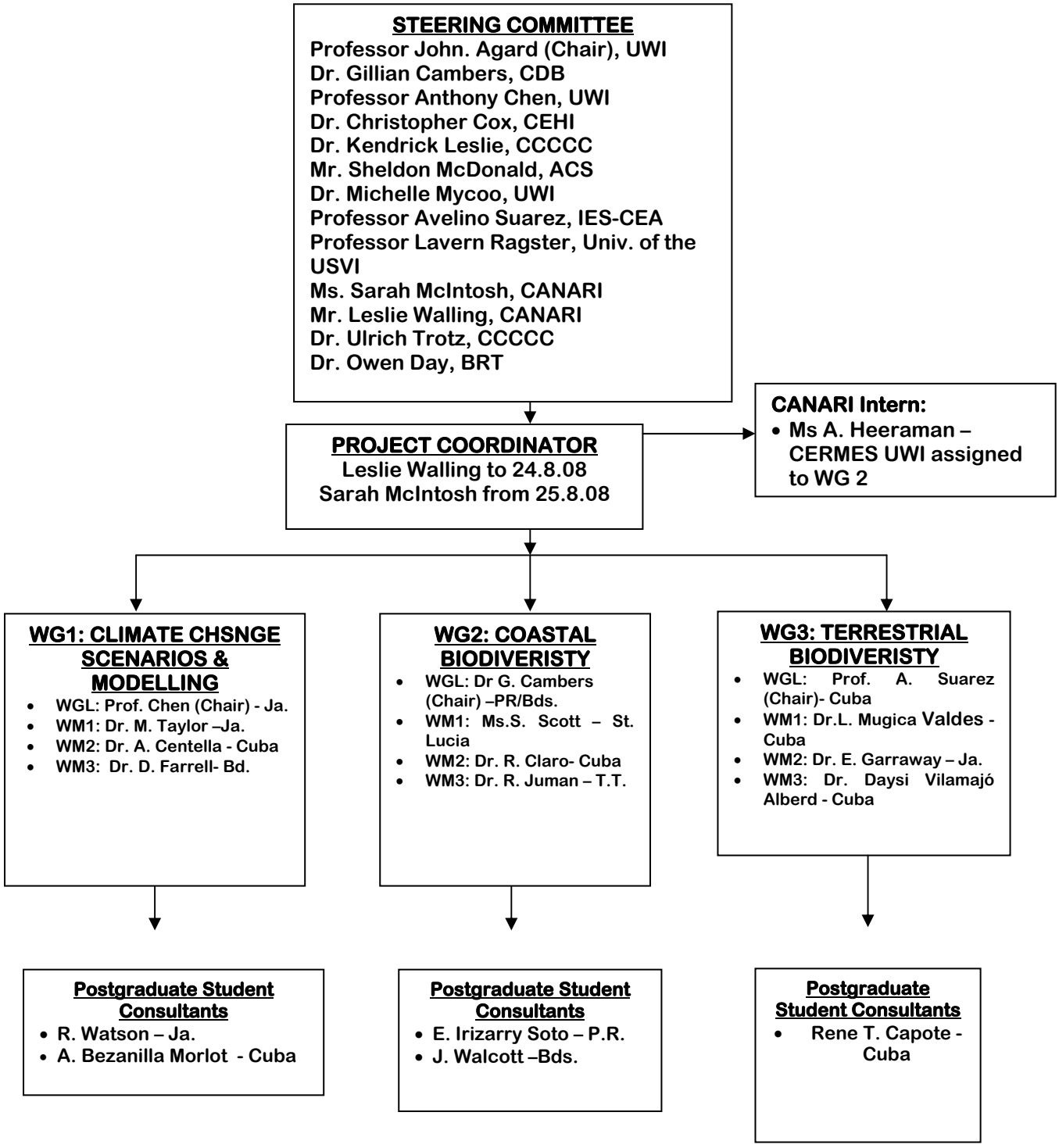
c) policy brief;

d) identification of next steps to integrate the project findings into the wider policy agenda.

5. Outcome

Greater collaboration between researchers and improved coordination of research and policy efforts focused on addressing the threats that climate change poses to biodiversity in Caribbean SIDS.

PROJECT COORDINATION



APPENDIX 1: Project concept note

Country Abbreviations
Bd.: Barbados
Ja.: Jamaica
P.R.: Puerto Rico
TT: Trinidad and Tobago

Project Abbreviations
WG: Working Group
WGL: Working Group Leader
WGM: Working Group Member

Institutional Abbreviations
ACS: Association of Caribbean States
BRT: Buccoo Reef Trust
CCCCC: Caribbean Community Climate Change Centre
CDB: Caribbean Development Bank
CEHI: Caribbean Environmental Health Institute
CERMES: Centre for Resource Management and Environmental Studies
IES-CEA: Institute of Ecology and Systematic, Cuban Environmental Agency Agencia de Medio Ambiente Cuba
USVI: United States Virgin Islands
UWI: University of the West Indies

APPENDIX 2: Meeting agenda

CLIMATE CHANGE AND BIODIVERSITY:
RESEARCH FOR A SUSTAINABLE TOMORROW

September 24th and 25th 2008, Trinidad and Tobago.
Normandie Hotel, St. Ann's, Port of Spain

Conference objectives:

- To present the findings of the Climate Change and Biodiversity in the Caribbean (CCBIC) project to key regional stakeholders;
- To develop a regional research agenda on climate change and biodiversity in the islands of the Caribbean.
- To identify the research priorities for the next three years.
- To identify the capacities that need to be built or enhanced in order to implement the research agenda.
- To develop a communication strategy for disseminating the findings of the CCBIC project
- To build participants' support for and buy-in to the regional research agenda and capacity building strategy and to discuss potential roles, partnerships and networks.

Conference inputs

- Reports from the three CCBIC Working Groups:
    I. Climate change models and scenarios
    II. Climate impacts on coastal and marine biodiversity
    III. Climate impacts on terrestrial biodiversity
- Synthesis of reviewers' comments on the working group reports
- Draft research agenda
- Draft communication strategy

Conference outputs:

- Regional research agenda
- Capacity building strategy
- Communication strategy

APPENDIX 2: Meeting agenda
CONFERENCE AGENDA

Wednesday September 24th 2008

Chair: Professor John Agard, Life Sciences, University of the West Indies, St Augustine campus

Time	**Activity**	***Facilitators/chairs*** *(provisional)*
8.30-9.00 a.m.	**Registration**	*Kwesi Dennis*
9.00 – 10.30 a.m.	**Welcome, introductions and conference overview**	
5 mins	o Welcome	*John Agard*
70 mins	o Participant introductions *(name, organisation, area of interest/current research)*	*Sarah McIntosh*
15 mins	o Overview of conference agenda and objectives	*John Agard*
10.30-11.00 a.m.	**Break**	
11.00-11.15 a.m.	**Global overview of the MacArthur Foundation climate change impact assessments**	*Sarah McIntosh*
11.15-11.30 a.m.	**Overview of CCBIC activities to date**	*Sarah McIntosh*
11.30 a.m.-1.00 p.m.	**Presentations of the Working Group (WG) findings**	
30 mins each incl. period for clarifications	o WG I: Climate change models and scenarios	*Anthony Chen*
	o WGII: Coastal and marine	*Rahanna Juman*
	o WGIII: Terrestrial	*Avelino Suarez*
1.00-2.00 p.m.	**Lunch**	
2.00-2.2.45 p.m.	**Synthesis of reviewers' comments, draft research agenda and capacity needs assessment**	*Owen Day*
2.30 -3.30 p.m.	**Plenary discussion of research framework, findings to date and research agenda** (omissions, additions)	*John Agard (Chair)*
3.30-4.00 p.m.	**Identifying the priorities for the next 3 years in terms of research and capacity building** (small group work):	*Group facilitators (to be selected)*
	o Group 1:: Climate change models and scenarios	
	o Group 2: Coastal and marine	
	o Group 3: Terrestrial	
	o Group 4: Effective communication of research findings to support mitigation and adaptation	
	Presentation and discussion of group reports	*John Agard (Chair)*
4.00-4.30 p.m.	Group 1 report	
4.30-5.00 p.m.	Group 2 report	
	FREE TIME	
6.00-7.30 p.m.	Cocktail *with additional invitees from Trinidad and Tobago*	

APPENDIX 2: Meeting agenda

Thursday September 25th 2008

Chair: Professor John Agard, Life Sciences, University of the West Indies, St Augustine campus

8.30-9.00 a.m.	**Presentation and discussion of group reports (cont.)**	*John Agard (Chair)*
8.30-9.00 a.m.	Group 3 report	
9.00-9.30 a.m.	Group 4 report	
9.30-10.15 a.m.	Synthesis and finalisation of research agenda and capacity building strategy *Discussion of implications for funding needs, research partnerships, who could deliver capacity building etc?*	
10.15-10.45 a.m.	**Break**	
10.45-11.30 a.m.	**Presentation, discussion and finalisation of communication strategy,** o *proposed products* o *identification of additional communication products needed beyond project timeframe/budget*	*Sarah McIntosh and Owen Day*
11.30 a.m.-12.15 pm.	**Next steps**	*John Agard chair*
	o Participants' organisations	*All*
	o CANARI/MacArthur Foundation	*Sarah McIntosh*
12.15-12.30 p.m.	**Wrap up and final remarks**	*John Agard*
12.30-1.30 p.m.	**Lunch**	

APPENDIX 3: Participant list

Name	Organisation	Address	Country	Telephone	Fax	E-mail
Professor John Agard	Department of Life Sciences, Faculty of Science and Agriculture	University of the West Indies, St. Augustine	TRINIDAD AND TOBAGO	868 662 2002 Ext 2047	868 663 5241	johnagard@yahoo.com
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Ms. Nicole Brown	Associate	28 Par Drive, Kingston 8	JAMAICA	876 925 3371/978 1618		nabrown@btinternet.com
Professor Anthony Chen	Department of Physics	University of the West Indies,Mona Campus	JAMAICA	876 927 2480	876 977 1595	Anthony.chen@uwimona.edu.jm
Dr. Arlington Chesney	Caribbean Agricultural Research and Development Institute	University of the West Indies, St Augustine	TRINIDAD AND TOBAGO	1 868 645 1205/7		executive@cardi.org
Ms. Judi Clarke	Independent Consultant	# 3 Fairway Villas, Steeplechase Drive, Dairy Meadows, St James	BARBADOS	246 432 6744 or 246 266 9604 (C)	246 432 6744	clarkejudi@yahoo.com
Dr. Owen Day	Director, Buccoo Reef Trust	Broadwindsor, BeaminsterDorset, DT8 3QP	UNITED KINGDOM	011 44 1308 868690		o.day@buccooreef.org
Mr. Kwesi Dennis	CANARI	Fernandes Industrial Centre, Laventille	TRINIDAD AND TOBAGO	868 626 1062	868 626 1788	kwesi@canari.org
Dr. David Dodman	International Institute for Environment and Development	3 Endsleigh Street, London WC1H 0DD	UNITED KINGDOM	4420 7388 2117	4420 7388 2826	david.dodman@iied.org
Mr. Jose Gerhartz	WWF-Canada,	Museo Nacional de Historia Natural, 4to piso Obispo # 61. Plaza de Armas Habana Vieja.10100	CUBA	(53-7) 204 9016		jgerhartz@wwfcanada.org

APPENDIX 3: Participant list

Dr. Judith Gobin	Faculty of Agriculture and Natural Sciences	University of the West Indies, St Augustine	TRINIDAD AND TOBAGO	645-3232/9 Ext. 2046	663-9686	Judith.Gobin@sta.uwi.edu
Dr. Rahanna Juman	Institute of Marine Affairs	Hilltop Lane, Chaguaramas, P.O. Box 3160	TRINIDAD AND TOBAGO	868 634 4291	868 634 4433	rjuman@ima.gov.tt
Mr. Sheldon McDonald	Association of Caribbean States	5-7 Sweet Briar Road, St. Clair	TRINIDAD AND TOBAGO	868 622 9575	868 622 1653	smcdonald@acs-aec.org
Ms. Sarah Mc Intosh	CANARI	Fernandes Industrial Centre, Laventille	TRINIDAD AND TOBAGO	868 626 1062	868 626 1788	sarah@canari.org
Dr. Michelle Mycoo	Department of Surveying and Land Information	University of the West Indies-St. Augustine Campus	TRINIDAD AND TOBAGO	868 662 2002 Ext 2519	868 662 4414	mmycoo@eng.uwi.tt
Dr. Howard Nelson	Multilateral Environmental Unit Environmental Policy and Planning Division	Level 13, Eric Williams Finance Complex, Port-of-Spain	TRINIDAD AND TOBAGO	868 627 9700 ext 2075	868 623 8123	howard.nelson@phe.gov.tt
Ms. Saudia Rahat	Caribbean Disaster and Emergency Response Agency	Building #1Manor Lodge	BARBADOS	1 246 425 0386		saudia.rahat@cedera.org
Dr. Laverne Ragster	University of the Virgin Islands	2 John Brewers BaySt. Thomas	US VIRGIN ISLANDS VI00802-9990	340 693 1061	340 693 1005	lragster@uvi.edu
Ms. Leandra Sebastion	Caribbean Network for Integrated Rural Development	40 Eastern Main Road, St. Augustine	TRINIDAD AND TOBAGO	868 645 6448	868 645 5936	cnird@carib-link.net
Dr. Leslie Simpson	Caribbean Agricultural Research and Development Institute	University of the West Indies, Mona	JAMAICA	876 927 1231/0652	876 927 2099	leslieasimpson@hotmail.com
Prof. Avelino Suarez	Institute of Ecology and Systematics, Cuban Environmental Agency	Carr. Varona km 3 1/2, Capdevila, Boyeros. P.O. Bpx 8029 10800, Havanna	CUBA			avelino.suarez@ama.cu

APPENDIX 3: Participant list

Dr. Michael Taylor	Department of Physics	University of the West Indies, Mona	JAMAICA	876 935-8735		michael.taylor@uwimona.edu.jm
Mr. Adrian Trotman	Caribbean Institute of Meteorology and Hydrology	P.O. Box 130	BARBADOS	1 246 425 1362/3/5		atrotman@cimh.edu.bb
Dr. Ulric Trotz	Caribbean Community Climate Change Centre	Lawrence Nicholas Building, Bliss Parade 2nd Floor Belmopan, Cayo District	BELIZE	501 822 1094		utrotz@yahoo.com
Ms. Judith Turbyne	Christian Aid	14 South Avenue, Kingston 10	JAMAICA	876 754 8384	876 754 8384	Jturbyne@christian-aid.org

Caribbean Natural Resources Institute

Change and biodiversity: research for a sustainable tomorrow

Regional meeting
24-25 September 2008, Trinidad

Conservation & Sustainable Development (CSD) Grants

John D and Catherine T MacArthur Foundation Climate Change grant-making theme

- Identified as theme in 2002
- Launched in 2006 following consultation with policy-makers and scientists:
  - Focus on adaptation
  - R&D on adaptation strategies that would effectively conserve biodiversity that is already facing climate change pressures

Conservation & Sustainable Development (CSD) Grants

Components of climate change grant-making theme

1. Developing a new strand of grantmaking to adapt current biodiversity conservation efforts to climate change;
2. Reducing the production of greenhouse gases by slowing or stopping deforestation within CSD's focal areas

Conservation & Sustainable Development (CSD) Grants

Interim strategy 2006-2010

- Main focus on assessment of current knowledge about impacts, vulnerabilities and resilience;
- Subsidiary/supporting focus on exploring possible ways to address risks to biodiversity and piloting modest adapative strategies in CSD focal areas

Conservation & Sustainable Development (CSD) Grants

Interim strategy 2006-2010

- Phase 1: impact assessments in 8 CSD focal areas (phased 2006-2009):
  - Eastern Himalaya
  - Lower Mekong
  - Melanesia
  - Madagascar
  - Albertine Rift
  - Northern Andes
  - Southern Andes
  - Insular Caribbean

Conservation & Sustainable Development (CSD) Grants

Interim strategy 2006-2010

- Phase 2: Respond to recommendations of Phase 1 in three main areas:
  - Deepen and consolidate science of adaptation as it relates to biodiversity vulnerability and resilience
  - Develop and test new technologies, tools and interventions that directly assist adaptation work
  - Begin extensive effort to build individual adaptation practice and develop policy frameworks at local, national and global scale

CANARI

Conservation & Sustainable Development (CSD) Grants

Interim strategy 2006-2010

- Phase 3: Mainstream climate change adaptation into MacArthur's conservation work (*dependent outcomes Phase 1 and 2 and integrated into strategic planning process)*

CANARI

Conservation & Sustainable Development (CSD) Grants

Subsequent strategy from 2010

- Integration of Interim Strategy findings and outcomes into comprehensive planning process to define MacArthur conservation grant making after 2010 which might include:
  - shift in geographic priorities
  - Increased investment in areas that are especially resilient/qualify as "Noah's Parks"

CANARI

Conservation & Sustainable Development (CSD) Grants

Grant making activities to date

- 20 grants totally US $5.7 million
  - Mainly impact assessments
  - Modest grant making to address Phase 2 objectives

CANARI

Conservation & Sustainable Development (CSD) Grants

Regional impact assessments

- **Objective**: to broadly assess threats and vulnerability of biodiversity in specific focal areas
- Regional coordinators adopt most appropriate research protocol
- Comparative self-review of approaches (and findings to date) at IUCN Congress October 2008

CANARI

Conservation & Sustainable Development (CSD) Grants

IUCN Congress Meeting

1. Facilitate conversation among professionals engaged in climate change adaptation work to help them learn from each other, stimulate new ideas and galvanise collective action in the future

CANARI

Conservation & Sustainable Development (CSD) Grants

IUCN Congress Meeting

2. Develop projects from the vulnerability assessment stage to the adaptation implementation phase
3. Communicate with and catalyse the broader conservation community on the issue of climate change and adaptation

Caribbean Natural Resources Institute

Change and biodiversity: research for a sustainable tomorrow

Regional meeting
24-25 September 2008, Trinidad

CANARI

- An independent regional technical non-profit organisation registered in St Croix, Saint Lucia and Trinidad & Tobago;
- Operating in the region for over 20 years;
- Internal governance structure based on a Partnership between Board members (Elected Partners) and senior staff (Staff Partners);
- Capacity enhanced by the use of Associates

CANARI Mission

- To promote equitable participation and effective collaboration in managing the natural resources critical to development.

CANARI Mission

- CANARI seeks to achieve its mission through:
  - applied and action research on, and analysis, monitoring and evaluation of, innovative policies, institutions and approaches to participation and governance;
  - sharing and dissemination of lessons learned, including capacity building; and
  - fostering partnerships, particularly those that build on regional assets and talents and contribute to closer regional cooperation.

Climate change and biodiversity in the insular Caribbean (CCBIC)

- Response to RFP from MacArthur, reflecting long-standing working relationship between MacArthur and CANARI on regional projects;
- Addressed several programme areas and research questions identified in CANARI's strategic plan;
- Strong focus on process as well as outcomes building on an area of CANARI expertise;

Goal

To increase understanding and consensus on what is known, and perhaps more importantly what is not known, about the predicted climate change trends and their impact on biodiversity in the islands of the Caribbean with a view to developing **a research agenda and capacity needs assessment** in relation to how protected area management, biodiversity protection, and conservation policy might address climate change in the region.

Project approach

- Interdisciplinary multi-sectoral approach
- Wide geographic spread (i.e. all the Anglophone, Hispanophone and Francophone independent countries and dependent territories)
- Close partnership with WWF Canada for Cuba
- Primary language of project meetings and other communications English, but key outputs to be translated into Spanish and French.

Project outputs

- Three main reports on status of current research:
  - Trends and scenarios for climate change in the insular Caribbean;
  - Impacts of climate change on marine and coastal ecosystems;
  - Impacts of climate change on tropical forests and other terrestrial
- Report of regional workshop

Project outputs

- Summary(ies) of project findings in English and Spanish for different target audiences (e.g. researchers, donor community, sectoral policy-makers)
- A strategic research agenda
- A preliminary capacity needs assessment
- List of individuals and institutions within and outside of the region working in the field of climate change and biodiversity in the insular Caribbean

Longer-term CANARI objectives

- Identify areas of CANARI interest within the research agenda and capacity building strategy;
- Development of a communication strategy;
- Incorporation of climate change reports and other outputs in CANARI's communication research

Climate change work since inception of project

- Workshop on *Enhancing the Role of Civil Society in Raising Awareness and Building Capacity for Adaptation to Climate Change* (October 2007)
- Series of climate change materials for different target audiences in UK Overseas Territories (June 2008)

Climate change work since inception of project

- Development of proposal for implementing a comprehensive regional climate change public education and outreach (PEO) programme.
- Development of partnerships for implementation of PEO programme (e.g. Panos, Buccoo Reef Trust, JNCC, Commonwealth Foundation)

Working Group 1 Report
CLIMATE SCENARIOS FOR THE CARIBBEAN, NEEDS AND LIMITATIONS

Climate Change and Biodiversity Research For a Sustainable Tomorrow

Port of Spain, Trinidad
September 24-25, 2008

A. Anthony Chen
Climate Studies Group Mona
University of the West Indies, Mona

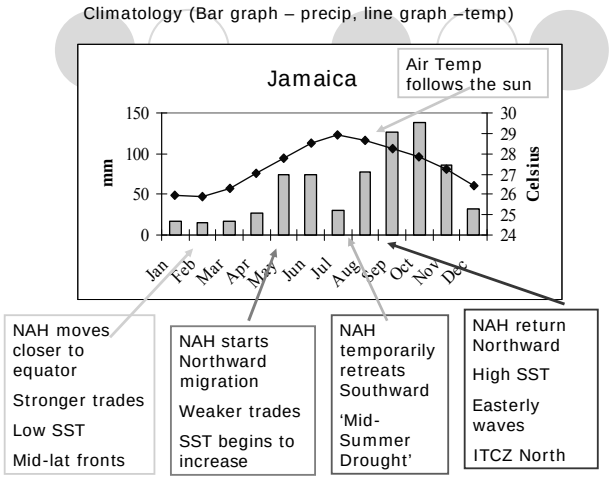
Members

- Dr. Abel Centella, Instituto de Meteorologia (INSMET),
- Prof. Anthony Chen, Climate Studies Group Mona (CSGM) , Chairman
- Dr. David Farrell, Caribbean Institute of Meteorology and Hydrology (CIMH)
- Dr. Michael Taylor (CSGM)
- Mr. Arnoldo Benzanilla Morlot, Postgraduate Student (ISMET)
- Ms. Rhodene Watson, Postgraduate Student (CSGM)

Needed

- Climatology or average weather
- More or less known for precipitations and Temperature
- More needed winds, SSTs, Radiation, Relative Humidity, Evapotranspiration, etc

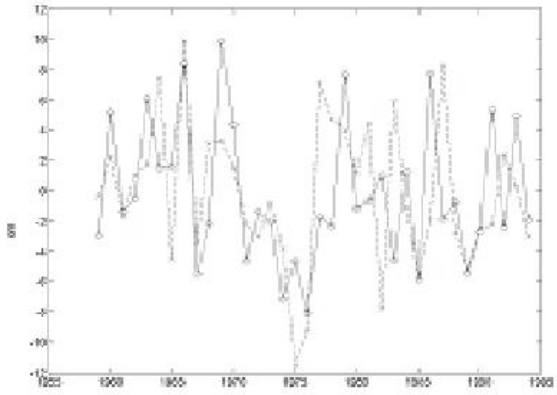
Climatology



Needed

- Knowledge of variability in climate
- Effects of ENSO (El Niño Southern Oscillation), NAO (North Atlantic Oscillation)
- Needed for short term adaptation
  - Water management, disease control, life stock management
- Need to know more
  - Variability in tropical cyclones
  - Low level jets
  - Etc.

Example: Solid line and circles represent observed MMJ rainfall values over South Eastern Caribbean . Dashed lines and crosses represent forecasted MJJ rainfall



Needed for all islands for long term adaptation:

- Scenarios like this (for Ja.)►
- And more
  - •Relative humidity, wind etc.

Estimated changes from 1961-1990 averages				
	2015s	2030s	2050s	20280s
Temperature change (ºC)	0.53	0.66	1.05	2.45
Precipitation change (%)				
Region 1	-2.28	4.54	0	-30
Region 2	-2.28	4.54	-10	-30
Region 3	-2.28	4.54	-10	-20
Region 4:	-2.28	4.54		
Portland	-2.28	4.54	No estimate	-40
St. Thomas	-2.28	4.54	No estimate	-20
Region 5	-2.28	4.54	-10	-40
Region 6	-2.28	4.54	-10	-30
Region 7	-2.28	4.54	-10	-30
Wet-day%				
Manley, URCR	0	-2	-2	-7
Sangster	-9	-18	-24	-44
Wet spell length				
Manley, URCR	-1	-4	-3	-6
Sangster	-4	-8	-7	-10
Dry spell length				
Manley, URCR	0	3	1	4

More Scenarios needed

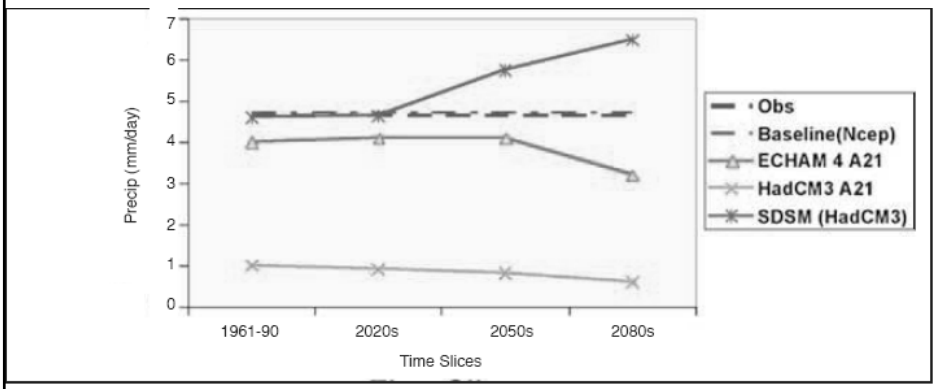


Fig. 6.6: Observed and baseline (NCEP) precipitation and precipitation scenarios at Piarco Airport in Trinidad for present (1961-90), 2020s, 2050s and 2080s time slices obtained by SDSM using HadCM3 with A2 emission scenario. Corresponding results for the Caribbean region given by HadCM3 and ECHAM4 are also shown.

More Scenario models needed

- The more regional and statistical models run, the greater confidence
- Evapotranspiraton
- Run-off
- Humidity
- Storm surges, etc.

Needed

- Models of relationship between climate and biodiversity
  - E.g., Sugar cane yield, rice yield and climate (Cuba)
  - Range of climate for biodiversity
- Use climate model and biodiversity model to generate scenarios of what will happen to biodiversity
  - How will yields be affected?
  - Will species become extinct?

Needed

- More data
- Daily, monthly
- More Parmeters
  - Relative Humidity
  - Evapotranspiration
  - Wind
  - Etc

Key questions

- Caribbean climate databases and baseline climate information?
- Research on climate variability and climate change in the Caribbean?
- Climate change scenarios for the Caribbean?
- Present manpower and equipment needs?
- What else about climate change, especially as it relates to bio-diversity?
- How can these needs be achieved?
- What Climate models best suited for addressing climate change and biodiversity?

The Contentss of working Group 1 Report

- **Chapter 1. Introduction**
- **Chapter 2. Baseline Databases and Climate**
- **Chapter 3. Present Understanding, Future Scenarios of Caribbean Climate and Related Studies**
- **Chapter 4. Present Capacity**
- **Chapter 5. Gaps and Bridging Them**
- **Chapter 6. Climate Models**
- **Chapter 7. Concluding Remarks**
- **Appendix 1. List of Databases**
- **Appendix 2. Extensive Bibliography of English Publications**

This Presentation

- Available Caribbean Based Climate Databases
- Climate trends
- Climate Scenarios
- Gaps/Needs in Data, Capacity, Equipment and Knowledge
- Filling the Gaps
- Climate Models suitable for Caribbean

Data Sets Available in the Caribbean

- Caribbean Institute for Meteorology & Hydrology (CIMH)
  - All member countries of CMO (All English Speaking)
  - http://www.cimh.edu.bb
- Caribbean Climate Interactive Database (CCID)
  - Interactive statistics
  - Climate Studies Group Mona, UWI Mona
  - michael.taylor@uwimona.edu.jm
- Center of Climate
  - http://www..met.int.inf.cu
- Parameters
  - Precipitation (intensity and duration), temperature (daily maximum and minimum), wind speed, direction, radiation, relative humidity among others
  - Processed
- Data sets vary with some data sets containing more parameters than others.
- Some unprocessed data exist

Climate Trends- Temperature

- Global temperatures increased by about 0.74˚C (0.56˚C to 0.92˚C) since the 19th century (IPCC, 2007).
- Similar trend was observed for the Caribbean 1950 -2000 (Peterson and Taylor et al., 2002).
  - Temperatures falling at or above the 90th percentile (extremes in high temperature) are increasing
  - Temperatures at or below the 10th percentile (extremes in low temperatures) are decreasing
  - Number of very warm days and nights increasing
  - Number of very cool days and nights decreasing.

Trends in Precipitation

- Two of the precipitation indices used by (Peterson et al. 2002) showed significant changes,
  - greatest 5 day rainfall total (more intense rainfall) is increasing (10% significance level)
  - number of consecutive dry days has decreased (1% significant level).
  - Results may not have taken into account differing behaviour in precipitation in the North and South Caribbean.
- Neelin et al., (2006)
  - Modest but statistically significant drying trend for the Caribbean's summer period in recent decades.

Trends in Hurricanes I

- Dramatic increase since 1995.
  - Some attributed to positive (warm) phase of a multidecadal signal (Goldenburg et al., 2001);
    - Some to global warming (Emmanuel)
  - 20 to 50 year multidecadal signal linked to thermohaline circulation
  - 0.5 hurricanes per year in the Caribbean Sea during negative (cold) phase
  - 1.7 per year during the positive phase.
- Webster et al., (2005)
  - only North Atlantic Ocean (NATL) shows a significant increase in the total number of hurricanes since 1995
    - Although SSTs in all tropical oceans have increased by approximately 0.5°C between 1970 and 2004
  - No significant trends in frequency and duration were noted for ocean basins except for the NATL.
  - ~ doubling of the categories 4 and 5 for all ocean basins.
  - maximum intensity of hurricanes remained ~ constant over the period.

Trends in hurricanes II– a mixed bag

IPCC

- Human contribution to observed trend more likely than not (> 50% probability)

Trends in Sea Level Rise

- 1950 - 2000 Global Observations (Church etal, 2004: *J. Clim.*, 17, 2609-2625).
  - The rise in the Caribbean appears to be near the global mean
  - 1.8 $\pm$ 0.3 mm per year or 0.18m per 100year.

XXI Century Projections

- IPCC 4th Assessment
- Climate Change 2007 – The Physical Sciences Basis
- Chapter 10 Global Climate Projections
- Chapter 11 Regional Climate Projections

Temperature XXI Projections for Caribbean:

- Very likely (> 90% probability) that Caribbean temperatures will increase
- Agreement of observation, global models, statistical downscaling, good physical basis
- Extent will depend on actual green house gas emissions
  - ~ slightly below global average of 3.4ºC (above pre-industrial level) by end of century, based on A1B

Precipitation XXI Projection

- Likely (> 66% probability) drying in the Greater Antilles in June, July and August (JJA)
  - General Agreement between Global Models
  - A Global model run for the Caribbean show decrease in JJA (Angeles et al, 2007)
  - Some statistical runs show decreases in JJA
  - Drying trend in observed data (Neelin et al., 2006)
  - Theoretically, drying is probable in Greater Antilles (Chou and Neelin,2004)

Post WGI & Post IPCC Projections for Jamaica

Estimated changes from 1961-1990 averages				
	2015s	2030s	2050s	20280s
Temperature change (ºC)	0.53	0.66	1.05	2.45
Precipitation change (%)				
Region 1	-2.28	4.54	0	-30
Region 2	-2.28	4.54	-10	-30
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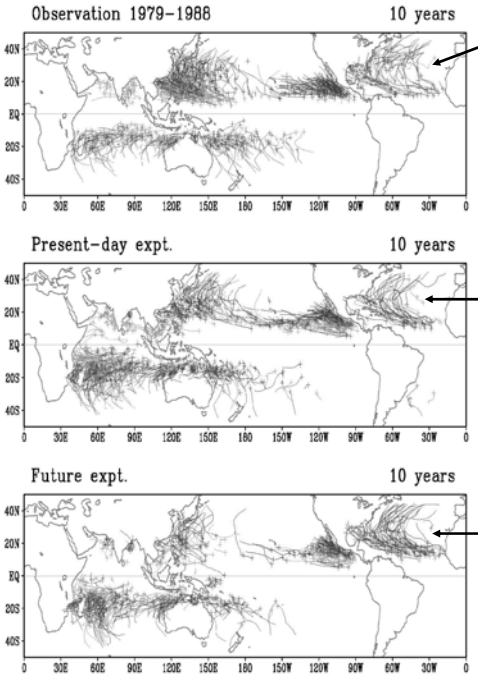
Sangster	-4	-8	-7	-10
Dry spell length				
Manley, URCR	0	3	1	4

Hurricanes XXI Projections

- Likely (>66%) that intense tropical cyclone will increase in some regions
  - Not enough information to make specific statement about the Caribbean
- Only one reported AOGCM has captured hurricanes in its results (Oochie et al 2000)
  - IPCC did not make a projection from this single model

20 Km Japanese model result of Hurricane tracks (Oouchie et al, 2000)



Actual (observed) tracks 1979-1988

Simulated Present day tracks

Simulated Future tracks (2080-2099)

Greater density

20 km Japanese model (cont.)

- Tropical cyclone frequency decreased 30% globally
- Increased about 34% in the North Atlantic.
- The strongest tropical cyclones increased in number
- Weaker storms decreased.
- Tracks were not appreciably altered
- Maximum peak wind speeds increased by about 14%
  - statistically significant increases were not found in all basins.
- Competing effects
  - Greater stabilisation of the tropical troposphere (more warming in upper troposphere → less storms)
  - Greater SSTs (→ more storms, more intense)
- SST warming has a greater effect than the vertical stabilisation in the Atlantic and produces not only more storms but also more intense storms there.
- Changes are largely dependent on the spatial pattern of future simulated SST changes (Yoshimura et al., 2006).

Hurricanes – Post IPCC

- Knutson et al., (2008) in a downscaling exercise of global climate models, found that Atlantic hurricane and tropical storm frequencies are reduced.
- At the same time, near-storm rainfall rates increase substantially.
- The simulated reduction in frequency of Atlantic hurricanes and storms seemingly contradicts one of the results obtained by Oouchi et al., (2006)
- However it does not contradict the possibility of increases of stronger storms, only with the total increase of Atlantic cyclones, and it supports heavier rainfall

Sea Level Rise XXI Projections

- Modelling
  - Large deviation among models
  - No regional modelling
  - Global mean rise expected: 0.2 to 0.5 m up to 2090's
- General statement: Sea level rise are likely (>66% probability) to continue to rise on average around the small islands of the Caribbean (near the global mean)

Post WGI and Post IPCC Projections for Sea Level rise

- "If current climate models from the IPCC included data from ice dynamics in Greenland, the sea level rise estimated during this century could be twice as high as what they are currently projecting,"
  - University at Buffalo scientists (Science Daily, Feb. 12, 2008)
- More than double (guardian.co.uk, September 01 2008)

Gaps
The Data Deficit I

Needs:

- To increase the density of stations
- For daily station data of sufficient temporal length (30 years or more)
  - for scenario generation via statistical means.
- To expand the number of climatic variables captured
  - current emphasis is on precipitation, maximum and minimum temperature.
  - Not be sufficient for the generation of scenarios of relevance to the biodiversity sector.

The Data Deficit II

Needs:

- To expand the number of climatic variables captured (cont.)
  - include variables such as, SST, soil moisture, concentration of atmospheric constituents, etc.
- To ensure easy access to the existing data stores, for legitimate users e.g. researchers.
- To ensure that data currently being recorded meet adopted global and regional standards
- To capture secondary or derived information
  - e.g. No of wet days, dry spell length for storage alongside the primary data.

The Data Deficit III

- In many territories additional data exist which could supplement existing databases, but in non-traditional archives
  - e.g. records of sugar plantations, agricultural and hydrological bodies
  - in non-digitized forms, and are therefore yet to be captured.
- There is at present no coordinated region-wide data capture effort, in spite of a growing sense of urgency about the deterioration of the media on which some the data is currently captured.

Gaps: Capacity Constraints

- Small Pool professionals who can combine disciplines (e.g. meteorology and the biosciences),
- Small Pool with skills to effectively assess and/or examine vulnerability or adaptation.
  - Need to hire consultants from outside the region to do such evaluations and assessments.
  - Experts leave their results but not their methodologies
    - does not facilitate a transfer of knowledge.
- 'Aging', cadre of professionals in the meteorological institutions of the region remains a problem.

Gaps: Technical Constraints

- High cost of maintenance and calibration of meteorological instruments
  - ➢ gradual deterioration of the meteorological network.
- The climate database suffers when
  - Replacement instruments do not exist
  - must wait on grant or government funding to be obtained
  - inappropriate substitutions are made
- High performance computers and massive data storage systems required
  - Necessary to generate useful and high quality information for forecasting purposes and for the research community.
  - Outside of e.g. Puerto Rico, it is impossible to give a detailed local forecast using currently installed capacity.

Gaps: Knowledge Needs I

- For further understanding of Caribbean climate variability
  - sub seasonal, seasonal, interannual and decadal scales.
  - E.g., low level jet, dry season dynamics, easterly wave dynamics and interactions.
  - Needed to provide context for examining future change
- For investigation of local or sub regional climates and climate gradations within individual territories and how these will likely be altered by climate change.
- For further application of regional modeling techniques (dynamical and statistical),
  - sub regions, territories, cities, towns, and station sites.
  - e.g. as was done for Jamaica

Knowledge Needs II

- For dialogue between climate researchers and scientists within the biodiversity to jointly set foci, priorities, and an agenda of needs and deliverables.
  - climatic variables, scales, and thresholds needed for analysis of the impact of climate change on the sector.
  - E.g., changes in oxygen levels in the water, or in the composition of gases in the atmosphere (ozone, methane)
- For a better understanding of sea level rise estimations due to global warming and the implications this will have for Caribbean coastlines especially during extreme events.

Knowledge Needs III

- For better understanding of Caribbean Sea circulation at the regional, sub regional and coastal levels
- For more region specific information/studies on deforestation, flooding, and the role of climate in determining such things as human settlements and health.
- For a clearer understanding of the usefulness of the various types of climate data needed to be archived for use in modelling biodiversity impacts
  - limitations and boundaries within which the data can/should be used.

Filling the Gaps
Filling the Data Gaps I

- Putting in place mechanisms (protocols and agreements for sharing, online facilities, etc.) to facilitate the sharing of data located in existing archives and databases scattered throughout the Caribbean.
- Putting in place structures/programs to capture data that is not yet digitized and not yet available for use by researchers.
- Putting in place programmes, infrastructure, and instrumentation to enable and/or support the capture of new data.

Filling the data Gaps II

- Subjecting existing data to rigorous quality control techniques in order to build a climate database for use by other sectors.
- Acquiring useful datasets from sources outside the Caribbean, e.g., detailed bathymetric and ocean circulation maps of the Caribbean region,
- Creating additional databases (where possible) of variables deemed necessary for interdisciplinary work e.g. soil moisture, SST, etc.

Filling the capacity Gaps

- Investing in postgraduate training
  - Caribbean climate variability and change,
  - numerical modelling of climate,
  - Oceanography,
  - modelling of climate change impact on various sectors including biodiversity
- Supporting student exchanges within and outside of the region.
- Support for staff education and training (especially for existing staff at meteorological services)
  - numeric and impact modelling,
  - interpretation of results,
  - methods for analyzing climate change, etc.

Filling the Equipment Gaps

- Acquiring equipment and software
  - Including massive storage devices, high speed intranet, radar networks, satellite images, software licenses and professional packages (e.g. Fortran, Matlab, GIS and professional Linux)
- Updating meteorological infrastructure to ensure recording of quality data.
  - Automatic stations and calibration equipment for basic meteorological instruments
    - e.g. Rain guages, thermometers, barometers, etc.
  - Specific meteorological instruments
    - e.g.Bowen ratio (evapotranspiration), buoys, mareographs, and gradient towers to study the turbulent layer and the wind properties near the ground level, solar radiometers and UV sensors, to study the solar potential of our region, etc.

Filling the Knowledge Gap

- Developing online mechanisms for storing and disseminating information
  - e.g. a web-page compendium for use as a document clearing house for information.
- Developing a Caribbean climate atlas.
- Facilitating dialogue between climate researchers and scientists of other sectors
  - to establish priorities, needs and deliverables for climate change studies.
- Supporting graduate student research and cross disciplinary training.
- More regional and Statistical downscaling to reduce uncertainty

Comparison of climate models

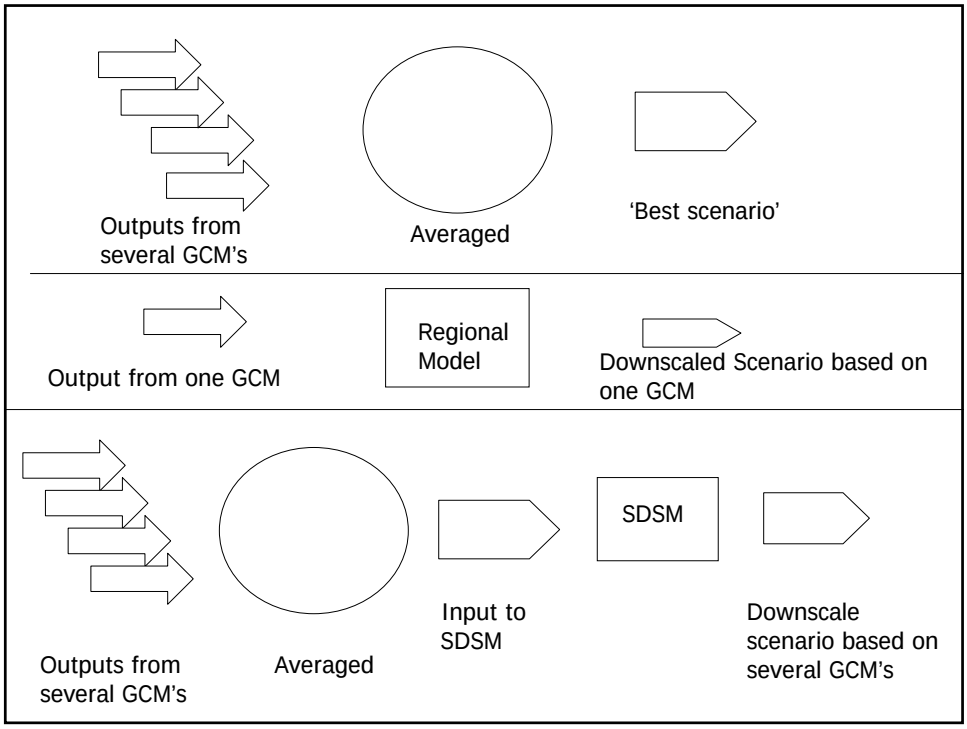
- General Circulation models used to study Caribbean region as a whole.
- For finer resolution, e.g., studying an individual islands, a regional model with resolutions of 25 to 50 km would be required.
- For studies of smaller areas, e.g., biodiversity around a station, statistical downscaling would have to be used.
  - The statistical method however requires an input of a long time series of daily data, preferably of at least 30 years duration but it has been know to be used with as short as 15 years of data.

Advantage of Statistical Downscaling I

- Versatile in terms of the parameterization and generation of future climate.
- E.g., if vegetation growth rate were related to relative humidity.
  - A long time series would allow for better correlation between vegetation and relative humidity.
  - Scenarios of a time series of relative humidity could be obtained for sometime in the future
    - ➢used this to develop scenarios of growth rate.

Advantage of Statistical Downscaling II

- Properly designed statistical method more reliable than a regional modelling using a single model.
- Convention for most reliable scenario from dynamic models is to use the average scenario from a number of models.
- In properly designed statistical downscaling
  - obtained average values of predictors from outputs of several GCM's
  - use these averages as future predictors in statistical model
  - Scenario generated by the statistical model would then be more reliable than that obtained by single regional model using inputs from a single GCM
- Main limitation would be uncertainty that the regression equations developed between the predictors and predictant in the present climate remain the same in the future climate.
- However the likelihood of this is quite good
  - we know most of the atmospheric physics and chemistry involved, and there is not much room left for surprises.



Summary of Priority Needs

- Need more data
  - Frequency and variety
- More studies of Climate Variability
- Seasonal forecasts
- More regional and statistical models to reduce uncertainty for individual islands

Concluding Remarks

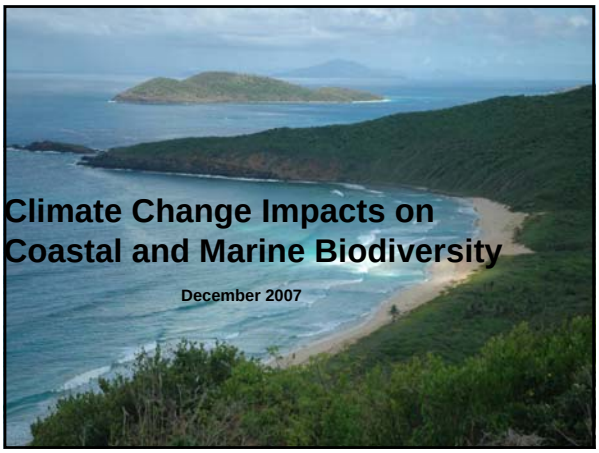
What if we can limit global warming and eventually reverse it, will our efforts be in vain?

- We are already committed to increases (less than 2ºC) over the century due to the long life time of greenhouse gases in the atmosphere and the 'long' memory of the ocean even if conditions were stabilized.
- There are many advantages to be gained, outside of global warming concerns.
  - Increased capacity in climate studies will lead to better forecasting of daily weather and of seasonal changes, such as drought and floods.
  - Crop models and climate models could be combined to predict crop yields.
  - Models could be run to determine the effects of deforestation, or better yet, the effects for re-forestation, etc.

Acknowledgements

- John D. and Catherine T. MacArthur Foundation
- Caribbean Natural Resources Institute (CANARI)
- Leslie Walling
- Jose Luis Gerhartz

Thank You



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Methodology

- June to August 2007: literature surveys by postgraduate students from UWI
- August 2007: Working group meeting in Jamaica
- August – December 2007:
  - detailed report outline prepared
  - working group members wrote specific sections
  - sections combined and draft prepared
  - draft reviewed by working group members
  - present report represents 4th full draft

Basis for report

- Report based on:
  - 320 cited references (published and gray literature)
  - academic and applied experiences of the working group
  - interpretation of the literature coupled with professional experience

Coastal systems

1. Coastal and marine systems and their linkages
2. Emergent coastal wetlands
3. Coastal forests
4. Dunes, beaches, cliffs and rocky shores
5. Seagrass beds
6. Coral reefs
7. Coastal and pelagic fish species
8. Seabirds and coastal waterfowl
9. Marine mammals
10. Sea turtles

Impacts of climate change

For each coastal system, the report provides:

- A definition
- Regional status review
- Impacts of climate change:
  - Sea level rise
  - Increasing temperature
  - Increasing carbon dioxide
  - Precipitation changes
  - Salinity changes
  - Tropical storms & hurricanes
  - Diseases
  - Sahara dust

Climate predictions for insular Caribbean, based on IPCC, 2007

Climate parameter	Predicted change
Air temperature	Increase of 1.8 - 4.0°C by 2099
Global sea level	Rise of 0.18 – 0.59 m by 2099
Carbon dioxide	Reduction in pH of the oceans by 0.14 - 0.35 units by 2099
Hurricanes	More intense with larger peak wind speeds and heavier precipitation
Precipitation	Unclear

General comments on main knowledge gaps

- Available information very generic both for habitats and species; the ability to define boundary conditions for different species and different climatic scenarios is a long way off
- Conflicts in available information
- Insufficient ground truthing for model studies
- Limited information, especially for the smaller islands
- There is a wealth of difficult-to-access information in the unpublished literature
- Level and depth of information varies according to the particular system

Gaps and recommendations

1. Long term monitoring of changes in coastal and marine ecosystems
2. Connectivity between systems in the insular Caribbean
3. Modeling of circulation changes
4. Sea level and sea surface temperature data
5. Ocean acidification
6. Diseases and invasive species
7. Algal blooms and plankton
8. Remediation techniques and ecosystem resilience
9. Biological research and assessments
10. Species response to changes in temperature

1. Long-term monitoring of changes in coastal and marine ecosystems

Gaps

- Large variation from island to island in existence of data relating to spatial extent of ecosystems, inventories of flora and fauna, and monitoring of ecosystem changes
- Accessibility of data
- Analysis of results

Recommendations

- Compile and analyze existing data and prepare a regional baseline against which future changes can be compared
- Establish an effective data management and data sharing mechanisms

2. Connectivity between systems in the insular Caribbean

Gaps

- Connectivity and interrelationships between species and systems in the Caribbean large marine ecosystem
- Recruitment and retention of coral larvae

Recommendations

- Research to better understand interrelationships in the Caribbean large marine ecosystem
- Predictive models on how climate change will affect key species, and predator/prey relationships
- Analyze potential changes in environmental services and economic benefits

3. Circulation changes in the Caribbean Sea & adjacent water bodies

Gaps

How temperature change will affect water circulation in the Caribbean Sea and adjacent water bodies, sites of upwelling and downwelling, and marine flora and fauna

Recommendations

Predictive models to show horizontal and vertical water movements likely to result from climate change and their effects on dispersal, productivity, migration and habitats of marine flora and fauna

4. Sea level and sea surface temperature data

Gaps
- Accurate sea level change data
- Sea surface temperature data

Recommendations
- Establish a representative network of tide gauge stations
- Establish an effective temperature data collection system including nearshore waters

5. Ocean acidification

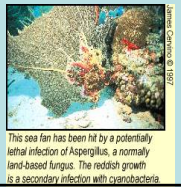
Gaps
- Calcification response to increased CO_2 in key species
- Changes in calcification rates
- Mechanisms of calcification
- Diurnal and seasonal cycles of the carbonate system

Recommendations
- Select key species and conduct research into calcification rates, responses and mechanisms
- Establish baseline and long-term monitoring of pH and calcification rates on corals

6.Diseases and invasive species

Gaps
- Coral diseases and how they respond to temperature changes
- Diseases affecting Caribbean marine mammals and turtles
- Distribution and abundance of marine invasive species

Recommendations
- Develop a database of diseases affecting marine species and determine their present and future trends
- Prepare a database of marine invasive species
- Select key diseases for further research in relation to climate change



This sea fan has been hit by a potentially lethal infection of Aspergillus, a normally land-based fungus. The reddish growth is a secondary infection with cyanobacteria.

7. Algal blooms and plankton

Gaps
- Current trends in algal blooms and plankton distribution, and how these are impacted by changes in climatic parameters

Recommendations
- Baseline survey and long term monitoring of algal blooms and plankton distribution patterns in the region and the effects of changes in climatic indicators

8. Remediation techniques and ecosystem resilience

Gaps
- Incomplete knowledge on ecosystem remediation techniques suitable for national and regional situations and their efficacy

Recommendations
- Compile information on ecosystem remediation techniques
- Involve the wider community in monitoring selected sites and implementing measures that strengthen the resilience of the ecosystem to change

9. Biological research and assessments

Gaps
- Information on basic biology, behaviour, distribution, abundance, migration and habitats of smaller odontocetes, seabirds and waterfowl, in particular

Recommendations
- Determination of biology, status assessments, life histories and impacts of climate change on selected species

10. Species responses to changes in temperature

Gaps

- Uncertainties about future fish stocks, including spawning times, in the light of climate change
- Sex ratio in turtle hatchlings and increasing temperatures

Recommendations

- Select key species for detailed research on tolerance levels and increased temperatures

Existing capacity

- The report lists research institutes, national, regional and international
- National fisheries and environmental agencies
- NGOs, e.g. Nevis Historical and Conservation Society

Policy initiatives

- Convention on Biological Diversity (all of insular Caribbean except Puerto Rico & USVI, reporting mechanisms in place to achieve 2010 targets
- UNFCCC (all islands) & Kyoto Protocol (all islands except US territories)
- Ramsar Convention (14 islands)
- National climate change committees in most islands
- Other initiatives e.g. Grenada and protected areas commitment with TNC, Cuba-Haiti-DR Caribbean Biological Corridor

The Nevis Biodiversity Project

Mission Statement: Due to the effects of local development, global climate change and the subsequent loss of habitat, the Nevis Historical & Conservation Society's Biodiversity Committee seeks to identify and catalogue the existing species of all flora and fauna on Nevis as an indispensable aid in the struggle to conserve them.

Community Involvement: This site is maintained and updated regularly by The Biodiversity Team, a group of 6th Form students from Charlestown Secondary School, Nevis

http://www.bio-diversity-nevis.org/index.htm

Further comments

- Working group did not prioritize the 10 main recommendations
- All the recommendations provide directions for further research
- No. 8 deals with remediation techniques and ecosystem resilience and includes provisions for community-based activities

Opportunities for community involvement

Monitoring selected sites with the help of the wider community and then implementing measures to strengthen the resilience of the system to climate change

1. Site selection based on specific criteria
2. Ecosystem monitoring by communities and scientists
3. Resilience strengthening activities

Concluding remarks

The following comment from Mrs. Candace Key, Principal of Hope Town Primary School, Abaco, The Bahamas, indicates that now is an opportune time to begin/continue community-based ecosystem resilience activities.

"*The media thinks a new idea is on the scene……..we have been talking and teaching global warming for years……tomorrow we are going out to move an abandoned fishing net that is smothering our reef." January 21, 2007*

A time for research and also a time for action

Report of the Working Group on Terrestrial Biodiversity (GWIII).

Participants:

Eric Garraway
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Lourdes Mujica
José L. Gerhartz
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René T. Capote
Avelino G. Suárez

The ***biological diversity*** or ***biodiversity*** is considered as :

- ***The variability among all living organisms from all sources.***
- This includes diversity within species, between species, and of ecosystems.
-Three levels: genetic, ***species,*** and ***ecosystems***
-It includes both intensively (agriculture, plantation forestry) and non-intensively (e.g., grasslands, native forests, freshwater ecosystems, and oceans) managed ecosystems.

- Following CBD, and the IPCC we understood ***wildlife*** as one component of biodiversity together with ***all components of biological diversity that constitute the agro-ecosystem*** (i.e., the variety and variability of ***ani***mals, plants and micro-organisms at the three levels).

Projected climate change impacts on the Caribbean terrestrial biodiversity

•Seven models project increased surface air temperature
•Projections on precipitation range widely, and even the direction of change is not clear (Ruosteenoja et al. 2003, quoted by Nimura et al 2007).

•Regarding Cuba, Suárez et al. (1999) and Ferrás et al. (1999) obtained that by year 2100 the ***composition of endemic plant species in six phytogeographic districts*** of eastern Cuba could be modified according to the changes in temperature that were projected in three General Circulation Models (GCM).

Dominica's vegetation types, especially in its mountainous interior, has a pronounced altitudinal zonality due to climate. Such zonality is likely to be affected by any change in climate. For example, assuming a lapse rate of 1 ° C per 500 ft, an increase of 1.7 ° C (lowest scenario) would elevate vegetation zones by 850 ft. In the high scenario (3.5 ° C), the elevation would be of 1750 ft. Under this high temperature scenario, ***elfin woodlands could completely disappear, and some species unique to Dominica could be lost*** (Parry, 2001 personal communication, quoted by Dominica UNFCCC First National Communication, 2001.

The expected impacts of climate change on terrestrial biodiversity in the Caribbean islands, was rather scarce and almost absent in the reviewed literature.
This is valid for the literature found in Spanish, English and French.

Island-based information.

In order to complete the gathering of available ***biological information*** relevant to assess the state of knowledge of the impacts of climate change on terrestrial biodiversity, ***a data-mining approach*** was followed, for each of the seven countries subjected to an in-depth assessment

The working team split into two groups. One group focused on the Spanish and French speaking countries of the Caribbean and conducted in depth assessments of ***Cuba***, the ***Dominican Republic***, and ***Haiti***.
The second group focused on the English-speaking islands and conducted in depth assessments of:
-***Antigua and Barbuda*** –small, low-lying, dry, OECS state.
-***The Bahamas*** – low-lying, dry, archipelagic state.
-***Dominica*** – small, mountainous, water-rich OECS state.
-***Jamaica*** – large, mountainous

Synthesis of state of knowledge of terrestrial biological information availability relevant to assess the impacts of climate change in the Caribbean
(Antigua, Bahamas, Cuba, Haiti, Dominican Republic, Dominica and Jamaica).

Biodiversity: species lists, ecology.

-For the islands addressed, there is ***baseline knowledge on their terrestrial biodiversity***. However, the available knowledge is not equally complete for all islands.
-***Species lists are available*** for all islands, although the compiled information has not allowed identifying if there are gaps for some groups.
-In all the islands ***the vegetation formations and/or ecosystems are identified.*** The information obtained did not allow identifying the degree of knowledge on the ecology of species and formations.

Protected area distribution and status.

- **All countries have declared protected areas**. Information on the **degree of biodiversity protection, or coverage of biodiversity** by the established protected areas, **is not always available**.

- Current management **plans of protected areas do not take climate change into account**.

Species distribution maps.

-There is a considerable body of knowledge on biodiversity, i.e., fauna, flora, vegetation, fungi. Nonetheless, **not much of the information can be found on regional cartographic products** (i.e., maps). *Only in the case of fungi such regional maps* have been found.

Species distribution maps (cont.)

-***Vegetation maps***, elaborated by The National Conservancy, are available on the web. Although these maps provide a potential source of spatial information on biodiversity distributions, the suitability of using these maps for modelling should still be checked.

- Regarding ***vegetation fragmentation***, only the Cuban national map of vegetation fragmentation (Capote et al. 2005) was found.

Data bases.

- A downloadable list (Species Database) of **Vertebrate Species** occurring in Caribbean Islands is freely available. That database lists 4077 species of the vertebrate classes Amphibia, Aves, Mammalia and Reptilia. (Conservation International, 2007a).

-Database **Fungi of the Caribbean**. An annotated checklist. With electronic Distribution Maps of Caribbean Fungi.

Data base (cont.)

-The Web page of the **Cuban CHM** has a major compilation of the Cuban information on diversity. The information available on the webpage includes links to documents, collections and databases (e.g., 75 databases on fauna, flora, fungi, endemism, and other topics related to biological diversity).

Agrobiodiversity

Is one of the main manifestations of collaboration between people and nature. The diversity of animals and plants (e.g., those used as food) exists due to thousands of years of selection and care by rural people. The Convention for the Biological Diversity supports actions regarding the conservation and sustainable use of the biodiversity relevant to agriculture.

Agrobiodiversity (cont.)

- In all cases the ***main plants and animals that are traditionally used by people are identified.***

-***Not in all the countries*** the species used by people and the genetic resources ***are protected by law or are in situ collections***.

-There is the ***risk that these resources and traditional knowledge can be lost***, and not only due to the projected impacts of climate change but also due to other socio-economic transformations. There is an urgent need to record the oral traditional knowledge.

Main gaps.

-***Information on the expected impacts of climate change on the terrestrial biodiversity of the Caribbean island*** was rather scarce and almost absent in the literature reviewed.

-***There is a marked dispersion of the knowledge on the regional biodiversity.*** The existence and location of such knowledge is commonly unknown, for instance regarding journals; books; biological databases, and maps, also applied to the existing information on agro biodiversity, and human and institutional resources

Main gaps (cont.)

-The regional databases related to the regional biodiversity should be geo referenced, including the altitude.

-There is no standardised record of observations on transformations of phenology and behaviour of biodiversity. Lack of phenological studies in the climate change related literature that was reviewed.

- The information on invasive and introduced species is disperse and incomplete

Main gaps (cont.)

-***There is need for a data porthole*** through which data and information on the impact of CC on the regional biodiversity can be accessed**.** The facility should be maintained in different languages

Needed capacities

- Data collection and monitoring.

-There is capacity for collecting biological data, although not in all the countries and not for all the taxa. Many scientists from outside of the Caribbean have participated in the development of biological inventories. There is a need to develop local capacities for collecting biodiversity data. Monitoring is a need, but local capacities should be developed, especially those oriented to **monitor the impacts of climate change on biodiversity.**

Needed capacities (Cont.)

-Database development and management.

-The mining of information has detected biodiversity databases in just a few countries. Attempts should be made to standardise existing and future databases to ensure a compatible structures to facilitate sharing, exchange, and use of biodiversity data at the regional level.

Needed capacities (Cont.)

- Biodiversity modelling.

-The national and regional capacities are almost non-existing. These capacities should be developed if the research on the impacts of the projected climate change on the regional biodiversity is to be undertaken to provide useful information for adapting planning.

- Caribbean information network

-There exists the need to develop a **Caribbean information network**. The network would collect and bring together the information or links to the information on Caribbean institutions working on climate change and biodiversity. It would provide information on the publications on the Caribbean biodiversity.
-A network connecting the web pages of the existing biodiversity clearing house mechanism (CHM) could be configured to provide information services relevant to the climate change and biodiversity community in the Caribbean

Research agenda for terrestrial biodiversity

***Guiding Principles*:**

-All approaches to biodiversity adaptation to climate change should consist of "win-win" measures. Actions shall be oriented not only to allow biodiversity to adapt to projected climate change. Such actions shall also solve current environmental problems.

-The impact of GCC on biodiversity will be assessed for natural, agro-and-modified ecosystems. Climate change will impact all the biodiversity in different ways and different intensities. Impacts will not be limited to wildlife.

Guiding Principles (cont.).

-The preservation of biodiversity, so that it can adapt to climate change, should occur not only in protected areas but also outside them.

-The analysis of climate change impacts on terrestrial biodiversity should incorporate socio-economic impacts like population pressure and economic pressures on land use intensity, and incomplete legal framework for biodiversity protection

Research activities.

-Completion of species and vegetation databases when necessary, especially for taxonomic groups and vegetation that are sensitive to climate change. All databases should be georeferenced, including the altitude.

-Completion of species and vegetation distribution maps at regional and national level.

-Completion of habitat fragmentation maps for each island. Habitat fragmentation assessment and modelling of future status.

Research activities (cont.)

-Completion of the information on traditional knowledge of biodiversity including agro-biodiversity that is significant to local and indigenous peoples.

-Phenological studies of the biodiversity to detect the evidence of climate change impacts on species and biological relationships.

- Vulnerability assessment (landscapes, ecosystems, habitats, species groups, and species).

Research activities. (cont.)

-Assessment at the regional and national levels of the vulnerability of protected areas to CC. The purpose would be identifying impacts and threats, and developing protected areas systems and adaptation plans.

-The role of community knowledge and agrobiodiversity in adaptation to the adverse impacts of climate change .

-The ways people cope with and reduce the impacts of climate variability in the formal and informal agricultural sector e.g. In situ conservation in villages

Recommendations.

-The ecosystem approach should be applied to future research on the impact of CC on biodiversity.

-Building of capacities into the region and co-ordinate those already existing for projecting and managing eventual climate change impacts on biodiversity on a regional basis.

Recommendations (cont.)

-Use protected areas as climatic and biodiversity monitoring sites for detecting the biological evidence of climate change impacts.

-The promotion of collaborative arrangements with Geo-information specialized organizations would allow addressing the need to geo-reference and map biodiversity information on regional and national basis.

Recommendation (cont.)

***-Some species, groups of species and formations of terrestrial biodiversity* will be more susceptible to the projected climate change impacts.** Their study should be *a priority*. For instance:

- Groups: *Amphibia*, *Lepidotera* (butterflies), *Birds*, *Soil fauna* and *Fungi*.
- Terrestrial vegetation formations like *wetlands* (e.g., herbaceous and forest wetlands, and mangroves); coastal vegetation (e.g., *coastal dunes*, *coastal karstic areas*) including that one located landward to coastline mangroves; *high elevation vegetation* (dependent on temperature) and *highly fragmented ecosystems*.

Science can help to ensure that decisions are made with the best available information, but ultimately the future of biodiversity will be determined by society (MEA, 2005).

Ecosystem approach

Principle 1: ***The objectives of management of land, water and living resources are a matter of societal choice.***

Principle 2: ***Management should be decentralized to the lowest appropriate level.***

Principle 3: ***Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.***

Principle 4: ***Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem-management programme should:***
(a) Reduce those market distortions that adversely affect biological diversity;
(b) Align incentives to promote biodiversity conservation and sustainable use;
(c) Internalize costs and benefits in the given ecosystem to the extent feasible

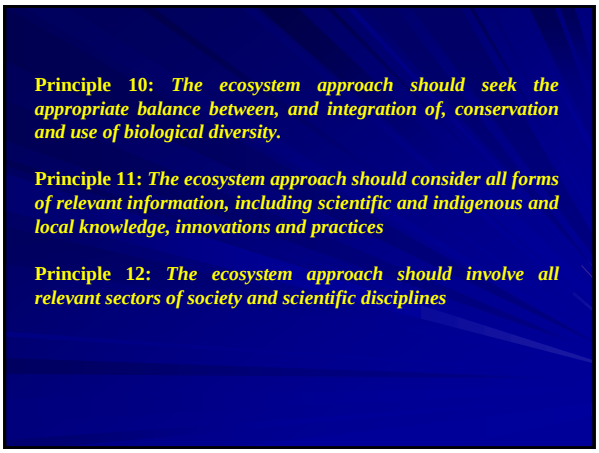
Principle 5: ***Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.***

Principle 6: ***Ecosystems must be managed within the limits of their functioning***

Principle 7: ***The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.***

Principle 8: ***Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term.***

Principle 9: ***Management must recognize that change is inevitable***


Principle 10: ***The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.***
Principle 11: ***The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices***
Principle 12: ***The ecosystem approach should involve all relevant sectors of society and scientific disciplines***

SYNTHESIS OF REVIEWER'S COMMENTS
DRAFT RESEARCH AGENDA
AND
CAPACITY NEEDS ASSESSEMENT

CHANGE AND BIODIVERSITY:
RESEARCH FOR A SUSTAINABLE TOMORROW

Owen Day
September 24th 2008

CANARI

Climate Change and Biodiversity
in the Caribbean

OBJECTIVES

- SYNTHESISE REVIEWERS COMMENTS
- IDENTIFY CROSS CUTTING ISSUES AND OVER-ARCHING PRIORITIES
- IDENTIFY OTHER RESEARCH AREAS NOT LISTED
- EXAMINE CRITERIA FOR PRIORITISATION OF RESEARCH AGENDA AND CAPACITY NEEDS

Climate Change and Biodiversity
in the Caribbean

Synthesis of Reviewers Comments

- Prof. Julia Horrocks
- Dr. Caroline Rogers
- Dr Judith Gobin
- Dr. Karen Eckert
- Dr. Adrian Trotman
- Dr. Esme Rawlins Charles
- Prof. Valdez-Pizzini

Climate Change and Biodiversity
in the Caribbean

Research Agenda

- Data Management of Existing Data
- Data Collection and Monitoring
- Maps, Trends, Connectivity and Modeling
- Vulnerability of Specific Species and Ecosystems
- Remediation Techniques and Resilience Management
- Protected Area Management
- Integrated Coastal Zone Management
- Community Awareness and Involvement
- Social Science, Politics and Economics

Climate Change and Biodiversity
in the Caribbean

Research Agenda

TOPIC	SUB-TOPIC	Working Group		
		I	II	III
DATA MANAGEMENT				
	Develop systems to enhance sharing and management of data (formats, networks, websites, etc.)	X	X	X
	Digitise data and perform quality-control checks	X		
	Develop a Caribbean Climate Atlas	X		
	Compile existing data to produce regional biodiversity database (GIS - geo-referenced)		X	X
	Compile database of traditional knowledge of biodiversity			X

Climate Change and Biodiversity
in the Caribbean

Research Agenda

TOPIC	SUB-TOPIC	Working Group		
		I	II	III
DATA COLLECTION & MONITORING				
	Increase density of stations for which quality controlled historical data is available	X		
	Capture daily station data of sufficient temporal length (30 years or more) to enable scenario generation	X		
	Expand the number of climatic variables captured by the historical data	X		
	Capture secondary or derived information (e.g. climate indices or data ranges or deviations) for storage alongside the primary data	X		
	Establish network of stations to measure sea level rise		X	
	Establish network to measure sea surface temperatures (SST)	X	X	
	Monitor ocean acidification		X	
	Monitor soil moisture	X		X
	Capture other variables such as concentration of atmospheric constituents,Ë	X		
	Develop database of diseases of key marine species		X	
	Develop database of invasive species		X	X

Climate Change and Biodiversity
in the Caribbean

Research Agenda

TOPIC	SUB-TOPIC	Working Group		
		I	II	III
MAPS, TRENDS, CONNECTIVITY AND MODELLING (GIS)				
	Analyze existing data to determine long-term trends	X	X	X
	Complete species and vegetation distribution maps at regional and national level			X
	Completion of habitat fragmentation maps for each island and modelling of future status			X
	Examine connectivity and interrelationships in the Caribbean Sea and adjacent water bodies		X	
	Prepare predictive models showing changes in connectivity likely to result from climate change, and examine potential changes to environmental services and economic benefits	X	X	X
	Model impacts on biodiversity of projected changes in meteorological variables projected by GCM models	X	X	X
	Use GIS and modelling to identify areas of special interest		X	X
	Model circulation changes in the Caribbean Sea and between adjacent water bodies		X	

Climate Change and Biodiversity in the Caribbean

Research Agenda

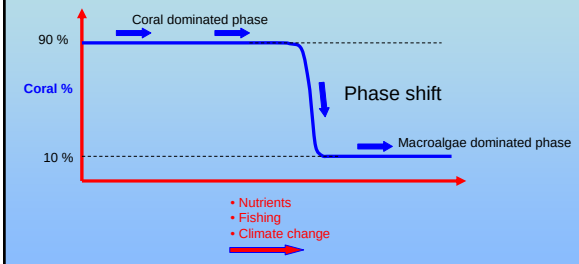
TOPIC	SUB-TOPIC	Working Group		
		I	II	III
VULNERABILITY OF SPECIFIC SPECIES AND ECOSYSTEMS (PHYSIOLOGY AND ECOLOGY)				
	Assess vulnerability of selected species to changes in temperature		X	X
	Assess vulnerability of selected species to ocean acidification		X	
	Assess vulnerability of landscapes, ecosystems, habitats, species groups, and species		X	X
	Assessment at the regional and national levels of the vulnerability of protected areas to CC and propose adaptation plans		X	X
	Phenological studies to detect climate change impacts on species and biological relationships			X
	List species and ecosystems most in need of research:			

Climate Change and Biodiversity in the Caribbean

Ecosystem Resilience and the Coral Reef Crisis

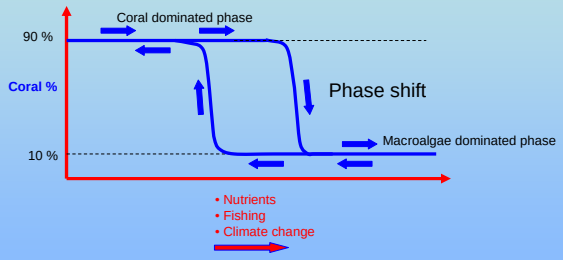
Climate Change and Biodiversity in the Caribbean

Ecosystem Resilience and the Coral Reef Crisis



Climate Change and Biodiversity in the Caribbean

Ecosystem Resilience and the Coral Reef Crisis



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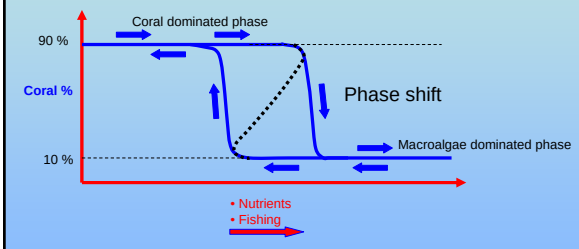
Ecosystem Resilience and the Coral Reef Crisis



Climate Change and Biodiversity in the Caribbean

Research Agenda

TOPIC	SUB-TOPIC	Working Group		
		I	II	III
REMEDIATION TECHNIQUES AND RESILIENCE MANAGEMENT				
	Review science of and management approaches for reef resilience		X	
	Review of global remediation techniques		X	
	Select pilot sites to test suitable resilience and remediation techniques		X	
	Select sites based on ecological and economic value, and inherent vulnerability		X	
	Monitor selected sites with the assistance of the wider community		X	
PROTECTED AREA MANAGEMENT				
	Examine factors influencing political will and community support for protected area management		X	X
	Promote co-management in planning, development and conservation		X	X
	Promote education and awareness of benefits of protected areas		X	X
	Use volunteers in data collection and monitoring in protected areas		X	X
	Examine new approaches for funding of protected areas		X	X

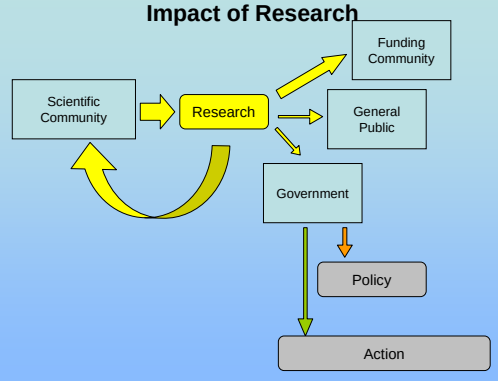
Climate Change and Biodiversity in the Caribbean

Research Agenda

TOPIC	SUB-TOPIC	Working Group		
		I	II	III
INTEGRATED COASTAL ZONE MANAGEMENT				
	Review national and regional policies for ICZM		X	X
	Establish national and regional policies for institutional arrangements pertaining to data collection, sharing and environmental management		X	X
	Promote creation of green-belt areas adjacent to protected areas		X	X
COMMUNITY AWARENESS AND INVOLVEMENT				
	Promote education and awareness	X	X	X
	Promote participation by all stakeholders in management activities		X	
	Promote co-management in planning, development and conservation		X	
SOCIAL SCIENCE, POLITICS AND ECONOMICS				
	Popularize science and environmental solutions	X	X	X
	Build political will	X	X	X
	Assign value to ecosystems - market and non-market values		X	X
	Explore new funding mechanisms (markets for ecosystem services?)			

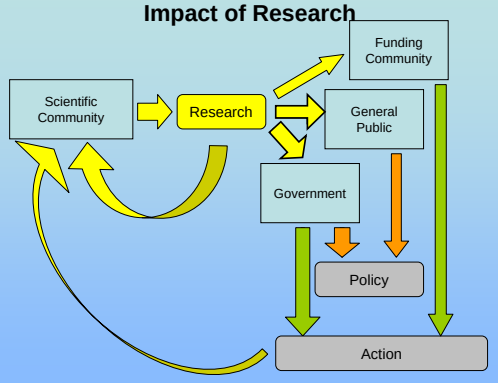
Climate Change and Biodiversity in the Caribbean

Impact of Research



Climate Change and Biodiversity in the Caribbean

Impact of Research



Climate Change and Biodiversity in the Caribbean

PROPOSED CRITERIA FOR PRIORITISATION OF RESEARCH AGENDA

TO BE DISCUSSED

A. Is the research likely to lead to tangible benefits in environmental management?

B. Does the research promote a "win-win" approach (i.e. useful with or without climate change)?

C. Is the cost of the research in keeping with the likely environmental and socio-economic benefits?

D. Is the timescale of research-to-implementation in keeping with the urgency of the specific issue?

E. Is the research already being done by other groups from outside the Caribbean?

F. Does it use an ecosystem-based approach?

G. Does the research meet the needs of policy-makers?

Climate Change and Biodiversity in the Caribbean

Capacity Needs

TOPIC	SUB-TOPIC	Working Group		
		I	II	III
HUMAN CAPACITY				
	Develop professionals with relevant interdisciplinary expertise (e.g. meteorology/ biosciences, vulnerability/adaptation)	X		
	Facilitate interdisciplinary dialogue between climate researchers and scientists of other sectors such as biodiversity	X	X	X
	Support graduate student research and cross disciplinary training	X		
	Data collection and monitoring skills			X
	Biodiversity modeling skills			X
TECHNICAL CAPACITY				
	Meteorological instruments	X		
	Powerful computers, software and large data storage facilities	X		
	Information networks		X	X

Climate Change and Biodiversity in the Caribbean

CHANGE AND BIODIVERSITY: RESEARCH FOR A SUSTAINABLE TOMORROW

RESEARCH AGENDA AND CAPACITY NEEDS

Proposed criteria for prioritization of research needs (to be discussed at the meeting)

A. Is the research likely to lead to tangible benefits in environmental management?

B. Does the research promote a “win-win” approach (i.e. useful with or without climate change)?

C. Is the cost of the research in keeping with the likely environmental and socio-economic benefits?

D. Is the timescale of research-to-implementation in keeping with the urgency of the specific issue?

E. Is the research already being done by other groups from outside the Caribbean?

F. Does it use an ecosystem-based approach?

G. Does the research meet the needs of policy-makers?

Research agenda

TOPIC	SUB-TOPIC	Working Group			CRITERIA					
		I	II	III	A	B	C	D	E	F
DATA MANAGEMENT										
	Develop systems to enhance sharing and management of data (formats, networks, websites, etc.)	X	X	X						
	Digitise data and perform quality-control checks	X								
	Develop a Caribbean Climate Atlas	X								
	Compile existing data to produce regional biodiversity database (GIS - geo-referenced)		X	X						
	Compile database of traditional knowledge of biodiversity			X						

TOPIC	SUB-TOPIC	Working Group			CRITERIA					
		I	II	III	A	B	C	D	E	F
DATA COLLECTION & MONITORING										
	Increase density of stations for which quality controlled historical data is available	X								
	Capture daily station data of sufficient temporal length (30 years or more) to enable scenario generation	X								
	Expand the number of climatic variables captured by the historical data	X								
	Capture secondary or derived information (e.g. climate indices or data ranges or deviations) for storage alongside the primary data	X								
	Establish network of stations to measure sea level rise		X							
	Establish network to measure sea surface temperatures (SST)	X	X							
	Monitor ocean acidification		X							
	Monitor soil moisture	X		X						
	Capture other variables such as concentration of atmospheric constituents,…	X								
	Develop database of diseases of key marine species		X							
	Develop database of invasive species		X	X						
	Monitor and investigate trends in algal blooms		X							

TOPIC	SUB-TOPIC	Working Group			CRITERIA					
		I	II	III	A	B	C	D	E	F
MAPS, TRENDS, CONNECTIVITY AND MODELLING (GIS)										
	Analyze existing data to determine long-term trends	X	X	X						
	Complete species and vegetation distribution maps at regional and national level			X						
	Completion of habitat fragmentation maps for each island and modelling of future status			X						
	Examine connectivity and interrelationships in the Caribbean Sea and adjacent water bodies		X							
	Prepare predictive models showing changes in connectivity likely to result from climate change, and examine potential changes to environmental services and economic benefits	X	X	X						
	Model impacts on biodiversity of projected changes in meteorological variables projected by GCM models	X	X	X						
	Use GIS and modelling to identify areas of special interest		X	X						
	Model circulation changes in the Caribbean Sea and between adjacent water bodies		X							
	Model projected changes on dispersal of eggs and larvae, productivity, migratory routes, etc.		X							
	Identify important upstream sources of eggs and larvae		X							
	Investigate correlations between diseases and climatic factors		X							

TOPIC	SUB-TOPIC	Working Group			CRITERIA					
		I	II	III	A	B	C	D	E	F
VULNERABILITY OF SPECIFIC SPECIES AND ECOSYSTEMS (PHYSIOLOGY AND ECOLOGY)										
	Assess vulnerability of selected species to changes in temperature		X	X						
	Assess vulnerability of selected species to ocean acidification		X							
	Assess vulnerability of landscapes, ecosystems, habitats, species groups, and species		X	X						
	Assessment at the regional and national levels of the vulnerability of protected areas to CC and propose adaptation plans		X	X						
	Phenological studies to detect climate change impacts on species and biological relationships			X						
	List species and ecosystems most in need of research:									

TOPIC	SUB-TOPIC	Working Group			CRITERIA					
		I	II	III	A	B	C	D	E	F
REMEDIATION TECHNIQUES AND RESILIENCE MANAGEMENT										
	Review science of and management approaches for reef resilience		X							
	Review of global remediation techniques		X							
	Select pilot sites to test suitable resilience and remediation techniques		X							
	Select sites based on ecological and economic value, and inherent vulnerability		X							
	Monitor selected sites with the assistance of the wider community		X							
PROTECTED AREA MANAGEMENT										
	Examine factors influencing political will and community support for protected area management		X	X						
	Promote co-management in planning, development and conservation		X	X						
	Promote education and awareness of benefits of protected areas		X	X						
	Use volunteers in data collection and monitoring in protected areas		X	X						
	Examine new approaches for funding of protected areas		X	X						

TOPIC	SUB-TOPIC	Working Group			CRITERIA					
		I	II	III	A	B	C	D	E	F
INTEGRATED COASTAL ZONE MANAGEMENT										
	Review national and regional policies for ICZM		X	X						
	Establish national and regional policies for institutional arrangements pertaining to data collection, sharing and management		X	X						
	Promote creation of green-belt areas adjacent to protected areas		X	X						
COMMUNITY AWARENESS AND INVOLVEMENT										
	Promote education and awareness	X	X	X						
	Promote participation by all stakeholders in management activities		X							
	Promote co-management in planning, development and conservation		X							
SOCIAL SCIENCE, POLITICS AND ECONOMICS										
	Popularize science and environmental solutions	X	X	X						
	Build political will	X	X	X						
	Assign value to ecosystems - market and non-market values		X	X						
	Explore new funding mechanisms (markets for ecosystem services?)									

CAPACITY NEEDS

TOPIC	SUB-TOPIC	Working Group			CRITERIA					
		I	II	III	A	B	C	D	E	F
HUMAN CAPACITY										
	Develop professionals with relevant interdisciplinary expertise (e.g. meteorology/ biosciences, vulnerability/adaptation)	X								
	Facilitate interdisciplinary dialogue between climate researchers and scientists of other sectors such as biodiversity	X	X	X						
	Support graduate student research and cross disciplinary training	X								
	Data collection and monitoring skills			X						
	Biodiversity modeling skills			X						
TECHNICAL CAPACITY										
	Meteorological instruments	X								
	Powerful computers, software and large data storage facilities	X								
	Information networks		X	X						

Identifying the Priorities for the next 3 years – research and capacity building

Group 1

Climate Change Models and Scenarios

- Michael Talyor, Chair
- John Agard
- Saudia Rahat
- Adrian Trotman
- Neville Trotz
- Anthony Chen, Recording Sec.

Research Idea 1
Data Rescue

- Data capture – existing data not archived
- CIMH proposal
- Identify sources (mainly done by CIMH)
- Others may have data
  - Anthony Ramdath (UWI, T&T)
- Paper based data to be digitally photographed
- Digitized by hand
- Put in Data base
- Pilot project already done in Jamaica
- Clear Understanding of use and possible remuneration to data donor
- ~ US$200K
- 1 year project

Research Idea 2
Monitoring Biodiversity related variables

- Creation of regional network of climate data relevant to understanding biodiversity vulnerability to climate change
- Consultation re monitoring needed with biodiversity group about the type of data needed
  - RH, NDVI, etc
  - Vegetation data from e.g., Japanese satellite ALOS
- Details to be worked out

Research Idea 3
Analysis of Model Runs

- Data analysis of all PRECIS runs, including runs using ECHAM (INSMET and 5C's), 20 km Japanese model for all islands
  - Future time slice scenarios
- Massive data storage and support for graduate students needed
- Explore the possibilities for the establishment of Nodes for storage over the Caribbean through the clearing house at CCCCC.

Research Idea 4
Reducing Uncertainties in Statistical Downscaling

- Project to obtain averages of outputs from 21 IPCC GCMs in format suitable for statistical downscaling for any island in the Caribbean
- Used for downscaling rainfall, streamflows and temp in 1st instance
- 3 year Ph. D. Project
- ~US100K

Research Idea 5
Caribbean Climate Atlas

- Climate Studies Group Mona (CSGM) proposal
- Climatology
- Variability
- Scenarios

Research Idea 6
Climate and Biodiversity- Correlation Studies

A
- Impacts of climate variability/extremes on fishery
- FAO, U. Of British Columbia has quality assured fishery data
- Correlate with recorded ENSO, SST gradients across Atlantic and Pacific etc.

B
- Impact of climate extremes in drought on forest fires .
- Need source of records of forest fires
  - OPDEM, Jamaica
  - SERVIR
  - Etc.

Research Idea 7
Reforest Haiti

- Use regional climate models to simulate what would happen in the future if Haiti is reforested
  - Impact on climate, human well being
- Use results to develop reforestation and land use plans which will generate carbon credits and improve human well being.

Research Idea 8
Coupling Climate and Biodiversity Models

- Try soft linking of climate change and biodiversity models at regional level
- Seek regional models in biodiversity
  - GLOBIO (Global Biodiversity Model)
  - Netherlands model- IMAGE
  - IMPACT model (land use management),
  - DIVA (impacts of sea level rise)

Biodiversity working group

Research priorities

1. Compilation of existing data to produce and complete species/vegetation/habitat maps as a baseline for further research
2. Identification of species/habitat/ natural ecosystems/ agroecosystems that are sensitive to climate change impacts as possible indicators, as well as species/habitat/ecosystems that are resilient to impacts of climate change
3. Vulnerability analysis of both terrestrial and marine specific (indicator) species/natural ecosystems/agroecosystems as well as of ecosystem assemblages linked to key sustainable economic activities.
4. Development of inventories and of comprehensive monitoring systems for the surveillance of the impact of CC on biodiversity as a tool for early warning and adaptive management
5. Vulnerability assessment of protected areas (both marine and terrestrials) and recommendations for adaptation and remediation in order to guarantee long-term viability of conservation and sustainability of the use of the resources.
6. Research and monitoring on the impacts of CC aimed at the development of appropriate co-management tools as a basis for the implementation of ICZM initiatives.
7. Modeling of the impacts of different CC scenarios on biodiversity and associated ecosystem services in order to propose adaptation strategies

	Research areas	Direct link to Sustainability	Need/Value/Benefit	Cost/Exist. capacity	Timeframe
1	Baseline maps				
2	Selection of indicators				
3	Biodiv. Vulnerability				
4	Inventory/Monitoring				
5	Protected Area vulnerability/adaptation				
6	ICZM				
7	Modeling of CC impact scenarios on biodiversity				

INSTITUTIONAL ARRANGEMENTS FOR COASTAL MANAGEMENT IN THE CARIBBEAN

A PRELIMINARY RESEARCH AGENDA

December
2005

Introduction

Over the past six years, a number of research projects have been implemented in the Caribbean, focusing on the relationship between coastal resources, livelihoods, poverty reduction, and governance. Most of this work was funded by the UK Department for International Development (DFID) as part of the Land-Water Interface (LWI) component of its Natural Resources Systems Programme (NRSP). These research projects have involved a range of organisations, including the Caribbean Conservation Association (CCA), the Caribbean Natural Resources Institute (CANARI), the Marine Resources Assessment Group Ltd. of the United Kingdom (MRAG), the University of the West Indies' Centre for Resource Management and Environment Studies (CERMES) and Sustainable Economic Development Unit (SEDU), and the University of Puerto Rico's Sea Grant College Program. In addition, important initiatives have been implemented in the field of sustainable tourism, notably the EC-funded Saint Lucia Heritage Tourism Programme (SLHTP), which is being implemented by Saint Lucia's Ministry of Tourism, as well as a number of local initiatives aimed at linking tourism development, environmental sustainability and community empowerment.

These efforts have contributed very significantly to the development and dissemination of new knowledge and new practice in coastal management and development. They have also helped to identify new issues and directions for future research. The purpose of this brief paper is to summarise this information, as one of the bases for future research planning and programming in this field in the Caribbean region. Without duplicating all the results and information contained in the reports and publications of the various institutions involved, this paper builds on the main conclusions of these projects as well as the presentations made to and discussions held at the seminar on "*Improving Coastal Livelihoods: Lessons Learned from Experience and Priorities for Future Research*" (Soufriere, Saint Lucia, July 2005).

Coastal livelihoods: a development priority, a research priority for the Caribbean region

The Caribbean is, by definition, a coastal region, a region where coastal resource management is critical to sustainable human development. Even when there are no large-scale economic activities (resort tourism, transportation, urban settlements, industry), the value of coastal resources remains high, as they provide a range of social and economic goods and services to local communities and offer great potential for economic development and diversification. However, because the coastal zone is subject to a range of severe environmental impacts from both terrestrial and marine sources, environmental degradation, resource use conflicts and unsustainable forms of resource use are threatening this value, with particularly severe impacts on poor communities.

Natural resources, livelihoods and institutions are subject to a constant process of change. Issues of coastal management and development are being made even more acute because of rapid urbanisation, migration from rural areas and the growing dependence on tourism as a prime economic activity in many of the eastern Caribbean countries, pursuing a path of development that focuses mainly on satisfying the needs of visitors and less on exploring economic opportunities that address issues of poverty, environmental sustainability and host community empowerment.

Coastal resource management issues are therefore both urgent and important to the social and economic development of the region. Yet the links between coastal management, sustainable livelihoods and poverty reduction are currently weak, because:

- most of the agencies that are responsible for coastal planning, management and development do not have a livelihoods perspective, and are not directly concerned with poverty reduction and social development agendas;
- while the "big issues", especially those that relate to the development and management of ports, industrial plants and large-scale tourism infrastructure, have

received and continue to receive the attention of researchers and planners, there is too little research being carried out on the "small issues", in spite of their relevance to thousands of people in small coastal communities;

- the scientific and development literature from other regions of the world is extensive and useful, but it does not always apply to the specific conditions of the insular Caribbean.

There is therefore a clear and urgent need for more research on the issues and opportunities that concern small scale settlements and coastal communities, and in particular on the linkages between coastal management, sustainable livelihoods, poverty reduction and governance. Such research must focus on current issues and needs, but it must also take into account future trends and scenarios, particularly as a result of climate change, population growth, economic transition and social change.

Testing and challenging myths, priorities and opportunities: some research questions

Recent research on coastal zone management and development in the insular Caribbean suggests that some of the dominant views on the relationship between coastal environments, poverty and livelihoods need to be re-examined, and possibly challenged. Some of the interesting questions that have been identified include:

- Do increases in poverty and unemployment among coastal communities necessarily lead to resource degradation? *Recent field experience in the region suggests that this is not the case, and that good environmental stewardship can occur even when socio-economic conditions deteriorate. If so, what are the factors that create and justify unsustainable patterns of resource use, and what are the key ingredients of effective local institutions?*

- What is the role of poor and marginalised people in coastal resource management? *Research in the region suggests that even poor people can manage natural resources sustainably and effectively, and that their involvement in planning and management is always desirable. If so, what is the role of poor and marginalised people, and how can this role be effectively performed and supported?*

- Are there specific pro-poor approaches to coastal resource management and development? *Recent research has concluded that such approaches have a number of specific characteristics, and that more empirical evidence is required to inform policy formulation and programme implementation, especially in relation to access to and tenure of resources, institutional arrangements, information creation and dissemination, and promotion of entrepreneurship and employment creation.*

- What is the place and role of popular knowledge in modern management? *Experience suggests that both scientific and popular knowledge are important, that there are various forms and systems of knowledge that often overlap, and that one of the challenges is for researchers and managers to recognise these systems and create bridges between them. How can these bridges be created? Are there specific tools, including those of community-based mapping and information management, that can contribute significantly to this process?*

- How could and should issues of equity be addressed by future research? *There is a need for a better understanding of the place and role of power and power relations in defining institutional arrangements and in determining how coastal resources are allocated and used. While there is a consensus on the need to promote equity, the factors that militate against equitable use and access are many, and more research*

is needed to explore them and to provide directions and options for policy reform and institutional change.

- Who are the winners, who are the losers, and who decides who wins and who loses? *Much of the current discourse on sustainable development and natural resource management talks about the need to search for "win-win solutions", but experience shows that such solutions are actually hard to find in reality. In the practice of coastal management and development, there are almost always losers (either resource or people), and research is needed to guide the management process, to provide tools for the assessment and mitigation of the negative impacts of change, with the compensation of 'losers' whenever appropriate*.

Research on coastal livelihoods and development must also probe the concept of *poverty* and the manner in which it is understood and communicated by various stakeholders, including the people who live in poverty. Recent focus on poverty within the international community has led to the adoption of a new discourse, and the relevance of that discourse to the realities of the region must be debated.

Sustainable livelihoods: from concept to action

While the concept of *sustainable livelihoods* is attractive and widely accepted, it is proving difficult to put it into practice. This is at least partially because the forces that shape livelihoods and patterns of resource use are constantly changing. There is therefore a need for extensive and systematic research that examines the interplay of opportunities and conditions that ensure that livelihood strategies and patterns of resource utilisation are indeed sustainable, while contributing optimally to poverty reduction.

Research projects of the past few years, as well as the papers, case studies and guidelines presented at the seminar of July 2005, provided interesting lessons on the approaches and tools that are required to promote sustainable development in coastal areas, all of which deserve more in-depth research and exploration, namely:

- there is a need to *mainstream poverty reduction* in all relevant policies, programmes and interventions, and to design mechanisms to *move from local action to macro-economic impacts*, especially in terms of poverty reduction;
- attention must be paid to the design and operations of effective, flexible and durable *institutions*;
- *co-management* can be an effective and suitable arrangement to link participation, sustainable resource use and poverty reduction;
- all programmes and interventions should take place in the context of *integrated planning and management* that responds to changing conditions;
- there is a need for *improved access to finance and credit*, especially for micro businesses and entrepreneurs;
- in order to *stimulate entrepreneurship*, there is a need for capacity and institutional development, but there is also a need for cultural and attitudinal change at all levels;
- in business development, there is also a need for policies, tools and approaches that facilitate the *mobilisation of community assets, including common property natural resources,* in support of entrepreneurship and business development, in a manner that is compatible with the needs and rights of the community;
- sustainable livelihoods and entrepreneurial development require the identification or creation and enabling of *markets* and the development of *products* that are suited to these markets;
- in all these efforts, increased *regional cooperation* is needed, to promote the exchange and enrichment of experiences, approaches and methods.

In the exploration of options for sustainable livelihoods, two particularly critical themes have emerged. First, the experience of the past few years, especially in the innovative work of the SLHTP, has shown the potential benefits of *community-based sustainable tourism*, and has confirmed the need for a more systematic exploration of options and opportunities, as community-based tourism offers one of the very few new opportunities for employment and revenue generation in coastal areas. Second, in tourism as in other sectors, there is need for increased attention to *entrepreneurship*, and for an understanding of the conditions under which such entrepreneurship can flourish in Caribbean coastal communities.

Institutional arrangements for coastal management and development: making co-management work in the Caribbean

One of the research projects of the past few years has focused on the requirements for developing successful co-management in the Caribbean, and it has concluded that collaborative management regimes and institutions hold much promise for the region, because of their effectiveness in sustaining the natural resource base, their flexible nature and their ability to meet the needs and expectations of a wide range of stakeholders.

But the region's practical experience in this field remains limited, and there is a need for field experimentation and analytical research focusing on key questions, including the following:

- what are the methods and processes required to make co-management work in the coastal zone?
- what are the criteria that can be used to assess the desirability and feasibility of different forms or systems of co-management in specific contexts and situations?
- how can the effectiveness and efficiency of co-management regimes and institutions be assessed and measured?
- what is the role of the various agencies, including those responsible for economic development, social protection and poverty reduction, in multi-stakeholder institutional arrangements and management activities for coastal development?
- what is the role of the private sector in various types of institutional arrangements and management programmes, and how can that role be nurtured and strengthened?
- how should the various property rights be defined and allocated among the partners in co-management?
- how can one define the type of decentralisation and delegation that is best suited to specific situations?
- how can the traditional rights of local resource users be recognised, especially the rights of those whose livelihoods depend directly on the use of coastal resources?
- how are individual and collective rights harmonised and reconciled, especially when there is active promotion of entrepreneurship and business development?
- what are the policy and legal instruments that are required to enable co-management, to guarantee the rights of the various management partners and to provide the basis for fair and effective co-management agreements?
- how can collaborative management arrangements contribute to the management and elimination of conflicts over the use of coastal resources, especially those that impact negatively on the poor and the powerless and that result in environmental degradation?
- what are the capacity requirements that enable organisations to participate in co-management arrangements?
- how can new approaches to coastal management and development be translated into new *governance arrangements* that facilitate partnerships, empowerment and effective action?

Past and current work on co-management also points to the fact that coastal management and development is, above all, an exercise in conflict management. Tools and concepts are

therefore needed to allow for a better understanding of these conflicts, and to assist policy makers and managers in making the decisions that are required to achieve desired management outcomes while minimising the negative impacts of conflicts.

Exploring and enhancing the contribution of protected areas to sustainable livelihoods

In the coastal zone, protected areas, usually called Marine Protected Areas (MPAs), have been used as one of the main instruments of natural resource conservation and management in the Caribbean. Over the past few years, a detailed analysis of this experience has been carried out, and an extensive data base has been created. From this work, a few critical questions emerge, which should receive the attention of managers and researchers, including the following:

- do MPAs contribute to effective coastal zone management outside of their boundaries?
- how can MPAs contribute to improved provision of social services to neighbouring communities and settlements?
- how can MPAs meet their conservation objectives while optimising their contributions to economic development and poverty reduction?
- what are the institutional options for coastal resource conservation and management outside of formal MPAs? are there other ways to achieve similar results?

Policy research

There is a need for a better understanding of the policy process, i.e. for research that can inform and guide policy influencing and policy formulation. Some of the research questions include:

- to what extent can *public understanding and awareness* of issues assist in creating demand for policy change?
- how *do public perceptions and expectations* influence the policy process?
- what are the formal and informal *policy mandates* in coastal management and development?
- what are the *priorities* for policy reform and formulation?
- what are the policy *gaps, conflicts and needs* that need to be addressed through policy reform and advocacy?

Policy reform and advocacy require appropriate approaches to and tools for communication, and specific observations can be made in this regard:

- the need to develop, refine and disseminate *communication tools and strategies*;
- the need to *engage civil society and non-governmental organisations* in communication and advocacy processes;
- the need *to involve the mass media* and to promote informed and responsible journalism;
- the need to support *policy action*, i.e. policy research and advocacy that lead to the development and implementation of actual policy instruments;
- the need to conduct activities that aim specifically at *preparing for change* and at facilitating the process of change in a given policy environment;
- the need to manage and guide *public expectations*;
- the need to use *communication tools and techniques*, e.g. websites, efficiently and effectively.

Research activities should be designed and implemented in order to design, test and refine these approaches and tools. They must also examine the policy dimensions and implications of the various issues and questions identified in this research agenda.

Making research useful and relevant to coastal livelihoods

The seminar of July 2005 and the review of various field projects has provided particularly useful views regarding the manner in which research should be designed and implemented, suggesting directions and priorities for the next steps. In this regard, the main points that should be noted as follows:

- appropriate *baselines* should be established in order to permit the *monitoring and evaluation* of social and economic change over time;
- there is a need for rigorous and harmonised, yet flexible, *research frameworks* that allow for the comparison of results and other beneficial interactions between research initiatives while making it possible to respond to new issues and research questions that may arise;
- *case studies* must be developed and disseminated, to provide the examples that are needed in support of capacity-building, advocacy and institutional and policy reform;
- there is a need to *develop cultures of 'learning-by-doing' and 'doing-by-learning'* within organisations, i.e. integrating a learning dimension into the practice of management and development agencies and practitioners, but also integrating a culture of applied research in the approaches of research institutions;
- while new research is needed, it is critical to *deepen the work that is already underway*, to refine past and current research, to provide opportunities to test and assess change and impacts over time, and to use the existing capital to further the exploration of priority issues and research questions;
- it is also important to accelerate the *dissemination of available findings*, to ensure that results are published, and to aim at reaching both a regional and an international audience;
- in this process, efforts must now be made *to link with other research communities and disciplines*, within the Caribbean and in other island developing states and regions, where similar research questions and issues are being explored from other angles and perspectives, as there is much to gain from such an exchange of experiences and lessons;
- *research should be participatory*, and all those who have a stake in the outcome of research processes, beginning with the coastal communities in the location of research activities, should be involved at the various stages of the research process. This involvement should begin with the definition and framing of research questions, to ensure that research activities actually meet the needs of intended beneficiaries. At all stages, suitable methods should be used in order to make genuine participation possible;
- research should serve to *empower communities* and redress power imbalances and to provide all stakeholders with the information, skills and resources they need to participate meaningfully in, and to benefit substantially from, research activities;
- *the results of research should be interpreted and disseminated in* the appropriate forms to all relevant stakeholders, including local resource users and managers. Research should be conceived as an integral component of management, contributing to learning and adaptation on an on-going basis.

Next steps

The views and recommendations contained in this paper should be shared among all stakeholders concerned with issues of sustainable development and coastal management in the Caribbean, and should serve as a platform for discussion and collaboration. While this paper does not provide a specific work plan, it is hoped that it will be used by agencies in the design of research activities, and in the planning and implementation of future research and development initiatives.

Please send comments to Sarah McIntosh at the Caribbean Natual Resources Institute, sarah@canari.org

Caribbean Natural Resources Institute

Change and biodiversity: research for a sustainable tomorrow

Regional meeting
24-25 September 2008, Trinidad

Communication products

- 3 Working group reports
- Strategic research agenda
- Capacity needs assessment

Available in English

Discussion point re WG reports:
- Incorporation of current comments?
- Continue encouraging comments?

Communication products

- Summary of findings of the 3 working group reports (approx 25 pages) in English, French and Spanish
- Policy brief (2-4 pages) in English, French and Spanish
  - Target audience policy makers
  - Messages: needs refining

Dissemination strategy

- All documents available electronically
  - on CANARI website
  - on partner websites
  - available in CD format
- WG summary and policy brief available in hard copy, primarily for libraries, conferences, meetings etc.
- Need: assistance with compiling electronic dissemination list, identifying relevant listservs, website links etc.

Timeframe

- All products to be produced by the end of the year (but could be disseminated in 2009).

Timeframe

- Actions:
  - Draft summary and policy brief (Owen Day/Sarah McIntosh): mid-November
  - Translations (Jose Gerhartz/Yves Renard): end Nov
  - Finalise WG reports to incorporate substantive comments (WG leaders): end Nov
  - Complete climate change webpage on new CANARI website (CANARI): mid November
  - Design and print summary and policy brief: end December
  - Disseminate electronically and hard copy: Jan 09