



Caribbean Community Climate Change Centre

Implementation Plan to guide the delivery of the 'Regional Framework to Achieving Development Resilient to Climate Change'

Regional Diagnostic: Climate Change and Development Research Capacities and Regional Priorities in the Caribbean

Report

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Report for
Caribbean Community Climate Change Centre

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Executive summary

This is a Regional Diagnostic on Research Capacity and Priorities for the Caribbean, designed to aid the delivery of the Implementation Plan for the *'Regional Framework for Achieving Development Resilient to Climate Change'* (the Regional Framework) which defines the region's strategic approach for coping with climate change.

In July 2009 the Heads of Government approved the Regional Framework, which defines CARICOM's strategic approach for coping with climate change and provides a roadmap for action by member states and regional organisations over the period 2009-2015. The Regional Framework comprises five strategic elements designed to significantly increase the resilience of the CARICOM member states' social, economic and environmental systems.

The draft Implementation Plan is now awaiting approval by the CARICOM Heads of Government. It acknowledges that a transformational change in mindset, institutional arrangements, operating systems, collaborative approaches and integrated planning mechanisms are essential to deliver the strategic elements and goals of the Regional Framework.

The Implementation Plan identifies a number of priority challenges and actions for the region, including the imperative to develop capacity by building on the knowledge, information and expertise that already exists in the region. It recognises that a great deal of time, research effort and resources have been invested into impact and vulnerability assessments and that, in some cases, the recommendations and guidance have not been implemented for lack of resources and coordination. The imperative to retain and grow technical, professional, managerial and academic research expertise and capacity in the region has been identified in the Implementation Plan as a priority challenge.

This Research Diagnostic aims to complement the Implementation Plan by documenting knowledge gaps and information requirements identified to deliver the strategic elements and goals of the Regional Framework, along with an assessment of the region's research capacity.

Acknowledgements

The Caribbean Community Climate Change Centre (CCCCC) and the project team wish to acknowledge the support and assistance received during the consultation process and in the drafting of this document. A list of consultees is provided in Annex 3.

Financial support for the development of the Regional Diagnostic

The development of the Regional Diagnostic has only been made possible with the support and financial assistance from The Climate & Development Knowledge Network (CDKN) and the United Kingdom's Department for International Development (DFID) Caribbean. The CCCCC would like place on record its appreciation of the financial support and the technical contribution made by DFID and CDKN.

About CDKN

CDKN is an alliance of six private and not-for-profit organisations, launched in March 2010. Led by PricewaterhouseCoopers LLP, the alliance also includes the Overseas Development Institute, LEAD International, INTRAC, SouthSouthNorth in Africa and Fundación Futuro Latinoamericano in Latin America and the Caribbean, bringing together a wide range of experience.

CDKN's purpose is to support decision makers in developing countries to design and deliver climate compatible development. We do this by combining research, advisory services, knowledge management and capacity building processes in support of locally owned and managed policy processes.

CDKN was set up and funded by DFID and other donors are now also contributing funding. CDKN is independent from DFID, although it works closely with DFID and other donor programmes wherever possible.

For more information visit the CDKN website: www.cdkn.org.

About DFID

DFID is the part of the UK government that manages Britain's aid to poor countries and works to get rid of extreme poverty. As well as headquarters in London and East Kilbride, near Glasgow, DFID has offices in around 40 developing countries and provides aid to around 90 countries.

DFID is working to reach the Millennium Development Goals (MDGs), the international targets agreed by the United Nations (UN) to halve world poverty by 2015.

DFID works with governments of developing countries as well as charities, businesses and international bodies, including the World Bank, UN agencies and the European Commission. All our partners share our ambition to achieve the MDGs.

In the Caribbean, DFID is supporting efforts to improve growth, insecurity and build resilience to reduce the region's extreme vulnerability to natural disasters and climate change and maintain its progress on poverty reduction. For more information visit the DFID website: www.dfid.gov.uk

1 Introduction

1.1 Rationale for this research diagnostic

Caribbean Community (CARICOM) countries have considerable cause for concern as the threats posed by a changing climate to their development prospects are severe, and both mitigation and adaptation will require a significant and sustained investment of resources that the Member States will be unable to provide on their own.

Building climate resilient low carbon economies requires a transformational change by governments, regional organisations, NGOs, the private sector and civil society supported by an unprecedented level of financial and technical assistance from the developed world.

This concern is reflected in the Liliendaal Declaration endorsed by the CARICOM Heads of Government (CARICOM, 2009). The Liliendaal Declaration defines the national and international position of the CARICOM member states and makes a number of declarations, which can only be delivered by transformational changes to build regional capacity to respond to the challenges brought on by climate change.

At the same meeting in Guyana in July 2009 the Heads of Government also approved the 'Regional Framework for Achieving Development Resilient to Climate Change' (the Regional Framework) which defines CARICOM's strategic approach for coping with climate change. The Regional Framework is guided by five strategic elements and some twenty goals designed to significantly increase the resilience of the CARICOM member states' social, economic and environmental systems. The strategic elements are as follows:

1. Mainstreaming climate change adaptation strategies into the sustainable development agendas of CARICOM states.
2. Promote the implementation of specific adaptation measures to address key vulnerabilities in the region.
3. Promote actions to reduce greenhouse gas emissions through fossil fuel reduction and conservation, and switching to renewable and cleaner energy sources.
4. Encouraging action to reduce the vulnerability of natural and human systems in CARICOM countries to the impacts of a changing climate.
5. Promoting action to derive social, economic, and environmental benefits through the prudent management of standing forests in CARICOM countries.

The Regional Framework provides a roadmap for action by member states and regional organisations over the period 2009-2015, while building on the groundwork laid by the Caribbean Community Climate Change Centre (CCCCC) and its precursor programmes and projects in climate change adaptation. It also builds upon the extensive work undertaken by governments, regional organisations, NGOs and academic institutions in recent years (and in many cases funded by the international development community) assessing the impacts of a changing climate.

The Heads of Government also asked the CCCCC to prepare an Implementation Plan (IP) to take forward and deliver the strategic elements and goals identified in the Regional Framework. The Implementation Plan acknowledges that a transformational change in mindset, institutional arrangements, operating systems, collaborative approaches and integrated planning mechanisms are essential to deliver the strategic elements and goals of the regional framework. The

Implementation Plan only covers the 15 CARICOM member states¹. This research report is focussed on these 15 countries, although many of the messages will have a wider regional application. CDKN research funding will be used to support research priorities as identified in the Implementation Plan.

The Regional Framework and Implementation Plan provide the context and the overview for a research programme in the Caribbean, a region which currently deals with climatic variability and extreme events, and is projected to be confronted with considerable impacts associated with a changing climate.

The Caribbean states share many of the following social, economic and environmental challenges:

- heavy dependence on natural resource base (agriculture, forestry, fishing, tourism, mining, and light manufacturing);
- high external indebtedness that in some cases is above 115% of gross domestic product (GDP);
- susceptibility to the vagaries of international trade;
- insufficient generation of scale economies;
- high transportation and communication costs;
- high energy costs that reduce the prices competitiveness of their products;
- high levels of emigration of skilled personnel;
- extreme vulnerability to natural disasters;
- scarce land resources; and
- ever-increasing pressures on coastal and marine environments.

These are compounded by the additional challenges of widespread poverty, high population density, rapid urbanisation, food and energy insecurity, a lack of infrastructural resources and inadequate data collection and management to allow for informed decision making and robust development planning. Climate change, combined with these challenges, poses a severe threat to Caribbean countries' development prospects. Given that the region contributes less than 0.1% of global greenhouse gases (GHG) (IPCC, 2007) the focus has been centrally on adaptation to climate change and its related events. But, adaptation will require a sizeable and sustained investment of resources.

1.2 Objectives of the regional diagnostic

The overall project objective is to identify the areas in the Regional Framework and the Implementation Plan which will require evidence-based research and research-based tools that are not already available. The specific objectives of the Regional Diagnostic are to:

- Identify knowledge gaps and research priorities required for the activities in the Regional Framework Implementation Plan;
- Document current priority research gaps on climate change and development with experts in the field to inform the CDKN regional research strategy;

¹ Members of CARICOM: Antigua and Barbuda, The Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, Saint Lucia, St. Kitts and Nevis, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago.

- Identify key research providers, applied academics and research-oriented policy makers in the region to raise awareness of CDKN and its mission amongst academics;
- Document existing research partnerships and structures;
- Investigate and document regional research capacities and strengths and relative weaknesses and abilities to engage on future research bids amongst research institutions in the region; and
- Provide a useful document for other potential research funders on climate change in the Caribbean.

This report will be included in the Implementation Plan as a technical annex, and will also be used as a basis to inform a regional research call by CDKN.

A potential funder of research activities in the Caribbean is CDKN, whose research outputs tie in closely with the rest of CDKN activities. Research is demand-driven, primarily by developing country governments, with additional expert inputs in its design. The research programme identifies where substantive knowledge gaps exist and seeks to fill these with robust, high quality research. CDKN will carry out research into a wide range of climate and development issues in order to respond to the breadth of demand, but CDKN's research calls will develop specific expertise on a number of key themes. CDKN's research focuses on a set of five key principles:

- Excellence and quality: "We focus on supporting the best quality research in climate change and development, to be produced as scientific journal articles and briefings for non-specialist consumption".
- Response to demand: "CDKN's well-targeted, accessible and high quality research benefits from the Network's direct link to policy-makers. We aim to integrate research throughout the policy-making process to ensure that decision-makers take it up as early as possible".
- Fostering partnerships and networks: "We foster relationships between research institutions and actors in the research-policy arena, in particular through training and mentoring, and by assisting the development of long-term South-North and South-South relationships".
- Impact: "CDKN will closely monitor the impact and uptake of research outputs created through its funding stream. We will hone and review the funding process on an ongoing basis to ensure greatest productivity, effectiveness and value for money".
- Ethics: "CDKN expects the highest ethical standards of its researchers, and alignment with rigorous ethics policies on research".

1.3 Research diagnostic methodology

This Regional Diagnostic:

- summarises the current priorities for climate change and development research in the CARICOM member states based on discussions with the regional research community,
- comments on regional capacity to conduct and communicate research,
- identifies existing networks and partnerships, and

- highlights potential barriers and opportunities for future research partnerships.

The report was produced following a desk review and consultation process, which included the following:

- A Regional Diagnostic Research Capacity and Priorities workshop, held in Saint Lucia on 5th May 2011. This workshop was attended by approximately 20 regional researchers, together with representatives from regional financial institutions and trade associations. A summary workshop report is provided in Annex 2.
- A comprehensive desk review stock-take compiling:
 - key research institutions in the region and internationally working on climate change and development issues in the region,
 - a summary of the main research projects and research networks in the region on climate change and development, and
 - links to existing reports and consultations.

This stock-take has been included within a database created during the preparation of the Implementation Plan. A web-based tool is being developed by the Caribbean Community Climate Change Centre (CCCCC) to enable open access.

- Further consultations (for those who were not able to attend the workshop) with Caribbean and international (e.g. North America and the UK) researchers and representatives.

The report also builds on the extensive consultation process undertaken by the CCCCC during the preparation of the Implementation Plan involving an extensive programme of in-country discussions with politicians, government officials, regional agencies, NGOs, the private sector, donors and development banks. For the most part these discussions were undertaken on a one-to-one basis or in small groups, followed by further engagement and focussed on identifying those actions stakeholders believed were required to be undertaken within the next 2 to 5 years. Meetings were held with over 140 stakeholders during the in-country discussions over a period from September 2010 to June 2011. Two major workshops were held in Barbados in November 2010, and in Saint Lucia in May 2011 in addition to the meetings.

The research diagnostic commenced in April 2011, building on the contacts developed and the discussions held during the Implementation Plan consultation process. A one day workshop was held in Saint Lucia in May 2011 and followed on from a two day workshop for the Implementation Plan.

2 Climate change and development priorities

This section of the report summarises prior knowledge on priorities on climate change and development in the region.

Global climate change is the most serious threat to sustainable development facing CARICOM states. According to the IPCC (2007), the projected impacts of global climate change are expected to be devastating. These impacts would be reinforced due to the limited adaptive capacity of CARICOM small island and low-lying coastal states. Specifically, global climate change is expected to result in more hostile regional climate change and rising sea levels. The rising sea levels with associated coastal erosion and salt water intrusion, an escalation in the frequency and intensity of tropical storms and hurricanes, and disruptions in rainfall and fresh-water supply threaten the very existence of the small island and low-lying coastal states of the Caribbean.

The seriousness of the challenge global climate change poses to the development prospects of small island and low-lying coastal states is addressed in the Barbados Plan of Action (BPOA), as the first of 14 priority areas for achieving sustainable development. In July 2009, the CARICOM Heads of Government at their meeting in Guyana endorsed the *Liliendaal Declaration*, expressing grave concern that the region's efforts to promote sustainable development and achieve the Millennium Development Goals (MDGs), including the eradication of extreme poverty and hunger and ensuring environmental sustainability, are under severe threat from the devastating effects of climate change and sea level rise. Of particular note is the increasing intensity of extreme weather events, resulting in severe damage to the region's socio-economic resource base, due to the direct and indirect climate impacts on infrastructure, tourism, agriculture, fisheries and forestry. Disaster risk reduction is crucial to aid the process of building resilience to climate change impacts and needs to be integrated with all future development plans. The *Declaration* emphasized that dangerous climate change is already occurring in all Small Islands and Low-lying Coastal Developing States (SIDS) regions, including the Caribbean, requiring urgent, ambitious and decisive action by CARICOM states and by the international community.

At the same meeting in 2009, the Heads of Government also approved the '*Regional Framework for Achieving Development Resilient to Climate Change*' (the Regional Framework) which defines CARICOM's strategic approach for coping with climate change. The Regional Framework is guided by five strategic elements and some twenty goals designed to significantly increase the resilience of the CARICOM member states' social, economic and environmental systems, as outlined in section 1.1. The Regional Framework provides the climate change and development priorities as defined by the strategic elements and goals, and the overall summary of knowledge on priorities.

In response to the priority given to the issue of climate change in the BPOA, the region has systematically been addressing the issue of capacity-building to climate change since 1998. Caribbean countries have implemented a range of national enabling activities and participated in a number of major regional projects designed to build institutional, national, and human capacities. This has resulted in a better understanding of actual and potential climate impacts on the region. The most important activities to date, as outlined in the Regional Framework, include:

- National Enabling Activities (NEAs): The completion of First National Communications, Green House Gas Inventories, and Vulnerability Assessments with assistance from a Global Environmental Facility-funded initiative, supported by the United Nation Development Programme's National Communications Support Programme.
- The Caribbean Planning for Adaptation to Climate Change (CPACC) project (1998-2001): This GEF Stage I project was implemented by the World Bank and executed by

the Organization of American States (OAS). It responded to mandates in the SIDS/BPoA at the national, regional and international levels. It has assisted CARICOM countries develop national programmes to address the challenges of climate change, including the design of a Regional Sea Level/Climate Monitoring Network, and regional database and information systems to help regional and national institutions acquire, analyse, store, and disseminate data. In addition, National Climate Committees were established in all CPACC participating countries.

- The Adaptation to Climate Change in the Caribbean (ACCC) project (2001-2004): This is a CIDA-funded initiative that provided an effective bridging facility between CPACC and the Mainstreaming Adaptation to Climate Change (MACC) project. It built on the foundation laid by CPACC, including addressing some of the gaps identified during implementation of the CPACC project. This Project facilitated the establishment of the Caribbean Community Climate Change Centre (CCCCC) that was founded at Belmopan, Belize (2004).
- The Mainstreaming Adaptation to Climate Change (MACC) project (2003-2009) is being finalized by the CCCCC with GEF funding through the World Bank: This project focuses on creating an enabling environment to enhance adaptation programmes across the region by:
 1. developing national policy frameworks for adaptation;
 2. mainstreaming climate change issues into key sectoral activities;
 3. preparing national pilot adaptation projects;
 4. strengthening public awareness and participation in climate change programmes;
 5. further strengthening of the knowledge base; and
 6. facilitating the development of monitoring, analysis, and the building of regulatory planning instruments for mainstreaming climate change issues in the region.
- The Implementation of Adaptation Measures in Coastal Zones (SPACC) project (2006 – 2011): This is a GEF activity which is funded through the World Bank to implement specific (integrated) pilot adaptation measures that primarily address the impacts of climate change on the natural resource base of Dominica, St. Lucia and St. Vincent and the Grenadines. Project activities include the design and implementation of adaptation measures to reduce the vulnerability of buildings to hurricanes, enhance water capture and use; pilot renewable energy options, support land use planning and management, and reduce anthropogenic stress on national parks and key natural habitats, while at the same time enhancing ecosystem resilience.

As evidenced in the list above, there are a number of external organisations supporting climate compatible development in the Caribbean, including the World Bank, largely through their Global Environmental Facility (GEF), the Organization of American States (OAS) and Canadian International Development Agency (CIDA). Amongst others, the United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP), UK Department for International Development (DFID), Inter-American Development Bank (IDB) and United Nations Economic Commission for Latin America and the Caribbean (UNECLAC) are also very active in the Caribbean region, providing funding and support to the following projects, which highlights the areas they view as a priority:

Water resources:

- National Integrated Water Resources Management Policy (including climate change) for Belize (World Bank, UNDP)
- Climate Change-induced drought adaptation strategy for the Caribbean region and beyond (UNDP)
- Water and Sanitation Programme, South East and Central Haiti (UNDP)
- Rainwater Harvesting (RWH) Project (UNEP)
- Case Study on the Impact of Climate Change on Water and Sanitation in Jamaica (UNDP)
- Adapting to climate change in water resources and water services in Caribbean and Pacific small island countries (GEF, UNDP, UNEP)

Disaster management:

- Needs Assessment for Capacity Building in Risk Management and Vulnerability Reduction in the Caribbean Islands of Antigua and Barbuda, Barbados, Cuba, Dominica, and Grenada (UNDP)
- Enhancing Disaster Preparedness in the Caribbean (UNDP)
- Comprehensive Approach for Disaster Management in the Caribbean (CDM) (UNDP)
- Caribbean Disaster Risk Management Program (CDRMP) (GEF, UNDP)
- Comprehensive Disaster Management Harmonized Implementation Programme (CDM-HIP) (Phase 1) (DFID, CIDA)
- Caribbean Hazard Mitigation Capacity Building Programme (CHAMP) (CIDA)
- Updating Building Codes of the Greater Caribbean for Winds and Earthquakes - Phase I (IDB)
- Caribbean Catastrophe Risk Insurance Facility (CCRIF) (UNECLAC)
- Enhancing Gender Visibility in Disaster Risk Management and Climate Change in the Caribbean (UNDP)
- CARIBSAVE Climate Change Risk Atlas (CCCRA) (DFID)

Agriculture and food security:

- Global Environmental Change and Food Systems Caribbean project (GECAFS Caribbean) (UNEP)
- Case Study on the Impact of Climate Change on Agriculture on an Indigenous Community in Guyana (UNDP)
- Case Study on the Impact of Climate Change on Agriculture and Housing on Indigenous Communities in Suriname (UNDP)

Economic sectors:

- Review of the Economics of Climate Change (RECC) in the Caribbean project (DFID, UNECLAC)

- Economics of Climate Adaptation (ECA) Initiative (UNECLAC)
- Assessments of Impacts and Adaptations to Climate Change (AIACC) (UNEP)
- CARIBSAVE Modelling Impacts of Climate change and Sea Level Rise (UNDP)
- CARIBSAVE Seed Funding Project (Caribbean Climate Change, Tourism and Livelihoods: A sectoral approach to vulnerability and resilience) (DFID, UNEP)
- Climate Change and Tourism: Responding to the Global Challenges (UNEP)
- Disaster Risk Management for Coastal Tourism Destinations Responding to Climate Change (UNEP)
- Regional Disaster Risk Management for Sustainable Tourism in the Caribbean Project (IDB)
- Analytical Support for Climate Change Action in Cities in Latin America and the Caribbean (IDB)

Energy:

- The Caribbean Renewable Energy Development Programme (CREDP) (UNDP, GEF)
- Sustainable Energy and Climate Change Initiative (SECCI) (IDB)
- Sustainable Energy Framework for Barbados (IDB)

Full details of these programmes will be available in the web-based tool currently being developed by the CCCCC.

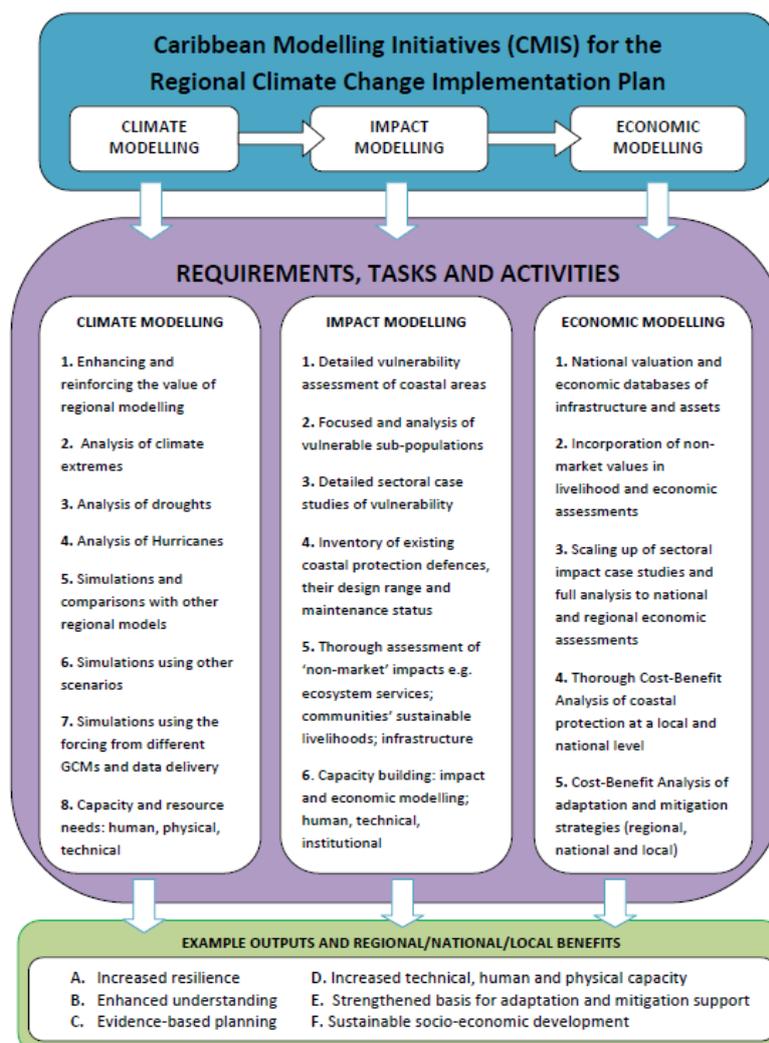
3 Published Caribbean research institution programmes

This section summarises current or recent research taking place at Caribbean research institutions and consortia. This information is based on several documents that were submitted in advance of the workshop, with the purpose of providing a basis for discussion, and hence does not provide a complete picture of all the research being undertaken in the region.

3.1 Climate Modelling, and Impact and Economic Modelling Implementation Plan (2011 –2021)

There are several activities that make up the Caribbean Modelling Initiatives (CMIS), which will provide outputs that can assist decision makers in the public and private sector understand the predicted changes in climate, their impacts and socio-economic effects in the Caribbean region. The modelling initiatives are divided into three sections:

1. Caribbean Climate Modelling Initiative (CCMI),
2. Impact Studies Modelling, and
3. Economic Modelling.



These will yield specific outputs and deliverables, the chief ones are listed below:

- A coordinated framework for pursuing climate science in the Caribbean and for the delivery of timely results.
- Multi-model analysis (under different scenarios) of climate change at the scale of the Caribbean basin.
- Expanded database of regional model output for the Caribbean, including maps and graphs differentiating the results by sub-regions.
- Validated methodology for detecting and projecting changes in tropical cyclone frequency and intensity in the Caribbean under climate change.
- A comprehensive study of meteorological and agro meteorological drought in the Caribbean under climate change
- A completed down-scaled analysis of climate extremes.
- A framework for conducting new impact and sectoral studies.
- Training of new regional experts, and institutional, human and technical capacity building in climate change modelling and its' applications (climate, impact and economic) and the launching of a climate model interface for the Caribbean
- An accurate valuation database of the assets (physical and livelihood/nonmarket) and costs associated with building protective structures along the coasts of the Caribbean islands, especially near major urban centres and popular tourism developments
- Comprehensive data on the vulnerabilities to climate change impacts for key sectors including: water, coastal and marine ecosystems, tourism, human health and energy
- Improved methodology for the costing of impacts including a database of asset values across countries and analysis of gender differential and vulnerable sub-groups
- Thorough and comprehensive cost-benefit analyses of adaptation and mitigation strategies, nationally, locally and across the region
- Inventory of nonmarket values and coastal protection defences (inc. design and maintenance)

The research institutions involved in the consortium are:

- Climate Studies Group, Mona (Climate Studies Group, Mona-CSGM) – Jamaica
- University of the West Indies, Cave Hill – Barbados
- Caribbean Institute of Meteorology and Hydrology (CIMH) – Barbados
- Instituto de Meteorología (INSMET) – Cuba
- Anton de Kom University of Suriname – Suriname
- Caribbean Community Climate Change Centre (CCCCC) – Belize
- The CARIBSAVE Partnership (CARIBSAVE) – Barbados
- The Hadley Centre – United Kingdom
- The University of Oxford – United Kingdom

3.2 Developing National Research and Monitoring Capacity for the Management of Belize's Marine Protected Areas and Natural Resources

In September 2010, the University of Belize Environmental Research Institute (ERI) was awarded a five year grant by the Oak Foundation, submitted on behalf of the University for a project entitled: Developing National Research and Monitoring Capacity for the Management of Belize's Marine Protected Areas and Natural Resources. Implementation of the project began on November 1st, 2010. The ultimate goal of this project is to develop a research and capacity building mechanism within the national University that will enable a sustained program of scientific research and monitoring in Belize.

<http://www.eriub.org/projects/national-research-monitoring.html>

3.3 Regional climate modelling, including PRECIS, WRF, RegCM3 and ERA15

At the University of the West Indies (UWI) Mona campus, PRECIS has been used present-day and SRES A2 studies using the HadAM3P and ECHAM4 boundary conditions data. WRF (4km resolution) is forced using ERA40 data to simulate present-day climate and with CCSM3 data for the A1B scenario and performs better with high-altitude areas because of its ability to represent orographic processes. However, the WRF does not capture the mid-summer drought. The performance of PRECIS over the Caribbean domain has been evaluated and published. In particular, their focus has been the studies of Caribbean Low-Level Jet (CLLJ) and the mid-summer drought (MSD). To supplement studies using PRECIS, there are plans to use the high-resolution (20km) climate model data from the Meteorological Research Institute (MRI), Japan and the REMO model from Max Plank Institute, Hamburg, Caribbean Natural Resources Institute (CANARI).

At the UWI Cave Hill campus, the modelling efforts are focused on 25km simulations using PRECIS over the small islands in the Eastern Caribbean. The completed simulations include present-day, SRES A2 and SRES B2 simulations using the HadAM3P and ECHAM4 forcing data. There are also efforts to use the method of “direct-area downscaling” of GCM’s to produce high-resolution outputs for small areas without running computationally expensive RCMs and in light of the absence of historical data.

At the Cuban Institute of Meteorology (INSMET), PRECIS has also been used to carry out present-day and scenario simulations using ERA15, HadAM3P and ECHAM4 data. Simulations to study the effect of resolution and domain size on model's ability to reproduce climate features of the Caribbean have been performed. The preliminary results highlight the need of using high resolution climate models to generate climate change information for the island nations in the Caribbean. Regional Climate Model RegCM3 is also used for present-day simulations driven with ERA15 and its results are compared with observations as well as those from PRECIS. The PRECIS experiments using the CORDEX domain are carried out at INSMET for the ERA Interim data and are presently being evaluated. INSMET is planning more PRECIS experiments using the perturbed physics boundary conditions from the Hadley Centre. These experiments will be carried out in collaboration with UWI Mona.

3.4 Hydrological modelling

At Caribbean Institute of Meteorology & Hydrology (CIMH), modelling activities mainly focus on surface and ground water modelling using FLO-2D, HydroGeosphere, and MIKSHE. There are also plans to carry out climate model simulations using WRF and REMO, together with a Flood Forecasting Project, Barbados Groundwater Study and CARIWIN project.

3.5 Climate Change and Biodiversity in the Caribbean (CCBIC) Project (2007 - 2008)

This project, which was funded by the John D. and Catherine T. MacArthur Foundation and undertaken by the Caribbean Natural Resource Institute (CANARI), focused on increasing understanding and consensus about the predicted climate change trends and their impact on biodiversity in Caribbean small island developing states. The goal was 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 might address climate change in the region. Three working groups focused on the development of climate change scenarios and models; coastal and marine biodiversity; and terrestrial biodiversity.

<http://www.canari.org/macarthurclimatechange.html>

3.6 Regional Framework

Within the Caribbean Agricultural Research and Development Institute (CARDI) Medium Term Plan (MTP) 2008 – 2010, climate change has a prominent position. It is under Strategic Action 1, which expresses the core functional elements of CARDI's mandate and is directly linked to food production. Strategic Axis 1 comprises two Focal Areas, 'Science, Technology and Innovation' and 'Natural Resource Management' (NRM).

The NRM Focal Area addresses environmental limitations, constraints and opportunities that influence the attainment of sustained and efficient production and productivity. The Priority Areas identified in this focal area are:

- Invasive species
- Climate change
- Biotechnology

The Programmes include support to invasive species initiatives Coordination of Climate Change and Disaster Management, and Biotechnology development.

<http://www.cardi.org/commodities-themes/natural-resource-management/>

3.7 Assessment of Legal Preparedness for Participation in the Carbon Market by Members of the Caribbean Community (2011)

In partnership with the CCCCC, the International Development and Law Organization (IDLO) will conduct an assessment of the national and regional legal environment that fosters participation in the carbon market. The proposed project will be the first phase of implementation in a more comprehensive program of Legal Preparedness for Climate Change, to be implemented subject to the availability of funding.

Project outputs will include:

- Legal Preparedness Assessment Report identifying legal and institutional barriers to participation in the carbon market.
- Stakeholder consensus building events convened to develop Legal Action Plans in select Caribbean countries.

<http://www.idlo.int/Documents/LPCCIRecipientCountries.pdf>

4 Priority research gaps and key research questions in the Caribbean

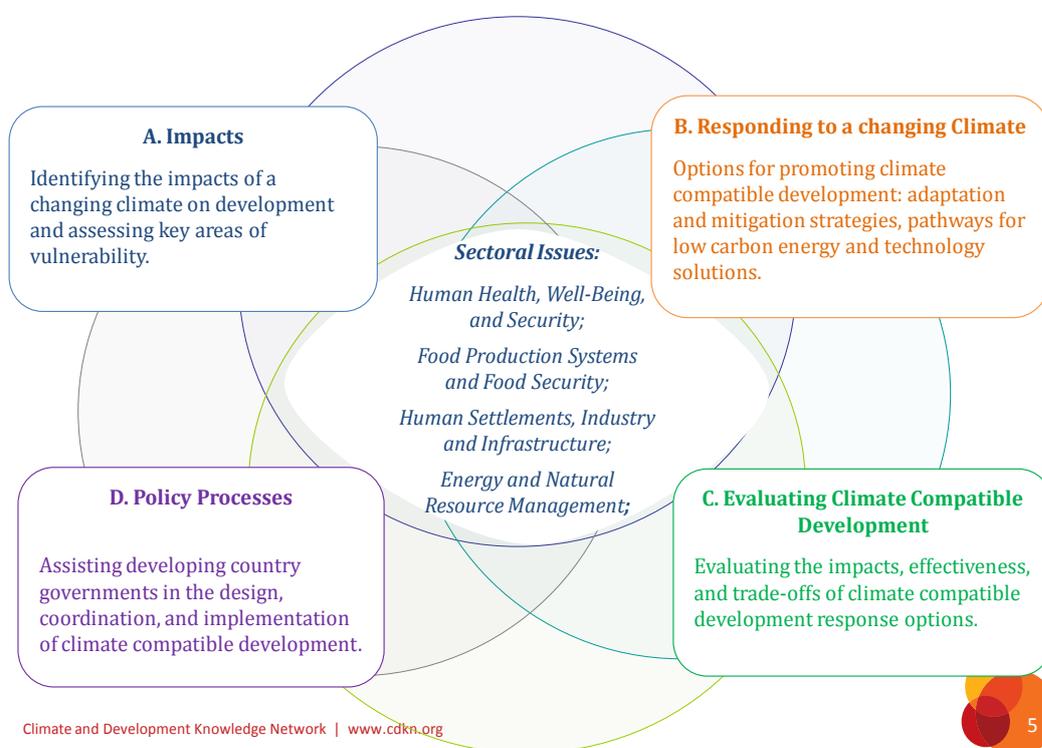
This section of the report presents and analyses the results of the consultations (conducted in person, through the regional workshop in Saint Lucia on 5th May 2011, and by telephone). The individuals consulted were predominantly active researchers based largely in the Caribbean, plus a couple in North America and the UK, together with representatives from regional financial institutions and trade associations. The full list of consultees can be found in Annex 3.

4.1 Priority research gaps

This chapter of the report presents and analyses the results of the consultations with regional research specialists. The research priorities for climate change and development in the Caribbean region are outlined below according to the four CDKN research themes (see **Error! Reference source not found.** below):

- **Impacts** (e.g. modelling bio-physical changes, assessing the socio-economic implications, identifying vulnerability hotspots)
- **Responding to a changing climate** (or the building blocks of climate compatible development e.g. adaptation or mitigation options)
- **Evaluating climate compatible development** (e.g. cost-benefit analysis, identifying trade-offs, decision-making tools)
- **Policy processes** (e.g. politics and power, the role of institutions)

Figure 1: CDKN Research Themes – Fostering Climate Compatible Development



4.1.1 Impacts

In order to assess and model the impacts of a changing climate, it is crucial that **climate hazards** are sufficiently understood. There is a need to focus climate change science research to ensure that the specific climatic drivers in the Caribbean are captured and understood. This will help policy-makers and practitioners understand the Caribbean's current exposure to climate variability and the actions that need to be taken. In order to do this, the following are required:

- Accurate and geographically dispersed baseline data, for example, the expansion of sea-level monitoring.
- Improve understanding of changes in oceanographic systems, physical oceanographic process and coastal geomorphology.
- Climate projections need to be country-specific, which could be addressed through the use of higher resolution climate models or statistical downscaling.
- Detailed analysis of tropical cyclones, particularly the effect of warming on tropical storms and how the frequency, geographic distribution, duration and intensity will change over time.
- Further research to gain a better understanding of the influences of the Equatorial Trough, the El-Niño Southern Oscillation (ENSO) and other regional influences on the area.
- Development of multi-hazards, multi-zone geographic information systems (GIS), to provide a detailed understanding of the overlays between climate hazards and receptors.
- Identifying and understanding the drivers for current climatic variability in the Caribbean.

Considering the assessment of the **impacts** of a changing climate, it is important to highlight the need for a holistic approach. Numerous interviewees stressed that the interconnections between natural resources (and in particular water) and other systems (e.g. social, economic systems) are not well studied or understood in the Caribbean. It was emphasised that cross-cutting research and collaboration needed to take place, for example one consultee stated that many people do not understand the relationship between agriculture, forestry and health, together with water and health. Research gaps appear when people within these disciplines work in isolation.

Having understood climate hazards, the next key challenge is to develop a risk ethic and undertake research within a risk assessment framework. This has been identified as a priority challenge in the Implementation Plan and underpins the Research Framework. A risk assessment approach will provide research that is more readily usable by decision-makers. It also has a major advantage in that it encourages exploring a wider research context, inter-relationships between hazards and impacts, and a multi-disciplinary approach.

Sectoral research gaps, with respect to climate change impacts, are explored in more detail below.

Coastal Zone: Coastal and marine infrastructure

It was stated by the consultees that some work is underway in this sector, with specific reference made to the UNDP-funded work undertaken by the CARIBSAVE partnership to assess the economic impacts of coastal inundation under different sea-level rise scenarios (Simpson et al., 2010). This report provides a detailed and vigorous assessment of the losses and damages associated with sea-level rise impacts on the population, ecosystems and key economic sectors in CARICOM. Although highly valuable in itself, it was stressed that there is a further need to undertake detailed and localised climate risk assessments of the vulnerability of infrastructure to inundation and erosion.

This should include infrastructure that supports economic sectors, either directly (e.g. tourism – ports, coastal highways, hotels, water supply, and beaches) or indirectly (e.g. health facilities, security and military installations, playgrounds and community centres/facilities, schools). Coordinated approaches to coastal zone management and robust data collection are necessary in order to comprehensively analyse the vulnerability of marine and coastal infrastructure to a changing climate, and to take account of these more formally in decision-making processes for efficient technology adoption and disaster preparedness.

Coastal Zone: Coastal and marine ecosystems

Historically, there has been a wealth of research undertaken and available on the impacts of climate change on coral reefs. The World Bank-funded project '*Caribbean Planning for Adaptation to Climate Change (CPACC)*', running between 1997 and 2001, contained a component that sought to increase the existing knowledge about the extent and sources of coral reef degradation in three countries (The Bahamas, Belize, Jamaica). CPACC was executed by the Organization of American States (OAS), overseen by a Project Advisory Committee chaired by CARICOM and implemented by a Regional Project Implementation Unit, established by the University of the West Indies (UWI) and based in Barbados. The CPACC project developed a number of informational tools, such as the Coastal Resources Information System (CRIS). This project was followed by the '*Mainstreaming Adaptation to Climate Change (MACC)*' project, between 2003 and 2009, that strengthened the climate and coral reef monitoring network, through upgrade and expansion of the sea level, coral reef, and climate monitoring network installed by CPACC.

However, there is a number of other gaps with respect to the coastal and marine ecosystem, with less information available on:

- Other coastal and marine ecosystems, such as mangroves, sea-grass and continental shelf fish communities,
- Coral diseases and invasive species in the region, and how they are influenced by climatic factors,
- Spatial extent of coastal and marine ecosystems,
- Inventories of flora and fauna,
- Basic biology and responses of species including seabirds, waterfowl, and key cetacean species,
- Climate change impacts on plankton distribution and algal blooms, which are key components of the marine food-chain and also potentially harmful to humans,
- Linkages among species and systems within the overall marine ecosystem which comprises the Caribbean Sea and adjacent water bodies,
- Linkages between coastal-marine areas and terrestrial ecosystems, both within the Caribbean region, at a catchment-scale, and externally (for example across regional watersheds such as the Amazon and Caribbean Sea),
- Physical oceanographic process and coastal geomorphology, and their changes as a result of climate change (e.g. ocean currents and circulation, sediment erosion, transportation and deposition, changes in salinity, water temperature, water chemistry and concentration of carbon dioxide in the oceans) within the region (at the regional and local levels),

- Man-made inputs into the marine environment, including sedimentation, pollution discharges and transportation, as well as the way that climate change may affect these inputs,
- Monitoring of ecosystem changes,
- Climate change impacts for marine flora and fauna, and hence fisheries (production, distribution, species composition etc) and the social and economic impacts (implication for employment and food security).

There is a need to map and assign a value to all coastal ecosystems, abundance, diversity and habitats; this would involve documenting their location, state of health and respective contribution to economic development. This would naturally build on the CARIBSAVE *Climate Change Risk Atlas (CCCRA)* project, which identifies the impacts of climate change in 15 countries across the Caribbean, on key sectors as they relate to tourism and livelihoods (see <http://caribsave.org/index.php?id=5>). The CCCRA project is using climate models, examining sectoral vulnerabilities, assessing adaptive capacity and developing practical response strategies with the countries across the region. There is also the need to construct different scenarios, i.e., different levels of sea level rise and what these would mean for the coastal assets. In this case, the use of aquacams to determine diversity, health, abundance, etc of various marine species may also be useful. The currently large variation in the availability of ecosystem data makes it difficult to go beyond site-specific statements.

Water resources

The Implementation Plan highlights that a priority action is to undertake a water resource assessment of both ground and surface water. Consultees also highlighted a number of specific research gaps regarding the supply, demand and management of water resources.

Supply:

- Impact of saline intrusions on freshwater resources, as a result of sea level rise;
- Assessment, quantification and mapping of groundwater resources;
- Understanding how different catchments will react under different climate and land management scenarios;
- Determining the environmental requirements in catchments and river systems.

Demand:

- Estimating future total water demand under various climate change scenarios and future water demand across different sectors (domestic and commercial users, farming, energy, tourism and ecosystems).

Management:

- Understanding how the natural storage capacity of the watershed will be impacted by climate change;
- Storage and rationing of water, including use of appropriate infrastructure and design. This may involve the potential redesign of the urban environment;
- Management of water during periods of excess water, in both rural and urban environments. There is a need to assess urban drainage issues and management of flood water from the marine, fluvial and pluvial sources.

- There is also the fundamental problem of water leakage and water wastage, with a need to assess the feasibility of a system that allows for better and more efficient water pricing, along with the incentive regime to encourage innovation, wastewater treatment, etc.

It was recognised by the participants that water must be considered as an integral element of all climate change impact research, rather than in isolation.

Agriculture and fisheries

With respect to agriculture, priority issues identified to reduce the risks to the region's food security associated with a changing climate include:

- Identifying drought-resistant crop varieties that yield more mass per unit of water consumed;
- Promoting better soil management, fertilization and pest and weed control;
- Improving irrigation management through better timing of the provision of water supplies to help reduce stress at critical crop growth periods;
- Using more deficit, supplemental and precision irrigation systems;
- Encouraging improved farming practices that reduce land degradation;
- Developing a hazard risk reduction strategy for the agricultural sector to address impacts over the short, medium and long term;
- Research in projected land use changes associated with climate change, which has implications for agriculture, food security, migration and other social impacts;
- Utilising traditional knowledge and its relevance for adaptation;
- Developing agricultural projects which increase Carbon sequestration and can gain support of the Clean Development Mechanism (CDM).

There is a need to undertake country-specific vulnerability studies for food security, which look at agricultural production and other elements / challenges (including climate change). It was highlighted that a series of pilot projects (sweet potato) are currently being undertaken in Jamaica by UWI (Mona – Climate Studies Group) that utilise climate and crop yield models in order to develop a tool for non-scientists. It was suggested that this could be extended across the Caribbean region to give wider coverage of staple and added value crops, and countries.

Furthermore, given that most of the agriculture crops are cultivated on the coast of the Caribbean countries, the issue of saltwater intrusion, associated with a rising sea level and exacerbated by dry El Nino type episodes, are all important to study and to gain a better appreciation of their occurrences. This is also vital for the impacts on coastal aquifers.

With respect to fisheries, there is a research need to better understand fisheries systems. At the national level, some fisheries data does exist, but there is a need to gain an understanding of the level of detail and completeness, together with knowledge of the areas where it needs strengthening. Research needs include:

- The collection of basic data and research to better understand the biology, ecology and population dynamics of commercially important fish species,
- Determination of catch and size limits for key fish species, including snappers, groupers, hogfish, barracuda, sharks, queen triggerfish and mackerel, and to monitor trends in production and biomass.

It was suggested that a tool could be developed to model the climate change impacts on fish stocks for commercially important fish species, and associated consequences for food security and employment. There is a need to develop / adapt ecosystem-based approaches to ensure optimum sustainable use, management and conservation of fisheries and other living marine resources. This will help inform the development and appraisal of appropriate adaptation strategies.

Energy

Energy is a key sector for the Caribbean region, particularly for manufacturing, tourism, transportation and agro-processing, and a comprehensive assessment of the energy sector's vulnerability to climate change impacts is crucial. There is an overriding imperative to improve the resilience of the economies of the Caribbean by reducing the dependency on imported high-cost fossil fuels by improving energy efficiency and the development of low carbon energy generation. This would transform economies, lower unit costs of production and enable countries to increase the resources devoted to resilience building. For those nations utilising or considering a shift to renewable energy resources, which is highlighted as a priority action in the CARICOM Implementation Plan (2011), it was highlighted that there is a need to undertake feasibility studies in order to gain an understanding of the impacts climate change may have on renewable technologies and initiatives (e.g. generating capacity of hydropower schemes), and effects on forest stocks. For the smaller islands, climate impacts on small hydro productivity are an important issue for their energy sector. There are a number of research and development areas of interest for the renewable energy technologies, including the feasibility of biofuel production from different feedstock (e.g. *Jatropha*, *Cohune*, *Arundo*), the production of photovoltaic cells from Guyana's silica deposits and utilising energy resources from Trinidad and Tobago.

It was also highlighted that there is a need to improve baseline data and systems of monitoring energy consumption, through energy audits and balances. This would help predict climate change-driven shifts in future energy demand.

Tourism

Tourism is a major part of the economies of Caribbean nations and until the recent UNDP-funded report titled "Quantification and Magnitude of Losses and Damages Resulting from the Impacts of Climate Change: Modelling the Transformational Impacts and Costs of Sea Level Rise in the Caribbean" (Simpson et al., 2010), the impacts of sea level rise on national economies had largely been overlooked. The study of Simpson et al. (2010) found that major resort properties were at significant risk to 1m sea-level rise in various countries, notably, Belize (73%), St. Kitts and Nevis (64%), Haiti (46%), Bahamas (36%) and Trinidad & Tobago (33%). Such impacts would transform coastal tourism in the region, with implications for property values, insurance costs, destination competitiveness, marketing and wider issues of local employment and economic well-being for thousands of employees (Simpson et al., 2010).

Focusing purely on climate change impacts on consumer behaviour (rather than the physical impacts, such as beach erosion and coral bleaching, which have been discussed elsewhere), there are a number of uncertainties and critical questions that further research may address:

- What will be the potential climate change impacts on pristine environments, as tourism is heavily dependent on these ecosystems?
- Can the Caribbean still maintain a quality product if less emphasis is placed on the sun, sea and sand product?

- Would tourists be willing to come if the hotel is more than X metres of the beach (as a flood risk management measure)? Is there a minimum threshold?
- How might customer behaviour change due to policy recognition about the environmental vulnerability of an area?
- How does demand change based on climate change impacts (e.g. higher temperature, precipitation)?
- Consumers are becoming more aware about energy and biodiversity challenges. Do we understand what might trigger changes in consumer behaviour?
- Research about international tourism trends and how that affects the Caribbean (e.g. airline industry taxes). Some of this information already exists through organisations such as the Caribbean Tourism Organisation (CTO) and there is a need to collate and then review this.
- What are the wider tourism impacts on natural resources (direct and indirect)? Is there a role for natural resource accounting?

Biodiversity

Island ecosystems are especially vulnerable to climate change because island species populations tend to be small, localized, and highly specialized, and thus can easily be driven to extinction. Biodiversity research is important to identify key species (both flora and fauna) that are particularly susceptible to climate change. A number of challenges and constraints within the field of biodiversity are highlighted below (as identified by CANARI in their Working Group III report, as part of the framework of the project '*Climate Change and Biodiversity in the Insular Caribbean (CCBIC)*' (2008)):

- The marked fragmentation of the information on the regional biodiversity,
- Lack of a comprehensive ecosystem assessment and species inventories and continued monitoring of key species,
- There are some biological-related parameters, like soil moisture, for which there are no available climate change projections,
- Information on invasive and introduced species, diseases and pest species is disperse and in some cases incomplete,
- Lack of a data portal through which data and information on the impact of climate change on the regional biodiversity can be accessed. It was stressed that the facility should be developed with at least bilingual capability.
- Documented information on the traditional knowledge of the biodiversity of significance to local and indigenous peoples is limited, dispersed and at risk of being lost. There is an urgent need to record the oral traditional knowledge.
- There is an absence of information on the effectiveness of protected areas under future climate change scenarios,
- Existing management plans for protected areas do not take climate change into account.

Addressing these issues would then allow independent verification of the impacts of environmental change and help inform decision-making on habitat protection under climate change. Projections must be modelled and generated to support adaptation planning for biodiversity conservation and for strategically important economic sectors. There is a need to understand how seasonal changes

would affect biodiversity (e.g. fruiting, reproduction, closed and open seasons for hunting) and what type of policy changes may be necessary.

It is worth noting that Guyana is developing plans to establish a Centre for Biological Diversity in support of its Low Carbon Development Strategy (LCDS).

Forests

The importance of forestry for all the 15 CARICOM nations was stressed at the Regional Workshop, through its role in watershed management and for those countries that have large standing forests (Belize, Guyana and Suriname). It was highlighted that there was a need to understand the impacts of climate change on forest ecosystems and indicator species, together with adaptability and extinction rates, at a country-specific level. This information would help inform how forests should be managed to build resilience to climate change. It was also suggested that an economic valuation of forest resources (timber and non-timber products and services, and ecosystem services) is needed, together with an assessment of how these resources (and the values provided) may change in the short and long-term as a consequence of climate change.

Health

Climate change, including climate variability, has multiple influences on human health. Both direct and indirect impacts can be expected including alterations in the geographic range and intensity of transmission of vectors, such as ticks and mosquitoes. It can also result in rodent borne diseases and food- and waterborne diseases, changes in the prevalence of diseases associated with air pollutants and aeroallergens. However, as identified in the Regional Framework, there is a massive information gap and lack of knowledge about appropriate responses to the negative health impacts of the climate change threat. It was stressed in the Regional Framework that this issue must feature as a high priority, as the poorest segments of the Caribbean populations stand to suffer the most.

A study published by the Lancet-UCL Commission (Costello et al., 2008), recommended some key areas that could in turn provide useful guidelines for studies on climate change and public health in the Caribbean. These include:

- Improving global health and health equity;
- Risk assessment of population displacement;
- Understanding degradation of water supplies;
- Assessing the effects of multiple environmental hazards on vulnerable populations;
- Taking action against climate sensitive risks and appropriate interventions to reduce current and future health burdens

The Global Environmental Facility (GEF) is initiating a project in Barbados in July 2011 titled: *'Piloting Climate Change Adaptation to Protect Human Health'*. Barbados, along with six other countries, (Bhutan, China, Fiji, Jordan, Kenya and Uzbekistan), were selected based the following criteria:

- Exhibit evidence of significant population vulnerability to climate change;
- Heightened awareness of health risks from climate change;
- Strong commitment to national agencies, WHO and UNDP country offices; and
- At least basic national capacity to respond to the challenges.

While Barbados and Fiji were recognised as small-island states with high proportions of their population living on coastlines, the water-stressed nature of Barbados also singled it out for selection. The emphasis of the global project is water scarcity and the impact that it will have on the health of the population, and the adaptation measures which will be implemented.

At the regional workshop, the potential climate change impacts on health were largely discussed in the context of water resources. For example, the links between water quality, health and extreme events or the impacts of Harmful Algal Blooms (HABs) and their relationship to public health (fresh and marine water). It was highlighted that there is a need to understand the impacts climate change may have on sanitation systems (municipal, community and individual), together with the potential impacts of disinfection by-products in water supply systems, particularly of water that originates in highly organic areas (surface water).

On a more general note, one consultee highlighted the use of key indicators to establish early warning systems for onset of diseases such as dengue, typhoid and malaria, and respiratory diseases. Furthermore, there is the need to conduct analyses of the full socio-economic impacts of climate change on health.

Social impacts

With respect to broader social dimensions of climate vulnerability, it was acknowledged that there is a broad gap in this field, which unfortunately has not been addressed through this assignment for CDKN, due to the lack of engagement with social scientists during the regional workshop and consultation process. It was highlighted that excellent work is currently being undertaken on Caribbean social challenges, but these are not tied up with climate change science. This is thought to reflect the global divide between natural sciences research (where it was thought that climate change most naturally sits) and social science research. This is slowly closing, but there is a time lag in the Caribbean. It was stressed that the sooner this happens the better.

Despite high levels of urbanisation in the region, a concerted policy effort to deal with urban issues in general (independent of climate change) is lacking. Because climate change research is concentrated in natural science studies programmes, urban climate issues have tended not to be seen as a priority. This represents a significant additional gap, and urban elements of vulnerability and adaptation, as well as impacts related to urban infrastructure, should be seen as a priority.

There is a need to understand how climate change will affect local community livelihoods, including gender perspectives. However, it is important that this research does not lose sight of the links between climate change and poverty / livelihoods. It was suggested that a monitoring system should be set-up to assess the impact of climate change on local communities; this would naturally build on CANARI's work on assessing livelihoods. The key livelihoods highlighted for the Caribbean context were forestry, tourism and fisheries. With respect to forest users, it is crucial to understand how their livelihood may be affected by climate change as forest resources are impacted.

4.1.2 Responding to a changing climate

Fundamentally, there is a crucial need to understand what are the enabling factors and constraints for mainstreaming climate compatible development. It is important to understand potential uptake for transformative change and technology transfer in the Caribbean context. For example,

- Is the Caribbean making use of the best available technology?
- Can local and indigenous practices and innovation be incorporated in the Caribbean responses to a changing climate

- What actions are farmers already taking to adapt?
- What are the best mechanisms to facilitate uptake of technology / practices that are already available and understood (but not at local level, e.g. individual farms)?

Furthermore, it was stressed that a thorough and comprehensive cost-benefit analyses of adaptation and mitigation strategies, nationally, locally and across the region is needed. The UN-ECLAC has undertaken several sectoral studies assessing the economic costs of climate change, through the following project: *'Review of the Economics of Climate Change in the Caribbean (RECCC)'* (see <http://www.eclac.org/id.asp?id=41807>). An example was provided at the regional workshop of a key question that cost-benefit analyses need to assess: what would be the costs associated with changing infrastructure within the tourism sector?

Adaptation actions

Again, there are a number of important considerations to highlight up-front:

- Adaptation measures need to be robust to uncertainty and therefore adaptable from event to event, without reliance on precise projections of future conditions (as many scenarios have limited utility at the island scale);
- Adaptation is a process and it should follow the established path of understanding the vulnerabilities, risks and impacts, developing the capacity and pursuing actual actions. This is where fact-based research and 'ground-truthing' become extremely useful.
- There is a need to be able to measure adaptation (e.g. indicators).

With respect to protection of the coastal zone, the need for an accurate valuation database of the assets (physical and livelihood/non-market) and costs associated with building protective structures along the coasts of the Caribbean islands, especially near major urban centres and popular tourism developments, was discussed. Equally, it was suggested that there needs to be an assessment of the social and economic benefits of ecosystem / biodiversity buffers (Marine Protected Areas, National Parks, and Active Management Areas) and the economic value of conservation and disaster mitigation. Furthermore, the complexity of financing protected areas in the Caribbean was noted.

It was stressed that coastal and fishing communities are particularly vulnerable to the effects of climate change and any associated adaptation actions. Research is needed to understand what the adaptation options for these communities are. For example, it might be appropriate to develop aquaculture techniques and methodologies for making indigenous species more resilient. Equally, it might be appropriate to explore alternative livelihood options, in order to reduce pressure and dependence on marine species that are likely to be impacted by changes in climate. Similarly for forest-based livelihoods and the assessment of potential adaptation actions, it is important to understand what the potential changes may be and the rate of change, together with any actions users are currently taking. There is a need to undertake feasibility studies into potential alternative livelihoods, including low-carbon uses and economic feasibility. Furthermore, an assessment of the establishment of micro-finance mechanisms for small communities (growers, fisheries, tourism service economies) was suggested, involving the private sector. It was suggested that this might get around the notion of large scale insurance, with associated high premiums that may be unaffordable to many.

With respect to agriculture and food security, research is needed on sustainable practices, such as low till agriculture, organic farming, water harvesting, drip irrigation, greenhouse cultivation and mulching, agroforestry, permaculture, and soil conservation in the Caribbean context. Equally, research is needed into the methods of processing agricultural products, to add value and variety to

output for food and other uses. This research will help inform national food security adaptation strategies, which include agriculture adaptation strategies, and facilitate the design of insurance schemes for small farmers.

A number of further, more specific agricultural research needs were also highlighted:

- Develop and identify drought / flood resistant and salt and temperature-tolerant varieties of staple and commercial crops, drawing upon local and indigenous knowledge. These would need to be placed in multiple sites around the Caribbean region. (This would expand on UWI Mona research currently being undertaken).
- Research and potentially introduce indigenous and other breeds of cattle, pigs, goats and poultry that are heat tolerant and more feed efficient for commercial meat, milk and egg production by 2020.
- What is stock of indigenous germplasm for key crops (food and feed) and livestock?

Energy and carbon management actions

The majority of discussions regarding mitigation actions naturally focused on the energy sector. Important questions to address include:

- What is a low carbon community in the Caribbean context?
- What is needed for transition to a low carbon community?
- What are the regulatory/legislative/fiscal incentive/policy barriers to the adoption of low carbon energy generation? How can these barriers be overcome?
- What are the available alternative energy sources (including some not being widely considered e.g. geothermal, solar thermal, hybrids)?
- What is the feasibility of the renewable energy mix at national, regional and local (e.g. rural community) level?
- What is their appropriateness considering efficiency and environmental and social impacts?

It was stressed that an assessment of mitigation actions within the energy sector needs to take place at the country-level, recognising that there are specific challenges due to the diversity of the energy sector within the Caribbean. For example, Trinidad and Tobago has significant oil and gas resources, whereas smaller Caribbean islands are dependent on oil and gas imports. There is a need to look at the issues in common and those that are divergent within the region.

In order to assess the potential for a low carbon community in the Caribbean, the first research priority is to map out the overall pattern of needs, which as explained above are very different between places. In all Caribbean countries, renewable energy projects are viable, if finance can be mobilised and the technical and regulatory challenges removed. There is also a need to map out the financing of energy alternatives across the Caribbean, which is a complicated calculation (e.g. due to different transport distances). Projections are needed at the country level. Following on from the mapping exercise, there is a need to provide different cost estimates for alternative energy sources and the level of subsidy needed (which will be spatially variable), in other words, the economy of adjustment policies. Policy-makers are largely not aware that the private sector can become involved in the financing. Finally, it was stressed that the region needed to think strategically and holistically for best sites for production of alternative energy.

Other mitigation actions and research needs mentioned included:

- Research into sustainable buildings and sustainable communities (urban centres), including retrofitting. The use of a pilot town in Montserrat was highlighted. However, there was a

general recognition that whilst pilot demonstration projects on new build are absolutely vital, the real challenge is to retrofit existing buildings with new technology to reduce energy demand.

- Assessments of vegetation cover and other resources, using remote sensing among other technologies and methodologies to facilitate participation in mitigation initiatives, potentially establishing permanent sample plots.
- Analysis of the impacts of climate change on forest/timber growth/sequestration.
- Understanding of the feasibility of Payment for Ecosystem Services (PES) schemes, including a valuation of services provided, the enabling environment and the impacts for forest communities' livelihoods.
- Carbon sequestration potential of mixed tropical forests
- Studies to improve technology, competitiveness and economic efficiency in fishing operations recognising that they currently use significant volumes of fossil fuels.

4.1.3 Evaluating climate compatible development

The research gaps identified by the consultations include:

- There is a need to research the sensitivity of economic indicators to the impacts of climate change. There is a need to present the “hard” economic facts and hence collation of economic data is necessary.
- There needs to be an improved methodology for the costing of impacts, including a database of asset impact costs across countries
- An analysis of the impacts on gender and vulnerable sub-groups to inform policy decisions is required.
- Understanding the context of climate change impacts and the wider sustainable development and growth objectives in developing countries.
- Developing a risk management ethic within the research community to deliver data sets and tools to meet the needs of decision-makers
- Working with business, financial and legal researchers in collaboration with financial institutions to develop alternative financial instruments in the Caribbean.

4.1.4 Policy processes

The lack of clarity and understanding regarding governance and decision-making was frequently cited as a research priority. There is very little information on government structures to facilitate decision-making. This is crucial in order to respond adequately to changes in climate. There needs to be an assessment of the policy, legal, regulatory and institutional frameworks and governance arrangements, together with compliance incentives, across a number of sectors, including tourism, fisheries and coastal and marine ecosystems. The assessment of policies, laws, regulations, codes and standards should also include cost-benefit analysis. For example, it might be appropriate to research the cost effectiveness of new building codes that incorporate climate change.

There is also a need for adoption of the principle of evidence-based decision-making as part of governance system. One consultee stated that: “We need to create a culture within the Caribbean of using climate change science as an aid to decision-making”. Researchers need to be able to offer a strong and sound knowledge base to decision-makers (policy makers, practitioners, private sector and members of the public). However, unfortunately the capacity of government to use this

information and facilitate adaptation is not yet developed. It is essential that governments recognise and act on their responsibility to find, manage and release data. A greater public awareness will increase the accountability on the part of policy makers and politicians to demonstrate that decisions are evidence-based. Furthermore, case studies (including costings) on knowledge based decision-making within the Caribbean are required. For example, an analysis of economic incentives and alternatives to water provision solutions (households and businesses including the tourism, and government sectors) may be appropriate.

There is a need to develop cross-agency institutional mechanisms to coordinate policies and programs, to build capacity for linking national development planning, project cycle management, collaborative management, and conflict resolution. These cross-agency networks need to develop and show the benefits of multi-way information exchanges that facilitate shared awareness and coordinated action.

With respect to Environmental Impact Assessment (EIA) legislation, it was suggested that it should be extended to include social impacts and the effect of climate change on the project during its lifetime. Monitoring of projects post-construction must also be enforced and publicly reported.

5 Research networks and partnerships

5.1 Existing research networks and partnerships on climate change and development in the Caribbean

Several regional programmes are strengthening partnerships and consolidating emerging networks among researchers within the Caribbean, as well as with research institutions outside the region. On issues central to the impact of climate on development consultees feel that, within the region, individual campuses and universities are working quite well with one another. The University of the West Indies (UWI) has a longstanding relationship with the US National Oceanic and Atmospheric Administration (NOAA) and the Caribbean Community Climate Change Centre (CCCCC) implementing early monitoring systems for coral reefs, climate and sea level monitoring. The Climate Studies Group (CSG) of the UWI Mona has also collaborated with the CCCCC, the UK Hadley Centre, and the Institute of Meteorology for Cuba (INSMET) on climate scenario development and downscaling activities.

Existing research networks and partnerships include:

CCCCC: the official archive and clearing house for regional climate change data in the Caribbean. The Climate Change Centre coordinates the Caribbean region's response to climate change, working on effective solutions and projects to combat the environmental impacts of climate change and global warming. The Centre also provides climate change-related policy advice and guidelines to the Caribbean Community (CARICOM) Member States through the CARICOM Secretariat. The CCCCC has been very successful in developing and encouraging partnerships across regional and international research institutions. Most of the CCCCC 15-20 staff members are funded on a project-by-project basis (fewer than 5 scientific professional staff are employed full time by the Centre independent of projects), though the organisation is trying to move towards longer-term funding for employees. The Centre employs a mix of social and physical scientists.

The Agreement establishing the CCCCC includes a number of functions directly relevant to research:

- Collecting, analysing, storing, retrieving and disseminating meteorological and sea-level data relevant to the observation of climate change and facilitating, in collaboration with specialized Caribbean agencies, the collection of information about the impact of climate change on the economic sectors in the Caribbean.
- In collaboration with Members and relevant agencies, develop special programmes to address implications in the Region for coastal zone management, disaster management, and potentially vulnerable sectors such as tourism, health, agriculture and insurance.
- Promoting the sharing of resources, technical co-operation and information exchange with other global climate change initiatives, in particular in Small Island Developing States and Latin America.
- Coordinating (and initiating) the development of regional research programmes, including adaptation of global climate and impact modelling efforts and specialized training focused on effective adaptation to global climate change.

www.caribbeanclimate.bz

Caribbean Natural Resources Institute (CANARI): a non-profit organisation whose mission is to promote equitable participation and effective collaboration in managing the natural resources critical to development. It conducts applied research, analysis, monitoring and evaluation of

innovative policies, institutions and approaches to participation and governance. The organisation also engages in capacity building and fostering partnerships, particularly those that build on regional assets and talents and contribute to closer regional cooperation. CANARI's main areas of expertise include biodiversity, ecology and fisheries sectors.

www.canari.org

Coastal Areas Climate Change Education Partnership (CACCE): A network of institutions, scientists, and educators seeking to help people in coastal areas learn about and address the impacts of climate change. Supported by the US National Science Foundation's Climate Change Education Partnership (CCEP) Program. Regional focus: Florida and the Caribbean, emphasizing coastline issues.

www.cacce.net

CARIBSAVE partnership: a not-for-profit organisation based in the Caribbean, headquartered in Barbados and formed in 2008. CARIBSAVE works with stakeholders to address the impacts and challenges surrounding climate change, the environment, economic development, tourism and community livelihoods across the Caribbean Basin, using an integrated and holistic approach.

www.caribsave.org

The Latin American and Caribbean Research Network: created by the Inter-American Development Bank in 1991. Though not focused on climate change, this network finances applied research and contributes to development policy agendas in the region by providing grant funding for studies on the economic and social issues. The network comprises nearly 350 regional research institutes. Its objectives are to improve the quality of research performed in the region, and to contribute to the development policy agenda in Latin America and the Caribbean.

<http://www.iadb.org/en/research-and-data/the-latin-american-and-caribbean-research-network,3316.html>

Caribbean Research and Innovation Networks (EUCARINET): a 4 year project whose main goal is to strengthen bi-regional sustainable policy dialogue on science and technology between EU Member States and the Caribbean. The project, which has already begun to look at renewable energy priority setting in the region, will work at policy, programme and institutional (research entities) levels. The consortium includes 12 partners, 6 from the EU and 6 from the Caribbean, representing stakeholders from research, industry, government and civil society.

<http://www.eucarinet.eu/>

Canada-Latin America and the Caribbean Research Exchange Grants (LACREG): a program designed to strengthen international partnerships and consolidate emerging networks among researchers from Canada, Latin America and the Caribbean. Managed by the Association of Universities and Colleges of Canada, and supported financially by the International Development Research Centre (IDRC), LACREG offers Latin American, Caribbean and Canadian researchers small grants to support joint activities that contribute to creating, disseminating and applying knowledge for international development.

http://www.aucc.ca/publications/auccpubs/brochures/lacreg_e.html

5.2 Potential partnerships

5.2.1 Working with donors and IFIs

The role of the international development community has been set out in the Implementation Plan. Several of the key elements of that role are particularly relevant to a Caribbean research programme including:

- Providing financial and technical resources.
- Facilitating technology transfers.
- Supporting the development of international research partnerships.
- Financing scholarships, graduate and teaching exchange programmes.
- Using Caribbean based institutions to undertake donor and IFI research.
- Providing financial and technical assistance to universities and research institutions to support long-term development plans.
- Ensuring that all baseline data collected as part of any funded project should be considered as open access, including data collected in projects undertaken to inform donor and IFI policy.

This research diagnostic can be used by the CCCCC and the research institutions to develop a co-ordinated research programme for discussion with potential funding partners.

5.2.2 Developing CDKN's role

The aims of regional initiatives and partnerships have synergies with CDKN's goal to support decision-makers in designing and delivering climate compatible development. The CCCCC, for example, coordinates the Caribbean region's response to climate change by acting as a key node for information on climate change issues and the region's response to managing and adapting to climate change. It is the official repository and clearing house for regional climate change data, and the organisation provides climate change-related policy advice and guidelines to CARICOM. Many of the researchers consulted during this exercise were very impressed with the CCCCC's efforts to coordinate and prioritise research and access research funding opportunities on behalf of the region.

Technical assistance and financial support is always welcome. Regional researchers would welcome access to practical research knowledge undertaken in other areas of the world and in particular with regard to technology transfer. CDKN working with the CCCCC could provide a useful mechanism for learning and sharing and facilitating cross-regional research partnerships.

Accessing financial support from CDKN in addition to other multi- and bilateral sources is clearly of interest to the Caribbean. Researchers did however comment on the need for sustainable long-term funding rather than discrete project based funding. Financial support is required to develop research units with permanent staff who can then support postgraduate and doctorate research on a continuing basis.

The scale of funding that CDKN can provide and the timescale needs to be considered. Discrete project based funding may have to be packaged up with other funding to deliver the requisite sustainability. Many of the research needs will have a long life or require detailed country based case projects to meet specific local needs. It is recommended that CDKN considers how its funding can deliver the greatest impact, for example, by supporting high cost long term/multi-project research, small discrete projects, or by using the funding to develop detailed programmes as a catalyst to accessing larger donor funding.

5.3 Developing the research / policy interface

A number of challenges were identified during the consultations regarding the importance of greater engagement between researchers, decision-makers and the wider society:

- A general question was raised on the process by which research could be integrated within and/or disseminated to existing regional networks of policy makers, academics, and/or civil society networks?
- It was recognised that there is a need for a greater level of co-ordination amongst the regional research community, which would enable cross-sectoral themes and a more holistic view to develop. This would assist in providing applied research for decision making.
- There is a need to assess the barriers to and opportunities for improving information sharing and communication on climate and climate impacts across the region.
- A major barrier was identified regarding ownership and access to data held by governments and regional agencies which for a variety of reasons is not readily available to the research community. This has been identified as a priority action in the Implementation Plan. Mechanisms for access must be practical and sufficient to support widespread dissemination and use.

A number of questions were raised during the consultations and at the Saint Lucia workshop:

- Do researchers understand what information and tools users need to make more effective decisions?
- How can governments and the private sector be encouraged to make evidence-based decisions using the best available information?
- What are the most effective communication strategies to influence policy-makers or other key audiences in the Caribbean (e.g. farmers and the private sector)?
- Can technologies (such as mobile ICT) be used as an effective tool for communication? (There has been a trial by UWI (Mona) to engage farmers by utilising mobile phones to provide information). There is a need to embrace ICT and recognise the potential multiplier effect it can have in leveraging scarce resources (particularly trained researchers) and in disseminating information.
- Several interviewees stated that extra funding is critically needed for engagement, communication and capacity-building. It was stressed that there needs to be a widespread recognition that science should be accessible to the people.

5.4 Developing research networks

At the 'Regional Diagnostic on Research Capacity and Priorities' workshop held in Saint Lucia in May 2001, it was generally agreed by the workshop participants that it would be beneficial to develop a Caribbean interdisciplinary climate change research network. Participants felt that the focus of this research network should be on:

- Creating greater collaboration between researchers and institutions.
- Identify joint-funding opportunities.
- Develop joint research institutions.

- Develop multi and inter-disciplinary research programmes to move away from single focus projects.
- Build on the body of research and knowledge about climate change that already exists in the region.
- Share baseline data and promote open-source and open-access cultures.
- Act as a research ‘clearing-house’ matching user needs with researcher skills and expertise.
- Develop international research programmes.

Consultees offered a number of clear and concrete recommendations for the development of future research networks more generally, mainly in the area of support for cross-sector or cross-agency working. It was thought, for example, that support for collaborative research among the individual faculties and campuses across the region’s universities (particularly for joint working between physical and social scientists) could be much improved and would offer beneficial multi-disciplinary results.

As few formal mechanisms currently exist to encourage collaboration between academics and regional ‘implementing organisations’ (e.g. health services, water resource managers, town and country planning agencies, etc.), many consultees underscored a critical need for agreed structures to facilitate and encourage research that is relevant to end-users and implementing organisations. The CCCCC recognises the need for research to be practically focused. Some partnerships of this type are beginning to emerge through individual projects, but they do not have long-term financial sustainability. Finally, because government funds tend to be focused on national needs rather than regional needs (there are few opportunities, for example, for coastal geomorphologists in one country to work with town planners and coastal flood risk managers in another country) many highlighted a basic need for mechanisms that enable joint working between researchers from different nations.

The workshop did not have time to develop the concept of a Caribbean climate change research network. In particular the workshop participants were unsure as to the formality and structure of a Caribbean interdisciplinary climate change research network. This may be an area where CDKN could provide some initial financial and technical support to develop the network ideas, working closely with the CCCCC.

5.5 Successful collaborative research networks

Several criteria and key elements that foster and support successful research networks were defined and described by consultees. The issue of collaboration was regarded as key to successful, enduring research partnerships. It was thought that research calls should be open to proposers outside the region, provided that responses to RFPs explicitly demonstrate well established existing links between external and regional organisations. Examples of existing links could include previous capacity building exercises, training, or project-based work, but a prior relationship should be a pre-requisite to proposals.

According to consultees, a successful *collaborative* framework of research:

- Should be linked to an *outlook forum*, which would provide a mechanism for public engagement that raises awareness and highlights forthcoming research so that it is more easily picked up by implementing organisations and the public planning process.
- Should include ongoing support for joint working and engagement between universities and the public and private sectors.

- Is integrative, problem-oriented, contextual (i.e. it addresses a particular problem or need), and multidisciplinary (i.e. not simply economics or agricultural sciences, but research that explicitly deals with cross-sectoral and knock-on impacts).
- Includes funding for capacity building, communication and knowledge management functions.

It should be noted that the value of collaborative research frameworks as described above is not limited to the Caribbean, and all climate change impacts and adaptation research could usefully be based on this model.

6 Research Capacity in the Caribbean

6.1 Regional Research Capacity

This section of the report explores what capacity exists or is lacking within research institutes and universities in the region at the systematic, institutional and individual levels, with respect to climate change and development. The approach follows the UNDP's 'National Capacity Self-Assessment' methodology that has been used across the Caribbean.

Capacity refers to the ability of entities (institutions, organizations, and communities) and individuals operating within a system to define specific objectives and work effectively and efficiently to attain those objectives.

6.1.1 Systemic research capacity

Systemic capacity is enhanced through:

- Inter-agency coordination arrangements,
- Political commitment,
- Public service incentives and accountability, and
- Legal and regulatory frameworks.

Workshop participants concluded that the region's formal mechanisms for building interdisciplinary research capacity and communicating research results are weak. Poor communication among scientists, especially between natural and social scientists, impairs dissemination of truly multi-disciplinary climate change research and prevents take-up of research results into policy. The timing of research was also seen as an important issue for building capacity, with participants recommending that researchers actively seek out windows of opportunity to insert research results into national policy-making processes as they become available.

Establishing climatic and socio-economic baselines are critical in order to conduct research that contributes toward progress on climate-compatible development. National assistance in collecting, maintaining and providing access to datasets was identified as a crucial requirement for building research capacity. The Caribbean Development Bank is providing financial resources to "rescue" climate related data across the region and develop protocols for data management – this should be expanded to other areas. The CCCCC currently facilitates information sharing through its Clearinghouse, but success in this initiative is dependent on national support to develop, maintain, and disseminate Clearinghouse contents regionally.

6.1.2 Institutional research capacity

Institutional capacity is strengthened by incorporating:

- Clear mandates and strategies,
- Management systems, structures and processes,
- Information management within and among organizations,
- Human and financial resources, infrastructure, and
- Public accountability and client orientation.

The academic expertise within regional universities is widely held to be very high. Within UWI, Mona (Jamaica) houses the well-regarded Climate Studies Group, while Barbados' Natural Resources

Group includes the Centre for Resource Management and Environmental Studies (CERMES). The Trinidad campus also contains a nascent climate studies group. The University of Belize is very involved in coastal and marine resources research and issues surrounding coral reefs. The University of Suriname is very engaged in mangrove and biodiversity research, and a Centre for the Study of Biological Diversity is to be established at the University of Guyana. Each of these universities has recognised expertise in climate change related research, and several representatives from these institutions participated in the Research Capacity workshop.

The basic academic resources at these institutions are of a high standard, and researchers are well integrated with international networks (Caribbean researchers are represented within the IPCC process, for example). UWI's capacity to lead research is felt to be exceedingly high. Importantly, work done by UWI has a particular legitimacy for policy makers, because it has high regional relevance, and because many were educated there. Resources to take on more research and access to funding are often limited within the region, however, and this lowers capacity.

Very good research is currently being conducted in the natural sciences (e.g. ecology, biodiversity, coral reefs, and forestry), though this is not necessarily climate change related at present. Regional academics possess excellent research skills in the areas of agricultural science, sociology of agriculture and food security, and some of that is just beginning to tie up with climate change research. Excellent work is also being done in the Faculty of Social Sciences at UWI Mona on the multi-dimensional aspects of poverty and Caribbean vulnerability, though this hasn't yet looked in detail at climate impacts. Though several consultees commented that very impressive work is currently underway in these sectors, and that this is indicative of what can be done in the region, the disconnect between physical and social science work with climate change impacts should be highlighted as a gap.

Interestingly, this artificial 'divide' between climate impacts assessment and natural/social science research was ascribed to two potential factors:

1. Different timescales - the focus on longer term planning in the adaptation community versus the emphasis on short-term and present-day impacts for agriculture, health, disaster management, etc. mean that these haven't been integrated as they should have. A possible solution is to look for co-benefits in both areas. Consultees also cautioned that attention needs to be paid to the overlap in implementation planning and practice to avoid doing the same thing twice.
2. Different funding mechanisms – much climate change funding has been tied to mitigation and emissions reductions issues, with vulnerability and adaptation research as an 'add-on'. Adaptation has generally been treated as a different funding 'pot' from other sectoral research funding. This is a critical issue which should be addressed in future research planning.

The capacity of research institutions that are not university-based is more mixed. For example, the Caribbean Natural Resources Institute (CANARI) is very strong, and has good convening power with the region, though other organisations were thought to be less successful.

There are also several international institutions which work very well with Caribbean research organisations. For example, there is capacity with organisations like International Institute for Environment and Development (IIED) to take on various work packages as a support to regional research leads. Organisations like IIED often have several employees who have worked and developed networks in the region, and have gained an appreciation for regional strengths and challenges.

6.1.3 Individual research capacity

Individual capacity is indicated through:

- Job descriptions, responsibilities and motivation,
- Technical skills, and
- Personal workspace facilities.

Consultees had several suggestions for initiatives to help researchers improve their individual research capacity, including building skills in modern data collection, analysis and interpretation, and enhancing researchers' ability to use modelling tools (e.g. catchment modelling, agent based modelling). Acquisition of cost benefit analysis skills was also thought to make a significant contribution to research capacity of individuals. Finally, workshop participants felt that use of innovative technology (e.g. mobile phones and video recorders) would aid in data collection from local communities, which would in turn facilitate identification of climate change impacts.

6.2 Capacity building requests from the Caribbean

At the Regional Diagnostic Research Capacity and Priorities workshop, participants made several specific capacity building requests. These included:

- Training for non-academics to undertake baseline data research and monitoring on climate trends and impacts;
- Continual professional training, and seminars/short courses on climate impacts and adaptation for practitioners;
- Scenarios for both climate and development pathways – these were seen as a useful cross-cutting tool in many areas;
- Support for data collection, data protocols, and data management;
- Use of CCCCCs clearinghouse to facilitate sharing of information on what research is being done;
- Better access for regional agencies to decision-makers;
- Improved ability to use modern data collection, analysis and interpretation tools.
- Improved ability to use modelling tools (i.e. catchments, agent based modelling).
- Improved ability to use cost benefit analysis (water economists).
- Improved identification and recording of climate change impacts.
- Collection of data from local communities using innovative technology tools e.g. mobile phones, video.

6.3 Regional capacity for policy influencing

Current methods of engagement between researchers and policy makers in the Caribbean include one-on-one personal relationships, ad-hoc workshops and presentations. It is widely felt that these mechanisms are not adequate, and far more engagement between researchers and the private and public sectors is needed.

A few consultees noted that there are very few formal entry points (e.g. white or green papers) within the parliamentary system in the region, where researchers' views and recommendations can

be taken into account. A second difficulty arises when policy makers attempt to manage negotiation and compromise between a fairly strong activist community on the one hand and equally strong financial/business stakeholders on the other. The research community is often seen as closer to environmental activism and distant from 'real world' policy decisions. Given the perceived need for regional development, policy-makers may have tended to see all input on 'environmental issues' (including research) as anti-development, and this might explain some reluctance for formal policy engagement with researchers. Helping policy makers to see climate change as an economic and social issue, as well as an environmental one, is critical to overcoming this reluctance.

There was a suggestion among consultees that sub-regional hubs, or 'boundary organisations' (at universities or other research institutions) could be set up to ensure that research becomes embedded in policy and planning. These boundary organisations would work between researchers and practitioners, producing information from research that is relevant and useful for end users. Boundary organisations would also sustain the dialogue between researchers and practitioners, so that research is not simply taken up in a crisis-oriented fashion. This role falls within the remit of the CCCCC and of other regional organisations to develop in conjunction with users and decision-makers. A good model for boundary organisations is the Regional Integrated Sciences and Assessments (RISA, http://www.climate.noaa.gov/cpo/cpo_pa/risa/) Program in the US.

7 Conclusion

CARICOM states share many social, economic and environmental challenges. These are compounded by the additional problems of poverty, high population density, rapid urbanisation, food and energy insecurity, a lack of infrastructural resources and inadequate data collection and management to allow for informed decision making and robust development planning. In combination with these challenges, climate change poses a severe threat to Caribbean countries' development prospects. Responding to climate change will require a large and sustained investment of resources. This report has attempted to support the areas in the Regional Framework and the Implementation Plan which will require evidence-based research and research-based tools that are not already available.

A broad range of climate change research is currently underway (or has recently been completed) at Caribbean research institutions and consortia, and it is vital that the results of this work are communicated effectively and taken up in policy discussions. Despite this broad range of research, several research gaps were identified.

In order to assess and model the impacts of a changing climate, it is crucial that climate hazards are assessed. There is a need to focus climate change science research to ensure that the specific climatic drivers in the Caribbean are captured and understood. This will help policy-makers and practitioners understand the Caribbean's current exposure to climate variability and the actions that need to be taken. A holistic approach is essential when considering the impacts of a changing climate. The interconnections between natural resources and other socio-economic systems are generally not well studied or understood in the Caribbean, and cross-cutting research and collaboration should be encouraged.

Another key challenge is the development of a risk assessment framework for research. There is a crucial need to understand which enabling factors and constraints facilitate or hinder the mainstreaming of climate compatible development. Furthermore a thorough and comprehensive cost-benefit analyses of adaptation and mitigation strategies, nationally, locally and across the region is needed.

There is a need to develop cross-agency institutional mechanisms to coordinate policies and programs, to build capacity for linking national development planning, project cycle management, collaborative management, and conflict resolution. Several regional programmes are strengthening partnerships and consolidating emerging networks among researchers within the Caribbean, as well as with research institutions outside the region, though this needs to be reinforced and more broadly developed.

At the 'Regional Diagnostic on Research Capacity and Priorities' workshop held in Saint Lucia in May 2001, it was generally agreed by the workshop participants that it would be beneficial to develop a Caribbean interdisciplinary climate change research network. This would support the critical need for agreed structures to facilitate and encourage research that is relevant to end-users and implementing organisations. Several criteria and elements that foster and support successful research networks were defined at this workshop and through consultation. Collaboration was regarded as the key ingredient to successful and enduring regional research partnerships.

In terms of research capacity, the academic expertise within regional universities is widely held to be very high. However, the region's formal mechanisms for building interdisciplinary research capacity and communicating research results are seen to be weak. Poor communication between scientists (particularly between natural and social scientists), hinders the development of truly multi-disciplinary climate change research and prevents take-up of research results into policy. Overall, far more engagement between researchers and the private and public sectors is needed.

8 Bibliography

- Caribbean Development Bank (2008) Position Paper Responding to Climate Change in the Caribbean Development Bank and its Borrowing Member Countries
- CANARI (2008). Climate change impacts on terrestrial biodiversity. Working Group III report of the project “Climate Change and Biodiversity in the Insular Caribbean (CCBIC)”.
- CARICOM (2009) Liliendaal Declaration on Climate Change and Development issued by the Thirtieth Meeting of the Conference of Heads of Government of the Caribbean Community, 2-5 July 2009, Georgetown, Guyana.
- Caribbean Community Climate Change Centre (CCCCC) (2011) Final Draft: Delivering Transformational Change 2011-21 - Implementing the CARICOM Regional Framework for Achieving Development Resilient to Climate Change.
- Caribbean Community Climate Change Centre (CCCCC) (2009). Climate Change and the Caribbean: A Regional Framework for Achieving Development resilient to Climate Change.
- Christensen, J.H., B. Hewitson, A. Busuioic, A. Chen, X. Gao, I. Held, R. Jones, R.K. Kolli, W.-T. Kwon, R. Laprise, V. Magaña Rueda, L. Mearns, C.G. Menéndez, J. Räisänen, A. Rinke, A. Sarr and P. Whetton, 2007: Regional Climate Projections. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Costello, A., Grant, M., and Horton, R. (2008) The Lancet-UCL Commission: health effects of climate change. *Lancet*: 371(9619): 1145-7.
- Simpson, M.C., Scott, D., Harrison, M., Sim, R., Silver, N., O’Keeffe, E., Harrison, S., Taylor, M., Lizcano, G., Rutty, M., Stager, H., Oldham, J., Wilson, M., New, M., Clarke, J., Day, O.J., Fields, N., Georges, J., Waithe, R., McSharry, P. (2010). Quantification and Magnitude of Losses and Damages Resulting from the Impacts of Climate Change: Modelling the Transformational Impacts and Costs of Sea Level Rise in the Caribbean. United Nations Development Programme (UNDP), Barbados, West Indies
- UNEP (2008) Climate Change in the Caribbean and the Challenge of Adaptation. UNEP Regional Office for Latin America and the Caribbean, Panama City, Panama.

Annexes

Annex 1. Regional Diagnostic Research Workshop – Agenda

Regional Diagnostic on Research Capacity and Priorities

Workshop agenda

Bay Gardens Hotel, Saint Lucia

5th May 2011

Workshop goals:

To begin to identify the knowledge gaps and information needs that must be addressed in order to put the Implementation Plan (IP) into operation. At the workshop, participants will be asked: **“What science and tools do we need in order to make better decisions?”**

Attendees will:

1. reflect on ‘research needs’ submissions already received from some institutions;
2. assess regional research capacity; and

Time	Item	Who
8.00 – 8.30	Registration	For new participants
8.30 – 9.00	Introduction and welcome, overview of project and purpose of workshop: “Fitting the research agenda into the IP”	Dr Trotz
9.00 – 9.45	Overview of the CDKN research strategy: <ul style="list-style-type: none">– Presentation on the various CDKN research funding streams available and ways in which regional researchers can become involved in the program– Q&A	Dr Michelle Kooy
9.45 – 11.15	Working session 1: What research gaps do we need to fill in the next 2-3 years, in order to effectively respond to decision-makers’ requirements for putting the IP into action?	All (attendees split into 3 groups)

Time	Item	Who
	<p>In advance of this session participants will have reviewed the ‘research needs’ documents already submitted by various regional research institutions (circulated in advance of the workshop), and had a chance to reflect on them in the context of the Regional Framework.</p> <p>Working through the Strategic Elements of the Regional Framework, attendees will discuss</p> <ul style="list-style-type: none"> • How can the research community be more effectively linked to end users? • What are the practical and research tools that end users need in order to put the IP into action? <p>Chair TBD, rapporteurs to be appointed from CCCCC/CDKN staff, John Firth to act as main facilitator. Each group will be given a <i>maximum</i> of 5 minutes to report back key headline issues only, though full group discussions will be incorporated into the workshop report.</p>	
11.15 – 11.45	Coffee/tea	All

Time	Item	Who
11.45 – 13.00	<p>Working session 2 – Climate science, information and tools</p> <p>The discussion will focus on use of climate science:</p> <ul style="list-style-type: none"> • What innovative approaches and tools can promote more effective dialogue between researchers and end users? • What efforts need to be made efforts to ensure greater understanding and more appropriate application of emerging climate science? <p>Chair TBD, rapporteurs to be appointed from CCCCC/CDKN staff, John Firth to act as main facilitator. Each group will be given a <i>maximum</i> of 5 minutes to report back key headline issues only.</p>	All (attendees split into 3 groups)
13.00 – 14.00	Lunch	All
14.00 – 15.30	<p>Working session 3 – Capacity of regional institutions to do research</p> <p>The discussion will explore:</p> <ul style="list-style-type: none"> • Whether sufficient research capacity exists within the region to deliver against the research needs identified earlier in the day – where are the gaps? • How we can improve capacity or otherwise address capacity issues. • How we can keep this research community together? <p>Chair TBD, rapporteurs to be appointed from CCCCC/CDKN staff, John Firth to act as main facilitator. Each group will be given a <i>maximum</i> of 5 minutes to report back key headline issues only.</p>	All (attendees split into 3 groups)

15.30 – 16.00	Coffee/tea	All
16.00 – 16.45	Brief summing up on headline workshop messages, and outlining next steps Brief discussion	Dr Trotz All
16.45 – 17.00	Thanks and close	Dr Trotz

Annex 2. Regional Diagnostic Research Workshop – Summary report

Regional Diagnostic on Research Capacity and Priorities

Workshop Summary

Bay Gardens Hotel, Saint Lucia

5th May 2011

1 Introduction

This document provides a summary of the discussion during the ‘Regional Diagnostic on Research Capacity and Priorities’ workshop. Section 2 describes the goals and objectives of the workshop. At the workshop, participants split into smaller, sector-based working groups. The research gaps identified in each sectoral discussion are outlined in Section 3. Some research gaps were identified in several (or all) sector discussions, and these have been gathered into a ‘Cross-cutting’ section. Institutional, technical and funding capacity challenges are described in Section 4. Finally, Section 5 summarises the ‘research needs’ documents received from individual researchers and institutions in advance of the workshop. Research needs identified in these documents that were *not* discussed at the workshop are highlighted in grey.

2 Workshop goals:

To begin to identify the knowledge gaps and information needs that must be addressed in order to put the Implementation Plan (IP) into operation. At the workshop, participants will be asked: “What science and tools do we need in order to make better decisions?”

Attendees:

1. reflected on ‘research needs’ submissions already received from some institutions;
2. considered regional research capacity; and
3. started to identify regional research priorities.
4. Identified early funding opportunities with CDKN related to the Regional Framework

3 Research gaps

3.1 Cross-cutting

Governance and decision-making

We must better understand the gaps in our governance systems that will prevent us from responding adequately to changes in climate. This will include the policy, legal, regulatory and institutional frameworks:

- Research about appropriate governance arrangements for tourism, fisheries and coastal and marine ecosystems (policy, legal and regulatory framework, compliance incentives).
- Include a cost benefit analysis when assessing the policies, legal, regulations, codes etc
- Research about cost effectiveness of new building codes incorporating climate change. (Existing research: SPACC Saint Lucia about building codes)
- What standards do we need and how should we adapt these standards for the subsectors of tourism, fisheries and other resources to include the impacts of climate change?
- Need for adoption of the principle of evidence based decision-making as part of governance system.
- Need for researchers to approach decision-makers and offer information.
- Do we understand (as researchers) what information and tools users need to make more effective decisions?

What are the enabling factors and constraints for mainstreaming climate change adaptation and mitigation?

What are the best strategies to be used?

Need for decision-making based on baseline data. Need to offer a strong basis to make these decisions. Providing a sounder knowledge base for decision-makers (policy makers, practitioners, private sector and members of the public).

It is essential that Governments recognise and act on their responsibility to find, manage and release data.

Greater public awareness will increase the accountability on the part of policy makers and politicians to demonstrate that decisions are evidence based.

Case studies (including costings) on knowledge based decision-making within the Caribbean are required.

Evidence-based decision making (do we need to research why this is not happening?).

EIA legislation across the Caribbean should be extended to include social impacts and the effect of climate change on the project during its lifetime. Monitoring of projects post-construction must be enforced and publicly reported.

Equipment and monitoring

Monitoring sea level. Existing policy: NOAA will upgrade existing sea level monitoring stations across the region. Capacity challenge: Enhance capacity to be able to use the outputs from a international monitoring systems (i.e. SERVIR, EG)

Data requirements, management and access

Need analysis of existing research and data to know what foundation of knowledge is already available to build in.

Need for baseline data.

Downscaling models – specific implications for each country.

How will climate change affect local community livelihoods, including gender perspective? Research should not lose sight of the links between the topic and poverty/ livelihoods.

What are the coping mechanisms being used?

Need to present the hard economic facts. Need for economic data.

Assessment of adaptation options, including costs of each option. Subthemes: Tourism sector (what does it cost to change infrastructure) Impacts on coastal and fishing communities which are especially vulnerable.

Access to research. Need to ensure that the mechanisms for access are practical and sufficient to support widespread dissemination

Treat data collection and management as resource.

Recognition that science should be accessible to the people.

Mainstream the data that is produced by the models that are available and will be available?

Need for coordination amongst the regional research community. Requirement for information sharing. A multi as well as inter disciplinary approach to arrive at solution to information sharing and research.

Cross-cutting Research modality: Develop modalities to enhance partnerships between research community and tourism industry (and other sectors). Should seek cooperation from the tourism sector. Linking research needs of the private sector and academia.

Current CIMH project on climate data rescue – this process should be extended to other core baseline data sets. Need to develop regional protocols for data collection, management and access across all core data sets.

Communication

What are the most effective communication strategies to influence policy in the Caribbean?

What are the most effective communication strategies to feed science information to influence decision-making by key audiences e.g. farmers and the private sector.

Too much pressure on the researcher to get their research out there. Need for the policy maker to request research and promote the dissemination of same. (Changing the culture).

Ability for scientists to communicate or to get the advice and use the resource of communications specialist.

Note UWI (Mona) Dept of Engineering is exploring the use of mobile ICT as an effective tool for communications to farmers. CANARI has a current project using mobile phones to provide information to farmers, and for farmers to send information back using video and messaging. We need to embrace ICT and recognise the potential multiplier effect it can have in leveraging scarce resources (particularly trained researchers) and in disseminating information.

Capacity

Research into capacity issues. Need for staff (research fellows and research assistants).

Getting researchers from within the sector and/or community that you are researching. Using/training non-academics to undertake baseline data research and monitoring.

What are the existing capacities and the capacity gaps? What is needed to address this within academic and regional research institutions (training, information exchange etc)?

Universities must be an integral part of this process because they will facilitate both research and training. Building capacity for future work.

Providing continual professional training. Seminars/Short courses for practitioners. Information exchange between practitioners and academics.

Do we know which non-Caribbean organisations and academic research institutions are active in the region? Are there other organisations/institutions that can be encouraged to work in the region and develop partnerships with Caribbean based researchers?

[GENERAL POINT: BUILD ON RESEARCH AGENDAS EXISTING – CANARI, UNIVERSITY OF BELIZE

FAO RESEARCH AGENDA (CANARI TO SEND)]

CROSS-CUTTING TOOL: Developing scenario building both in terms of climate and development pathways. As a cross cutting tool useful in many areas. Existing research: Food security scenarios, Caribbean Sea scenarios, work in Africa that we can learn from, CDB and Oxford partnership to develop scenarios for financial planners

System interconnections

The interconnections between natural resources and systems are not understood in the Caribbean.

3.2 Regional Research Network

It was generally agreed by the workshop participants that it would be beneficial to develop a Caribbean interdisciplinary climate change research network. The focus should be on creating greater collaboration between researchers and institutions to build on the knowledge that already exists.

3.3 Water and health

Water supply

Assessment, quantification and mapping of ground water resources in CARICOM member states.

Impact on fresh water resources from saline intrusion.

How different types of catchments will react under different climate and land management scenarios? Using the information to design the tools.

Ecological/environmental flows. Determining the environmental requirement in catchment and river systems (leaving water in the systems after all the draws) (Existing research: IUCN is interested in funding this work).

Water demand

What will be the estimated demand of water in 2020?

How do we estimate demands (domestic and commercial users, farming, energy, tourism and ecosystems) under various climate change scenarios?

What are the adaptation options against each of the scenarios to meet the demands from the various users?

Water management

Water management (storage, flood management) (Existing research: CEHI – work with rain water harvesting and flood management? UWI – flood).

- Storage and rationalization of water.
- How to manage periods that have excess water.
- Social and economic impacts.
- Appropriate infrastructure and design.

Given the challenges we foresee, how are we going to redesign the urban environment at the local level.

- How do we improve storage of water?
- How to convince regulatory authorities to use rain water harvesting? LOW HANGING FRUIT (the problem is not technology).
- Analysis of economic incentives and alternatives to water provision solutions (households and businesses including the tourism, and government sectors).

Storage capacity per head ideal for Caribbean conditions.

How will the natural storage capacity be impacted by climate change (water shed management)?

Water and interactions with health

Potential impacts of disinfection by-products in water supply systems, particularly of water that originates in highly organic areas (surface water).

Elements of research will come out from the water safety plan.

Link between water quality, health and extreme events?

Impacts on sanitation systems (municipal, community and individual) from future climate changes.

Harmful algal blooms and their relationship to public health (fresh and marine water).

Do we adequately understand the link between extreme events, water quality, and health?

3.4 Tourism

Consumer

Understanding consumer behaviour:

- Can we still maintain a quality product if we focus less on the sun, sea, sand product?
- Would tourists be willing to come if the hotel is within X metres of the beach? Is there a minimum threshold?
- How might customer behaviour change due to policy recognition about the environmental vulnerability of an area? (done for different markets)?
- How does demand change based on climate change impacts (e.g. higher temperature, precipitation)?
- Consumers are becoming more aware about energy and biodiversity challenges. Do we understand what might trigger changes in consumer behaviour?
- Research about international tourism trends and how that affects the Caribbean (e.g. airline industry taxes).
- We need to collate and then review the information that already exists.
- What are the wider tourism impacts on natural resources (direct and indirect)? Is there a role for natural resource accounting?

Tourism industry

Assessment of adaptation options for tourism industry (provide a range of options and costs, insurance implications).

Valuation of natural resources used by the tourism industry.

Current capacity of the tourism industry capacity to address climate change impacts and the institutional arrangements that could support them (e.g. through partnerships) may be limited.

TOOL: Improve the existing management information systems for tourism

3.5 Coastal and marine

Ecosystems

Research currently being done for coral reefs should also be done for other living coastal and marine ecosystems such as mangroves, seagrass, and continental shelf fish communities.

How do we store and share information?

Mapping and valuation of coastal ecosystems and habitats, including coral reefs, seagrass beds, mangrove systems, to document location, state of health and contribution to economic development.

Research to better understand the Interconnectedness between and among ecosystems in the Caribbean: coastal and marine areas and terrestrial ecosystems (e.g. watersheds) externally and internally. (Existing research: Existing work on understanding of fish kill incident in 2000).

TOOL: Learn from tools developed to explore impacts of the Gulf of Mexico oil spill.

Regional level: regional watersheds (i.e. Amazon and Caribbean Sea).

Local level: water catchment area on land and coastal area.

Research on manmade inputs into the marine ecosystems (Sedimentation, pollution discharges, transportation, ridge to reef).

Multi-hazard, multi-zone GIS systems, models.

Oceanography and coastal geomorphological processes

Research to improve understanding of changes in oceanographic systems (e.g. ocean currents and circulation, sediment transportation, changes in salinity, water temperature and water chemistry) within the region (at the regional and local levels) arising from climate change, and assess their impacts on fisheries (production, distribution, species composition etc) and other ecosystems, and the social and economic impacts (implication for employment and food security) in order to inform the development of adaptation strategies.

TOOL: Models for implications of fish stocks for commercially important fish species, and impacts on food security and employment.

Better understanding of sedimentation erosion and deposition in coastal areas. Integrated research exploring all the drivers with climate change and other impact models is required. (For example do we understand the consequences of climate change on oceanographic and geomorphological processes? What will be the impacts on the coastlines of Guyana and Suriname?) This also needs to consider social and economic impacts. Need to develop links with internationally renowned research institutions in these areas.

Fisheries

Research to better understand fisheries systems: collection of basic data and research to better understand the biology, ecology and population dynamics of commercially important fish species. This would include catches and effort data to monitor trends in production and biomass. In some cases basic data exists, but they need to be improved. (Existing research: Some systems exist at national level).

- Start by assessing what exists and what needs to be strengthened.

Support for fishing communities:

- Development of aquaculture techniques and methodologies for indigenous species that are more resilient.
- Alternative livelihood options in order to reduce pressure and dependence on marine species that are likely to be impacted by changes in climates.

Development/adaptation of ecosystem based approaches to ensure optimum sustainable use, management and conservation of fisheries and other living marine resources.

Studies to improve technology, competitiveness and economic efficiency in fishing operations recognizing that they currently use a lot of fossil fuels.

3.6 Agriculture

(USE GEFCAS CARIBBEAN SCIENCE PLAN AND IMPLEMENTATION STRATEGY) this should form the basis for developing a research programme in the Caribbean.

Food security

[Note: extend existing project under Jagdeo initiative]

Country vulnerability studies for food security – looking at agricultural production but other elements (distinguishing climate change as one of several challenges).

Implement national food security adaptation strategies (including agriculture adaptation strategies).

UWI (Mona) current pilot project in Jamaica on 3 plots using climate and crop yield models to develop a tool for non-scientists could be extended across the Caribbean to give wider coverage of staple and added value crops, countries etc.

Commodities, farming practice and technology

GENERAL POINT: TECHNOLOGY TRANSFER and UPTAKE FOR TRANSFORMATIVE CHANGE:

- appropriateness of existing technology available internationally
- local and indigenous practices and innovation
- what are the best mechanisms to facilitate uptake of technology that is already available and understood (but not at farmer level) / to transform agricultural practices: dissemination and distribution (incentives, etc)

Develop and identify drought/flood resistant and salt and temperature-tolerant varieties of staple and commercial crops drawing upon local and indigenous knowledge [with multiple sites around the region, expand on UWI Mona research]

- what are farmers doing to adapt?
- what is stock of indigenous germplasm for key crops (food and feed) and livestock?
- pilot on impact of agriculture on key crops – staples as well as economic value?

Research and introduce indigenous and other breeds of cattle, pigs, goats and poultry that are heat tolerant and more feed efficient for commercial meat, milk and egg production by 2020.

Research on sustainable practices such as low till agriculture, organic farming, water harvesting, drip irrigation, greenhouse cultivation and mulching, agroforestry, permaculture, and soil conservation in the Caribbean context.

Research into methods for processing of agricultural products, to add value and variety to output for food and other uses.

Information to allow for the design of insurance schemes for small farmers [build on report of IICA workshop, 5Cs proposal].

3.7 Forestry

Note: need to include all 15 countries - forestry plays an important part in all countries (for example watershed management) although it is recognised that the emphasis has been on the large standing forests in Belize, Guyana and Suriname.

Ecosystems

Need specific baseline on forest resource – what is it and how is it being used?

What are the impacts of climate change on forest ecosystems? [Note CANARI 2009 study].

Complete assessments of vegetation cover and other resources, using remote sensing among other technologies and methodologies to facilitate participation in mitigation initiatives [establishment of permanent sample plots].

Research on adaptability and extinction rates.

Research on indicator species.

What are impacts of agriculture on forests and emissions?

Forest management and governance

How should forests be managed to build resilience to climate change?

- integrated scenarios, including land use
- pilots

What are the impacts of climate change on forest/timber growth/sequestration? Need a forestry version of the UWI (Mona) climate and impact yield tool for forests.

Development of Measuring, Reporting and Verification (MRV) methodology

- appropriate indicators and methods,
- need country specific carbon inventories and baseline data – cannot rely on data from other countries.

Feasibility of payment for ecosystem services schemes?

- -valuation needed of services provided
- -enabling environment
- -livelihood impact

Investigate the potential of forests and forested protected areas for ecosystem-based adaptation [note: Interest from IUCN in partnering].

- Are existing protected areas adequate for adaptation of forests to climate change?

Emerging governance issues related to REDD, REDD++

Focus on 5 countries for REDD.

Livelihoods

How are the livelihoods of forest users (especially most vulnerable) going to be affected by climate change as forest resources are impacted?

Economic valuation of forest resources (timber and non-timber products and services, and ecosystem services)

How will these resources (and the values provided) change (short and long-term) due to climate change?

How can forest-based livelihoods adapt?

- what are changes and what will be rate of change?
- assessment of NTFPs and other resources being used and level of use
- how are forest users already changing their use of forests?
- Feasibility studies of potential alternative livelihoods – including low-carbon uses and economic feasibility
- participatory research on development of sustainable use systems

[build on existing NTFP and ecotourism research]

Setting up system for monitoring impact of climate change on local communities [build on CANARI's work on assessing livelihoods].

Develop model for reforestation of Haitian landscape, which addresses fuelwood use, and alternative livelihoods for fuelwood industry.

3.8 Energy

What are the regulatory/legislative/fiscal incentive/policy barriers to the adoption of low carbon energy generation? How can these barriers be overcome? Need to look at this in each country recognising that there are specific challenges.

Have CREDP, Caribbean Policy Research Institute or CARILEC developed an energy research programme?

Energy supply

What are the available alternative energy sources? (including some not being widely considered e.g. geothermal, solar thermal, hybrids)

What is their appropriateness considering efficiency and environmental and social impacts? - research needed on impacts of existing initiatives e.g. dams [Note: Use baseline data from EIA studies].

What is the impact of climate change on renewable energy resources for example, how will a changing climate affect generating capacity in hydropower schemes?

Feasibility of the renewable energy mix at national and regional level.

How can these be adapted to be used in Caribbean context?

Need to think strategically across region for best sites for production of alternative energy.

What are the energy options for rural communities?

Energy technology and driving mechanisms

What are the impacts of climate change on renewable energy technology/ initiatives? (need to do feasibility studies).

Feasibility of manufacturing solar panels in the Caribbean – using silica resources in Guyana and energy resources in Trinidad and Tobago, including market analysis.

Research into sustainable buildings and sustainable communities (urban centres), including retrofitting:

- pilot town in Montserrat.
- climate and natural disaster resilient shelters [Capacity: UWI Disaster Centre Mona].

There was a general recognition that whilst pilot demonstration projects on new build are absolutely vital, the real challenge is to retrofit existing buildings with new technology to reduce energy demand.

Research into legal and regulatory instruments for transformation of energy production.

What is a low carbon community in the Caribbean context? What is needed for transition to a low carbon community?

Analysis of institutional barriers and enabling factors to development of green businesses [Note: OAS project on removing legislative barriers; CARPRI did research; CANARI working on green economy, in partnership with Green Economy Coalition].

Energy demand

(Key sectors: manufacturing, tourism, transportation, agro-processing)

Baseline data and system of monitoring energy consumption.

Effects of climate change on the demand for energy.

- energy audits.
- energy balance.

3.9 Climate change

Although the workshop focused on sectoral research gaps a number of specific climate change issues were identified:

- We need to focus climate change science research to ensure that we are capturing and understanding the specific climatic drivers in the Caribbean. This will help us understand our current exposure to climate variability and the actions we can take.
- What are the causes behind the increasing variability in our seasonal climates?

- We need to create a culture within the Caribbean of using climate change science as an aid to decision-making.

4 Capacity challenges

4.1 Cross-cutting

Institutional

Countries need to remember that data collection and management is a basic function that ministries need to undertake.

Weak capacity for inter-disciplinary research spanning across the region – poor communication among scientists, especially between natural and social scientists. Countries need to assist in locating and providing data.

- use of 5Cs Clearinghouse to facilitate sharing of information on what research is being done.
- support needs to be given also at the national level to develop and maintain national Clearinghouse and also to feed into regional.

[CDB-funded existing project to “rescue” climate related data across the region and develop protocols for data management – need to expand to other areas].

Weak formal mechanisms.

Regional agencies do have access to decision-makers.

Timing and looking at windows of opportunity to insert into national policy-making processes as they are being done.

Need champions [CIMH and UWI St Augustine Department of Engineering / CANARI current work].

Technological

Improve the ability to use modern data collection, analysis and interpretation tools.

Improve the ability to use modelling tools (i.e. catchments, agent based modelling).

Improve ability to use cost benefit analysis (water economists).

Improve analysis of identification of distributional effects of climate change.

Collection of data from local communities using innovative technology tools e.g. mobile phones, video.

Funding

Can we develop a research fund for the Caribbean using donor money?

5 Summary of ‘research needs’ documents

This section summarises several ‘research needs’ documents that were submitted by various regional research institutions in advance of the workshop. Whilst the workshop discussions had the objective of developing consensus positions amongst the stakeholders, these documents necessarily present the views of an individual researcher or institution. Although much of the content of these documents corresponds with points raised at the workshop, several research needs are identified below that weren’t explicitly mentioned at the workshop – these are highlighted in grey below.

CANARI Climate Change and Biodiversity in Caribbean Island (CCBIC) (2007 – 2008)

• Report of Working Group I: Climate Scenarios and Models

Gaps identified include:

- A need for further understanding of Caribbean climate variability.
- A need for investigation of local or sub regional climates and climate gradations.
- A need for further application of regional modelling techniques to downscaling climate change results for sub regions, territories, cities, towns, and station sites.
- A need for dialogue between climate researchers and scientists within the biodiversity sector, e.g., to quantify climatic variables, scales, and thresholds which would be needed for analysis of the impact of climate change on the sector.
- A need for a better understanding of sea level rise estimations due to global warming.
- A need for more region specific information/studies on deforestation, flooding, and the role of climate in determining such things as human settlements and international commerce.
- A need for a clearer understanding of the usefulness of the various types of climate data currently being archived for modelling biodiversity impacts, as well as the limitations and boundaries within which the data can/should be used.

• Report of Working Group II: Coastal and Marine Biodiversity

Gaps identified include:

- The large variation in the availability of data relating to the spatial extent of coastal and marine ecosystems, inventories of flora and fauna, and the monitoring of ecosystem changes, makes it difficult to go beyond site-specific statements.
- The intricate linkages among species and systems within the overall marine ecosystem which comprises the Caribbean Sea and adjacent water bodies.
- The effects of temperature change on the circulation of the Caribbean Sea and likely changes in upwelling and downwelling and their effects on marine flora and fauna.
- Information on the rate of sea level rise is only available in four islands; and the impact of increased sea surface temperature on biota in seagrass and coral reef areas is little understood.
- The impacts of high concentrations of carbon dioxide in the oceans.
- Information on coral diseases and invasive species in the region and how they are influenced by climatic factors.
- Trends in algal blooms and plankton distribution patterns in the region and their responses to changes in temperature, salinity, pH, and other climatic factors.
- The state of ecosystem remediation techniques suitable for national and regional situations, and the efficacy of potential applications.

- Basic biology and assessments of little-studied species, including seabirds, waterfowl, and key cetacean species in the Caribbean region, and the influence of climatic factors on them.
- Physiology and ecology of marine and estuarine fishes and how they will react to climate change disturbances.

- **Report of Working Group III: Terrestrial Biodiversity**

Gaps identified include:

- Information on the expected impacts of climate change on terrestrial biodiversity in the Caribbean islands was rather scarce and almost absent in the literature reviewed. Not much of the information can be found on cartographic products (i.e., maps).
- There is a marked fragmentation of the information on the regional biodiversity. The existence and location of the majority of the existing biodiversity information such as journals; books; reports; bibliographic and biological databases; maps; genes banks is commonly unknown. This situation also applies to the existing information resources on agro biodiversity, and human and institutional resources.
- There is absence of information on the effectiveness of protected areas under future climate change scenarios. Existing management plans for protected areas do not take climate change into account.
- The information on vegetation fragmentation for the region, and for many countries, is scarce.
- The documented information on the traditional knowledge of the biodiversity of significance to local and indigenous peoples is limited, dispersed and at risk of being lost. There is an urgent need to record the oral traditional knowledge.
- There is no standardised record of observations on transformations of phenology and behaviour of biodiversity.
- There is need for a data portal through which data and information on the impact of CC on the regional biodiversity can be accessed. That facility shall be at least bilingual.
- A regional biodiversity databases should be established with data and information entries that are geo-referenced with an altitude component.
- There are some parameters, like soil moisture, for which there are no available climate change projections. These projections must be modelled and generated to support adaptation planning for biodiversity conservation and for strategically important economic sectors.
- The information on invasive and introduced species is disperse and in some cases incomplete.
- There was a notable scarcity of Caribbean phenological studies on the impact of climate change on phenological relationships in the Caribbean in the literature that was reviewed.

CARDI Regional Climate Change and Agriculture Strategic Plan (2010)

Priority issues identified to reduce the risks to the region's food security associated with a changing climate include:

- Identifying drought-resistant crop varieties that yield more mass per unit of water consumed;
- Promoting better soil management, fertilization and pest and weed control;
- Improving irrigation management through better timing of the provision of water supplies to help reduce stress at critical crop growth periods.
- Using more deficit, supplemental and precision irrigation systems;
- Encouraging improved farming practices that reduce land degradation;
- Developing a hazard risk reduction strategy for the agricultural sector to address impacts over the short, medium and long term;
- Developing agricultural projects which increase Carbon sequestration and can gain support of the Clean Development Mechanism (CDM).

Priorities for Coral Reef Research and Monitoring in the Caribbean (2011) Proposal Document

The proposed coral reef research priorities for the Caribbean need to be implemented to ensure that the countries of the region have adequate data and information to support effective decision making:

- Reef health and its assessment
- Coral reef restoration
- Bleaching of corals and other reef species
- Diseases of coral reef organisms
- Economic valuations of coral reefs and economic impact of loss

Summary Report of the International Caribbean Climate Change Modelling Action Group (ICCCMAG) Workshop on Regional Climate Models for the Caribbean (2010)

The purpose of the workshop was to build on the successful meeting of ICCCMAG held in the Bahamas in 2009 which, in collaboration with other initiatives in the Caribbean, highlighted an urgent need for high-resolution climate model simulations for the Caribbean Basin that would provide regional climate change information to stake-holders and policymakers in the region. The following research and capacity needs were highlighted:

- Use of high resolution climate models to general climate change information for the island nations in the Caribbean
- Analysis of tropical cyclones is required, for which the hourly model data is necessary
- Drought prediction is important for drought planning and mitigation

- Limited computational and storage resources at each of the research centres in the Caribbean.

IDB Climate Change: A Research Agenda for Latin America and the Caribbean (2010)

The objective of this research agenda is to outline the issues that need to be investigated in order to produce an informed assessment of what strategies and policies Latin America and the Caribbean and its international organizations should pursue with respect to climate change. In regard to future work, on the basis of the discussion in the paper IDB recommend the following “operational” and “research and development” agendas:

- **Operational agenda:**

- Guidelines for mitigation and adaptation project evaluation
- Identification of cost-effective adaptation actions
- Financial fragmentation and role of multilateral institutions
- Sustainable and efficient mechanisms of insurance
- Evaluation of trade and climate change using simulation models
- Certification and labelling

- **Research and development agenda:**

- Dynamics of growth and climate change: The LAC case
- Labour market issues
- Regional trade agreements
- Economic impact on LAS of new trade rules
- Trade regulations
- Sustainable cities
- Forestry
- Agriculture
- Adaptation interventions

University of Belize, Environmental Research Institute (ERI) National Environmental and Natural Resources Management (NRM) Research Agenda (2010)

The agenda is a guide to Belize’s priority research needs in the areas of environment and natural resources management, to guide the research work of the Environmental Research Institute (ERI) and to garner the support of local, regional and international partners for its implementation.

Marine research priority needs:

- Determine the status, distribution, abundance and connectivity of critical habitats and species of commercial importance to assess their representation in the natural system of protected areas

- Identify resilient coral reefs and determine the factors that contribute to resiliency
- Determine catch and size limits for finfish including snappers, groupers, hogfish, barracuda, sharks, queen triggerfish and mackerel
- Conduct cost-benefit analyses of oil, mineral, tourism and fisheries investments in the coastal zone versus the value of the ecosystem services that the coastal zone provides
- Evaluate the effectiveness of Belize’s MPAs in enhancing commercial stocks and the ecosystems that support them in order to meet global conservation targets
- Determine the extent of species being captured and their level of extraction (including illegal, undersized and unreported catch)
- Determine population and stock structure, and source of larval supply for fish stocks of the Belize Barrier Reef
- Determine areas at risk from coastal and caye erosion and causes of erosion
- Investigate the oceanographic and bathymetric patterns of Belize’s coastal and marine environment
- Determine the cumulative impacts of coastal and cayes development on the fishing industry and environmental health of marine ecosystems

Terrestrial research priority needs:

- Determine the impacts, including cumulative impacts, of different land-use practices on Belize’s natural resources and hydrology
- Determine how social, political and economic factors affect the natural resource base in order to identify the major factors that have an impact, and investigate the effect of natural resources and the environment on society and politics
- Determine the economic value of ecosystems and biodiversity
- Assess the impacts of climate change on terrestrial ecosystems, ecosystem services and communities
- Assess the impact of legal and illegal biological extraction on various natural resources
- Determine the ecosystems, and associated species, in Belize that are of national and international conservation concern and assess their status
- Determine the types, source, level and cumulative impacts of pollutants on environmental services to communities, ecosystems and biodiversity
- Determine the environmental effects and degree of impact of oil development and production and the mining industry on ecosystems and biodiversity
- Determine the impacts of invasive species, diseases and pest species on various natural resources
- Investigate the use and potential of alternative/ renewable energy sources

Some Regional Priorities for Research in Guyana with a focus on Iwokrama (2010)

Priorities in **climate research** include the following:

- Old paper-based (hand-written) records, currently stored with the Guyana Hydro-Meteorological Service, urgently need to be digitised and processed into digital form
- Substantial processing of the available meteorological datasets is required to establish the quality of the datasets and to remove errors.
- A full analysis of the available meteorological datasets is required to establish a baseline regional climatology.
- More research is also needed to fully understand the influences of the Equatorial Trough, the El-Niño Southern Oscillation (ENSO) and other regional influences on the area.
- The distribution of existing rainfall and evaporation stations is uneven mainly due to uneven population distribution and inaccessibility issues, especially in the interior of Guyana.
- Shortage of trained HydroMet staff to operate and maintain the network of rain gauges and weather stations and to digitise, manage, analyse and process the data produced.
- The analysis of regional climate using global climate model data³ highlighted the limitations of coarse-resolution climate models to reproduce rainfall at the resolution needed for hydrological assessments.

Priorities in **hydrological research** include the following:

- Old paper-based records stored with the Guyana HydroMeteorological Service need to be digitised and processed into digital form before loss of historical datasets occurs.
- The hydrological monitoring network in Guyana needs to be improved. Climate monitoring networks need to be improved, whilst automatic river level and water quality instrumentation should be installed at more locations in both major and minor rivers, particularly inland, and stage-discharge relationships need to be developed at each site.
- As well as precipitation, evaporation / evapotranspiration and surface water flow, groundwater surveys are also required.
- Water quality measurements should include chemical, biological and physical properties. Sediment discharge measurements would also be useful.
- Improving the hydrological network to the point that real-time river level data becomes available, may enable valuable early flood warnings to be given downstream.
- Current datasets need to be quality controlled and analysed for seasonal flow characteristics and the effects of extreme weather events.
- There is also a need to characterise the hydrological response of rivers in various environments (including mountains or valleys, different forest or geology types etc).
- Capacity building in hydrology is required at a national level.

Priorities in **geochemical research** include the following:

- Time series measurements of critical streams and rivers within and adjacent to Iwokrama, including comprehensive suites of chemical measurements – inorganics, organics, isotopes, and optical measurements.
- Characterization of soils and soil processes that impact stream water chemistry.
- Integration of the evidence from geochemistry into nested catchment, biogeochemistry systems and global climate modelling.

- Establish relationships between in-situ data at high resolution and the geochemistry data collected as part of the time series measurements at a weekly to monthly time-steps, so that extrapolations can be made.

Priorities areas of research to understand the impacts, mitigation and adaptation of **climate change** or **anthropological change** include the following:

- Research into the processes driving the regional climate will help to improve GCMs and their outputs thereby improving future climate change scenarios for the region.
- Synthesising the results of regional climate model (PRECIS) runs for Guyana in a similar way to the UK 21st Century Climate Scenarios (UKCIP) which provide a statistical distribution (a range of plausible changes with an estimated likelihood of occurrence) for each emissions scenario would be particularly useful for the Caribbean community. Furthermore, these results need to be made available in an easily accessible form to users.
- Conducting primary scientific research into physical environmental processes will help establish baseline conditions and understanding vital for establishing future climate change impacts on climate, hydrology, cycling of soil carbon and nutrients, biodiversity and ecosystems. A vulnerability assessment and potential mitigation measures are also required based on available data.
- Biodiversity research is important to identify key species (both flora and fauna) which are particularly susceptible to climate or anthropological induced environmental change. Continued monitoring of these key species will then allow independent verification of the impacts of environmental change.
- Research into the impacts of timber harvesting, mining for gold, diamonds and bauxite and large-scale agricultural development as well as development for hydro-electric power generation and primary infrastructure (road) are needed.

Priority areas of research into the **Payments for Ecosystem Services** (PES) include the following:

- Major policy gap remains in the clarification and development of high quality potential transfer mechanisms to disperse PES funds efficiently and equitably - through governments, or businesses - to forest dependent communities.
- There is therefore an urgent need to carry out research into the links between tropical forest biodiversity, ecosystems, well-being and human impacts and implement new models that minimize environmental impact but create economic growth in particular at local and national scale.
- A first step to PES mechanisms, is the valuation of existing ecosystem services such as those provided by standing forests or savannahs in terms of carbon storage and sequestration, water storage, rainfall generation, climate buffering, biodiversity, soil stabilisation and more.

Research gaps identified in **other areas** include:

- Research into sea level rise affecting coastal areas in general (adaptation strategies could include restoration of mangroves)
- Urban drainage issues affecting flooding in coastal urban areas from sea/river/rain.
- Agricultural issues including food security, water resources, pollution, pressures on land-use, over exploitation of soil resources, loss of habitats etc

- Patterns of disease (e.g. dengue fever / malaria caused by mosquitoes) and their links with climate, local sanitation and waste water infrastructure, and other factors
- Pollution and waste management issues
- Mining / forestry / power / transport
- Social issues – education, self-empowerment, poverty alleviation.

Regional research ideas, from initial discussions between NOAA and CCCCC

Research will span key interdisciplinary themes of assessing regional climate variability and change relevant for decision making; the interaction (social, behavioural, cultural) of human and climate impacts on agriculture, urban areas, and biodiversity; climate mitigation and climate policy in support of adaptation.

Potential topics:

- Social and Economic benefits of ecosystem/biodiversity buffers (Marine Protected Areas, National Parks, Active Management Areas)-economic value of conservation, disaster mitigation. Financing protected areas in the Caribbean
- Changes in Large Marine ecosystems (incl. fisheries)
- Development of early warning information system for climate change impacts-drought, hurricanes, floods
- Use of policy windows before during and after extremes events to inform and mainstream long-term adaptation
- Water use efficiency-technologies and processes for adoption
- Coupled sea-level rise and urban demands on nearshore aquifers
- Enhancing local food security: production and processing for tourism
- Role of Tourism in community resilience
- Establishing micro-finance mechanisms for small communities: growers, fisheries, tourism service economies (-jointly with private sector. This get's around (a bit) the notion of large scale insurance in which high premiums may be unaffordable to many
- Usability of waste products for biofuels
- Integrating watershed and coastal zone management
- Assessing barriers to and opportunities for improving information sharing and communication on climate and climate impacts across the region
- Green marketing

Risk assessments:

- Determination of the specific information characteristics (variables, lead times, etc.) required by the principal user communities in at-risk locations;
- Improved quantitative assessments of climate impacts across time and space scales;
- Improved meteorological and impact-related databases in the region in order to better understand and cope with change;
- Maps that reflect the spatial distribution of risk and the magnitude and frequency of events likely to occur;
- Maps of decision-making processes for disaster mitigation, preparedness and recovery to help identify entry points for climate change information;

- Multi-way information exchanges to facilitate shared perceptions of risk and coordinated action.

Annex 3. List of consultees

The following people participated in the Regional Diagnostic Research Workshop, held on 5th May 2011. The workshop discussions have been incorporated into this report.

Name	Organization/Institution
Dr. Michelle Kooy	Climate and Development Knowledge Network
Dr. Paulette Bynoe	School of Earth and Environmental Sciences, University of Guyana
Ms. Gabrielle Gellineau	Caribbean Association of Industry and Commerce (CAIC)
Dr. Elma Kay	Environmental Research Institute, University of Belize
Dr. Adrian Trotman	Caribbean Institute of Meteorology and Hydrology
Dr. Riad Nurmohamed	Faculty of Technology, Department Infrastructure, University of Suriname
Ms. Gail Henry	Caribbean Tourism Organization
Ms. Saudia Rahat	Caribbean Disaster and Emergency Management Agency
Ms. Cheryl Dixon	Caribbean Development Bank
Dr. Michael Taylor	Climate Studies Group, University of the West Indies, Mona
Mr. Keith Porter	Forestry Department, Jamaica
Dr. Adrian Cashman	Centre for Resource Management and Environmental Studies (CERMES)
Mr. Milton Haughton	Caribbean Regional Fisheries Mechanism
Dr. Leslie Simpson	Caribbean Agriculture Research and Development Institute
Dr. Christopher Cox	Caribbean Environmental Health Institute
Dr. Kenrick Leslie	Caribbean Community Climate Change Centre
Dr. Ulric Trotz	Caribbean Community Climate Change Centre
Dr. Mark Bynoe	Caribbean Community Climate Change Centre
John Firth	Acclimatise
Mrs. Nicole Leotaud	Caribbean Natural Resource Institute
Mr. Carlos Fuller	Caribbean Community Climate Change Centre
Patricia Leon	Climate and Development Knowledge Network
Sarah Horsfield	Climate and Development Knowledge Network
Alison Cambray	Climate and Development Knowledge Network

The following people were consulted after the workshop through telephone interviews. A list of interview questions is provided in Annex 4.

- Arnoldo Bezanilla, Instituto de Meteorología de la República de Cuba (INSMET)
- Dr. Dave Chadee, Department of Life Sciences, University of the West Indies St Augustine

- Dr. David Dodman, International Institute for Environment and Development
- Emily Morris, Centre for Latin American Research and Consultancy, London Metropolitan University
- Dr. Michelle Mycoo, Department of Surveying and Land Information, University of the West Indies St Augustine
- Dr. Roger Pulwarty, US National Oceanographic and Atmospheric Administration

Annex 4. List of consultation interview questions

Question 1: Research Capacities: What are the strengths and capacities of research institutions [your institution if applicable]?

Question 2: Research Gaps and Priorities: What are the research gaps related to climate change and development? What are the priorities for policy makers?

Question 3: Research Partnerships: What are the successful research partnerships in-country and why?

Question 3a: Do you feel that CDKN should devise an open call to research institutes outside the Caribbean, or keep it restricted to regional organisations?

Question 4: Do stakeholders have a **vision** of how they would like research on climate change and development to be in the future? What does this look like?

Question 5: Current **methods of engagement** of research with policy makers, covering: degree of consultations by policy makers; perceived role of research and function of research; perceived role of research in informing policy; role of civil society and other stakeholders involved (e.g. private sector).

Question 5a: What are the existing platforms for getting research to policy-makers? Should funding be made available for dissemination and communication?

Annex 5. Database of regional climate change and development research projects

As a separate deliverable, Acclimatise has completed a comprehensive desk review stock-take, based on existing information and data, on the various climate change related adaptation and mitigation research projects being carried out within the CARICOM member countries, as well as regionally and internationally. Each research initiative has been coded against the Regional Framework strategic elements and goals, providing a review of research already underway and enabling identification of gaps.

The desk review stock-take is compiled as a database, designed with query functionality in mind. Once implemented as a web-based tool on the CCCCC website, it is intended that the database will be searchable by:

- Regional Framework strategic elements and goals,
- Lead organisation or funding body,
- Date,
- Sector,
- Type of climate change response addressed (e.g. adaptation, mitigation or both).

This desk review stock-take is part of a larger database that includes climate change related adaptation and mitigation strategies, policies, programmes and actions being carried out within the region.

Annex 6. List of acronyms and abbreviations

ACCC - Adaptation to Climate Change
AIACC - Assessments of Impacts and Adaptations to Climate Change
BPoA – Barbados Plan of Action
CACCE - Coastal Areas Climate Change Education Partnership
CANARI - Caribbean Natural Resources Institute
CARDI - Caribbean Agricultural Research and Development Institute
CARICOM – Caribbean Community
CCBIC - Climate Change and Biodiversity in the Insular Caribbean
CCCCC – Caribbean Community Climate Change Centre
CCCR - CARIBSAVE Climate Change Risk Atlas
CCMI - Caribbean Climate Modelling Initiative
CCRIF - Caribbean Catastrophe Risk Insurance Facility
CDKN – Climate and Development Knowledge Network
CDM – Clean Development Mechanism
CDRMP - Caribbean Disaster Risk Management Program
CERMES - Centre for Resource Management and Environmental Studies
CHAMP - Caribbean Hazard Mitigation Capacity Building Programme
CIDA – Canadian International Development Agency
CIMH - Caribbean Institute of Meteorology and Hydrology
CLLJ – Caribbean Low-Level Jet
CMIS - Caribbean Modelling Initiatives
CPACC - Caribbean Planning for Adaptation to Climate Change
CREDP - Caribbean Renewable Energy Development Programme
CRIS - Coastal Resources Information System
CSGM - Climate Studies Group, Mona
DFID – UK Department for International Development
EIA – Environmental Impact Assessment
ENSO - El-Niño Southern Oscillation
EUCARINET – EU Caribbean Research and Innovation Networks
GDP – Gross Domestic Product
GECAFS - Global Environmental Change and Food Systems
GEF – Global Environmental Facility

GHG – Greenhouse Gas
GIS – Geographic Information Systems
HAB – Harmful Algal Bloom
ICT – Information and Communication Technology
IDB – Inter-American Development Bank
IDLO – International Development and Law Organization
IIED - International Institute for Environment and Development
INSMET - Instituto de Meteorología, Cuba
IP – Implementation Plan
IPCC – Intergovernmental Panel on Climate Change
LACREG - Canada-Latin America and the Caribbean Research Exchange Grants
LCDS – Low Carbon Development Strategy
MACC - Mainstreaming Adaptation to Climate Change
MDG – Millenium Development Goal
MRI - Meteorological Research Institute, Japan
MSD – Mid Summer Drought
NEA - National Enabling Activities
NGO – Non-government organisation
NOAA - US National Oceanic and Atmospheric Administration
NRM – Natural Resources Management
OAS - Organization of American States
RECCC - Review of the Economics of Climate Change in the Caribbean
RISA - Regional Integrated Sciences and Assessments
RWH – Rain water harvesting
SECCI - Sustainable Energy and Climate Change Initiative
SIDS – Small Island Developing State
SRES – Special Report on Emissions Scenarios
UNDP – United Nations Development Programme
UNECLAC - United Nations Economic Commission for Latin America and the Caribbean
UWI – University of the West Indies
WHO – World Health Organisation

