C-CHANGE
PROJECT OVERVIEW

by

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1. INTRODUCTION

1.1 Evidence and research relevance

The global climate is changing. Impacts are increasingly visible, and the trends are undeniable. Rising temperatures are melting polar ice and together with thermal expansion of water are contributing to: sea level rise, changing precipitation patterns, more frequent intense weather events, storm surges and flooding, coastal erosion, increased sedimentation of coastal waters, and, especially worrisome, pollution from flooded or destroyed infrastructure and storm runoff (IPCC 2007a,b, IISD 2007, FAO 2007, UNEP 2008). Nowhere is the problem more imminent or intense than in the small island states of the Caribbean, which rank among the most vulnerable economies in the world (UNEP 2007, 2006, UNFCCC 2007, Bueno et al 2008). In Canada, despite our capacity to predict severe storm events and coastal vulnerabilities to sea level rise, there are concerns that not enough has been done to establish strategic linkages between scientific knowledge and institutions responsible for needed planning and adaptation for coastal communities on Canada's three oceans.

The September 2008 Report of the Standing Senate Committee on National Security and Defence states that "Canadians have no assurance that essential government operations will function during emergencies." (Canada 2008, p.6) Severe weather events (Hurricanes Katrina-August 2005, Ike-September 2008, Juan-September 2003), have proven the vulnerability of coastal governance, industrial sectors, and social systems to severe storms and sea level rise. Hurricane Katrina flooded 80% of New Orleans and demonstrated the inadequate ability of governments to address impacts on humans and infrastructure damages. When Hurricane Juan hit Nova Scotia in September 2003 as only a Category One storm, it resulted in eight Canadian deaths and over $200CAD million in damage, and has been described as a "one hundred year storm" - the worst storm event to hit Halifax since 1893. Halifax was poorly prepared for such a storm event, as was evident in the time required to restore essential services in the Juan's wake.

Prior to Juan hitting Charlottetown, PEI, the city had expressed interest in planning for such an event. However, despite the fact that considerable analysis had been done to model the potential impacts of storm surges, the community had not developed effective means to mobilize people, businesses, and institutions to prepare for the storm and mitigate negative impacts. Aid from regional and national

governments can be slow to reach impacted areas, and cannot be counted on to provide immediate help. Coastal communities can be better prepared by linking the national and regional institutional resources and services with local community knowledge, planning and community response networks that can both anticipate potential impacts and strategically apply limited resources to priority areas to reduce negative impacts.

This research project proposes to develop local community capacity to close the gaps between inevitable environmental change and the urgent need for local coastal communities to adapt their own efforts to anticipate and plan for environmental impacts to their physical, economic, and social well-being. Community adaptation is acknowledged as the capacity of natural and human systems to adjust to global and local environmental change and to reduce adverse effects. We seek to improve planning for adaptation through the development and incorporation of new policy and management measures consistent with established planning theory and guidelines, and the local context, through the identification and implementation of practical local alternatives for coastal resource management. The focus is on immediate and downstream consequences to coastal communities of the insidious effects of sea level rise and the potential catastrophic impacts of extreme weather events. We agree with Sale et al (2008) that the keys to improving local capacity for planning adaptation and emergency preparedness lay in integrating local and traditional knowledge with available scientific, management, and institutional governance information.

The project therefore addresses the vital need to inform and adapt municipal and private sector capacity to make needed changes to development practices, existing and evolving infrastructure, transportation and utilities, health services, water and sewage distribution and treatment systems, and to the management of resource sectors in agriculture, aquaculture, and fisheries. Anticipated and significant environmental impacts to coastal biodiversity will have a domino effect on coastal resources. Development of scenarios and measures to assist adaptation to environmental change can best be achieved through cooperation and sharing of knowledge, applied resources and expertise between academic institutions allied with organizations in the coastal community in an output-driven, collaborative and applied research effort. This collaborative community-university research program will create alliances among selected and susceptible coastal communities in Canada and the Caribbean, postsecondary institutions strategically invited to provide needed research and training resources, and community businesses, and institutional and technical services leaders. These alliances are aimed at developing strategies and making decisions to equip the coastal community in planning for sea level rise and for storm related emergencies. The program will establish formal collaboration and mutual co-learning opportunities among the selected Canadian and Caribbean coastal communities on comparative research on policy implementation for adaptation to coastal environmental shifts. The research program also recognizes the fundamental need for capacity building through its commitment to training of university graduates and community decision-makers and through the creation of new adaptive policy and management measures.

1.2 Definition of communities and adaptation

For this research, selected coastal communities in Canada and the Caribbean are defined broadly and are comprised of: (1) governance and local decision makers (e.g., municipal governments); (2)

private and public infrastructure services (planners and design professionals, utilities and services, insurance); (3) business and economic activity organizations (corporations, small businesses, boards of trade and commerce); (4) citizens' groups (environmental advocates, indigenous communities); and (5) affected individuals (especially special interest or disadvantaged members of the local society who are socially differentiated by poverty and across gender, class, race and age).

1.3 Coastal Communities under Threat

Coastal communities under threat were drawn from a subset of areas in Canada and the Caribbean that met the following criteria: (i) serious, immediate threats to infrastructure and or natural environments (e.g. tourism infrastructure, natural resources, habitats, species), and to area residents (e.g. livelihoods, family structure, cultural assets, and vulnerabilities derived from poverty/gender issues); (ii) ease of access to available data; (iii) opportunities for partnerships and alliances; and (iv) team member familiarity with area and/or community champions in place. Moreover, selected communities have expressed interest in participating and providing support for this research initiative (Table 1). Supporting documentation from selected communities is provided in the Partnerships section of this application and evidenced by the Letters of Support as part of this application.

2. PROGRAM OBJECTIVES

The objectives of this research focus on communities, universities, and the created networks and alliances among these groups in keeping with the ICURA program themes.

2.1 Community Objectives

1. Establish formal Community-University alliances for management of the impacts of environmental change in each study area, with membership from each community to assist in information gathering, priority-setting, decision making, reporting, and application of research deliverables.

2. Strengthen community institutional arrangements through the development of new management instruments, planning policy, guidelines, strategic plans, and decision support methods.

3. Establish long-term linkages among research institutions and the communities within each community, to facilitate the flow of information, access to outside resources, and capacity building.

4. Prepare community action plans based on existing governance and institutional authorities, and in cooperation with the Community-University alliance group, to advance preparedness for environmental shifts and emergencies.

Table 1. Project Study Areas - Twinned Canada - Caribbean

Community	Distinctiveness	Threats	Partnerships & Alliances
Charlottetown, Prince Edward Island	Provincial capital city and coastal port; Population 60,000, centre of industrial and commercial activity; historic downtown	Impacts to infrastructure and historic sites from flooding associated with predicted SLR and storm surges	City council; provincial government, local university, businesses and services, UPEI
Georgetown, Guyana	National capital city and coastal port; centre of industrial and commercial activity, Population 215,000; largest city in region, 14' below sea level;	Breaching of the protective sea walls and dykes by storm surges, salt water contamination of drinking water supplies	Central government planning agency; local community groups; local businesses and enterprises
Iqaluit, Nunavut	Territorial capital city in Canada's high North. Population highly sensitive terrestrial and marine Arctic environment Eco-tourism including whale-watching; whale hunting permitted by native peoples using traditional methods; nearby shipping lanes	Melting/destabilization of permafrost areas of shoreline leading to erosion and sedimentation and coastal hydrological and biodiversity changes - leading to impacts on ecosystems & indigenous cultures	Local contacts, team members with experience in working in these communities
Belize Barrier Reef	Island atolls on 300 km section of the 2nd largest reef in world - the Mesoamerican Barrier Reef System,World Heritage Site ;destination for half of region's 260,000 tourists, nearby shipping lanes	Impacts from SLR and storm surge on coral reefs, and on local tourism and fish and shellfish fisheries	Local contacts, team members with experience in working in these communities
Gibsons, British Columbia	Sunshine Coast coastal town, unique location with proximity to Vancouver, popular resort town, significant eco-tourism and hiking and camping area	Impacts from SLR and severe storms leading to beach erosion and risk of groundwater exposure to salinisation	Town council and planning committee support, Local contacts with tourism and environmental groups
Grand Riviere,	Isolated village of fishermen	Immediate potential for	Local contacts with

Trinidad & Tobago	and small crop farmers, popular local eco- tourism area, protected nesting area for giant leatherneck turtles; nearby shipping and important agricultural areas	impacts from sea level rise and severe storms	tourism and environmental groups
Isle Madame, Nova Scotia	Local fishing and aquaculture area, eco-tourism, archipelago of small isolated coastal communities; historic settlement area for Acadians	Impacts from SLR and severe storms on unique transportation links and potential isolation due to infrastructure damage	Municipality Council, local development association (DIMA), industrial, professional activities, businesses, trade & tourism, Université Sainte-Anne
Island of Bequia	Island archipelago and coral reefs. Popular boating area for cruising yachts; marine and eco-tourism based on whale-watching; significant natural habitats, native peoples' traditional marine hunting activities, nearby shipping lanes	Impacts from SLR and severe storms, unique transportation links, potential isolation due to infrastructure damage	Local governments, industrial, professional activities, businesses

2.2 University objectives

1. Develop academic alliances among university researchers in Canada and the Caribbean. These project alliances will share comparative knowledge, resources and expertise on the adaptive capacity of coastal communities re coastal health and vulnerabilities, combine resources to improve the capacity of local areas to anticipate and respond to the challenges presented by environmental change and use insightful alternatives to promote the sustainable use of coastal marine resources.

2. Collaborate on global research to compare and share the results of socioeconomic research with international links and global institutions, e.g., the United Nations, the IPCC, related to environmental change impacts affecting coastal communities throughout the world through publication in known journals, participation in international conferences, and membership in Canada and in the Caribbean region environmental change institutions.

3. Develop new curricula for Managing Adaptation to Environmental Change in Canada (among the Canadian partner universities) and in the Caribbean (in the University of West Indies network) including joint graduate and undergraduate level courses in science, social science, and management prepared by researchers in Canada and Trinidad and Tobago to provide training and research for

evaluating and addressing the integrated and interdisciplinary physical and socioeconomic impacts of coastal community-based systems and infrastructure from environmental change.

2.3 Joint Community-University Alliances objectives

1. Identify the short and long term vulnerabilities for each coastal community due to sea level rise, storm surge and severe storm events by developing and cataloguing risks.

2. Mobilize knowledge and innovation to mitigate coastal community risks through workshops, data and research collaboration, and linkages within the Canada-Caribbean communities and among the academic participants.

3. Build capacity through the training of graduate and undergraduate students in the universities, and local participants and decision-makers in the communities re coastal environmental impacts by regular exposure to workshops, seminars, and local field work and reports to the community.

4. Develop impact scenarios, and prepare adaptation action plans using university resources in partnership with the priorities and concerns of the local community government, services, and community members.

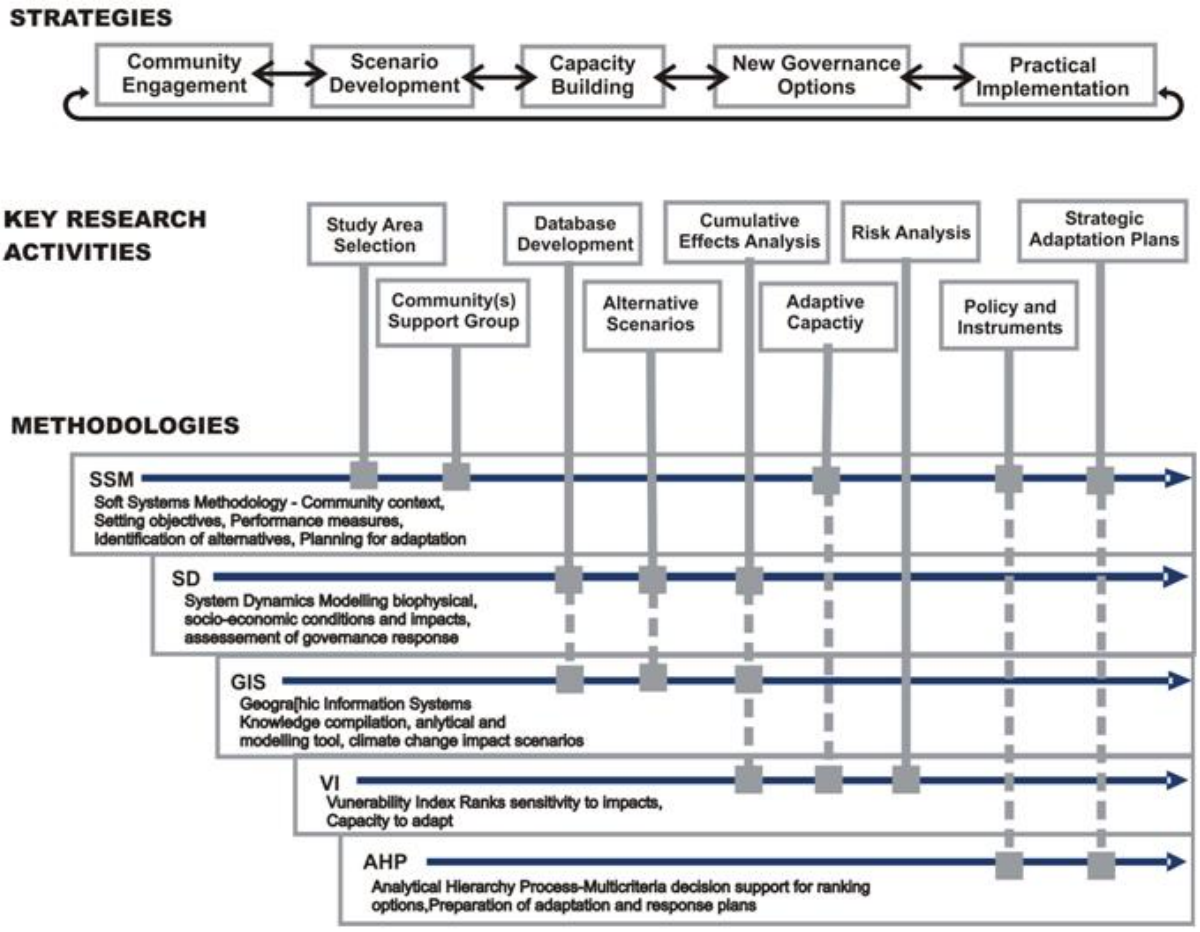
2.4 The Research Process – Activities, Strategies, and Milestones

The research process is an interdisciplinary collaboration that employs key research strategies, activities and methodologies (Figure 1). Information will flow electronically between the central administrative sites (University of Ottawa and University of West Indies, St. Augustine) through the program website (currently in place) and out to the selected coastal communities. The website is the core of communication, data-sharing and knowledge exchange among researchers and community participants. In the first year, Canadian and Caribbean research teams establish the local C-Change Community-University Support Groups. The Support Groups mobilize community engagement, gather information and local priorities, and inventory community resources, services, institutional and governance linkages.

This information permits the locally-assisted development of environmental vulnerability indices for the community. Community spatial models will be presented to the community to examine environmental impact scenarios including integrated econometric and socioeconomic impacts models from data projections for community discussion and review. Baseline indices will be updated regularly over the course of the project with changes to the value of the community vulnerability and adaptive capacity indicators to reflect ongoing project activities and the recommended policy measures. Community groups will guide questionnaires, assist with meetings, be the first to view recommendations and facilitate 'buy-in' by the wider communities including taking ownership of local community meetings and workshops with the assistance of University researchers. Local community workshops will provide training in "Managing Adaptation to Environmental Change" and use of the vulnerability index and adaptive capacity measures and build knowledge towards planning for change. Working documents from local workshops will be prepared and disseminated through the project website to community leaders, practitioners and policy makers. Graduate students will work on

specific project elements such as geomatics and information management, web database development, multi criteria decision making, policy evaluation, risk management, and will be overseen by academic as well as community team members, with opportunities to gain experience working in practical application of research findings.

Figure 1. Research Process



2.5 Resources and Personnel

The research team represents a unique collaboration among academics and professionals from government and the private sector. The Canadian Co-Director (Lane) is chair of the C-FOAM Research Cluster, whose members were responsible for the early development of the research project. C-FOAM members provide senior advice, considerable Canada and Caribbean experience, and assistance with specific aspects of the research and a special focus on training in adaptation skills, e.g., coastal and marine policy, economics and management (Parsons, Hinds, Mitchell, Powles), coastal planning and development, interdisciplinary and trans-disciplinary project management (Mercer Clarke), pollution prevention and environmental compliance (Clarke), organizational management, systems modelling and decision making (Crabbé, Lane).

The Canadian and Caribbean academic team members were carefully assembled to provide both the specific expertise necessary to carry out this project, as well as proven skills in collaboration and interdisciplinary research. Disciplinary expertise includes information systems and geomatic and ecosystem modeling (Forbes, Nichols, Sutherland) including poverty, cultural and gender analysis (Nichols, Watson, Sookram), economic impact analysis (Crabbé, Watson, Sookram), analysis of social institutional and governance arrangements (Matthews), community planning and tourism (Williams), and community socioeconomic and cultural analysis (Woodrow). Caribbean expertise is centred at SALISES and led by the SALISES Director and project Caribbean Co-Director (Watson). SALISES brings considerable experience in Caribbean environmental economics and fisheries (Teelucksingh), survey analysis and design, statistical analysis (Teelucksingh, Watson, Franklin, Sookram), ICT (Franklin), social policy (Henry-Lee), Coastal Land Use Planning (Mycoo). Commercial partners in coastal engineering (Zuzek) and community leaders in the Canadian and Caribbean communities complete the collaborative team. Working relationships have already been developed with key government agencies and departments in both Canada and the Caribbean to reduce overlapping efforts, and to ensure efficient transfer and application of existing knowledge. Further information on these partnerships is provided elsewhere.

3. METHODOLOGY & RESEARCH APPROACH

The methodological process follows the steps of problem solving and risk management (Australia 2007).

1. Problem definition - Soft Systems Methodology (SSM, Checkland 1992) is used to embed the community to establish local priorities, to define the scope of the local research, to pinpoint local institutional arrangements, decision makers and affected organizations, to establish measurable performance indicators, and to develop decision alternatives. SSM is the tool that addresses issues of adaptation and sustainable development at the local community level by acknowledging that human problems are complex and issue-based, requiring inter-disciplinary collaboration to develop solutions, and are accomplished though accommodation by all community members rather than though consensus or optimization. SSM seeks 'common ground' through respectful and structured debate on management where the need is for a system of inquiry and adaptive learning, reacting to events and responding to behaviour rather than changing patterns of behaviour and their underlying causes (Senge 1990).

2. Data collection and community database – the identification, analysis, and evaluation of risks from climate impact scenarios will be guided by structured database development of available community resource inventories including physical, economic, and social capital. Data also include base maps, storm histories, topography, coastal hydrography, and cadastral data for assessing outcomes and projecting the likelihood of real threats to local infrastructures, environments, economies and cultures.

3. Visual Modeling - spatial modeling of integrated dynamics of the ecological, socioeconomic, and cultural subsystems will be developed using GIS software including hardcopy maps, tables, graphs and images to support visual and manual analyses (e.g. using readily available modelling software

such as Google Earth). Spatial mapping and visualization will be used to simulate and animate hypothetical situations for community discussion including exploring the impacts and response of adaptation and mitigation strategies to perceived and real threats. Systems Dynamics (SD) techniques are used to describe and link the physical, economic and social baselines through visual spatial and temporal maps.

4. Vulnerability Modeling - community Vulnerability Indices (VIs) will be produced using static and dynamic maps that present both current vulnerability conditions as well as potential future scenarios subject to coastal environmental risks. VIs provide measures of the sensitivity of coastal communities and are a criterion for the allocation of financial and technical assistance. The index of community vulnerability is designed to be simple, affordable, comparative, and transparent. Coastal community vulnerability stems from detrimental impacts to natural systems that are exacerbated by factors such as a narrow economic base, dependence on trade, and susceptibility to external economic fluctuations (e.g. oil prices). This research program uses the UN/Commonwealth VI to identify risks as well as to assess community capacity of to adapt to changing conditions (Sale et al. 2008). Socioeconomic VIs are modified from Briguglio (1995) and Adger (2006).

5. Adaptive Capacity and Resilience Modeling – communities' abilities to develop and implement a strategy for environmental changes are determined as a function of: (i) technological options; (ii) available resources; (iii) institutional structure and decision-making; (iv) existing social infrastructure; (v) access to risk-spreading mechanisms; (vi) decision-makers' ability to manage information; and (vii) public's perception of the source and significance of the impact to its local manifestations (Yohe and Tol 2002). Adaptation is constrained by the resilience of the natural systems in evolution with human systems, i.e., by their respective ability to cope with external shocks (Gunderson and Holling 2002, Adger et al. 2001). Resilience refers to the coping ability or adaptation capacity of the affected community and ability of an affected community to recover from a damaging external impact. This project seeks to build resilience in the selected coastal communities. Coastal communities need to plan to adapt to environmental change by adopting measures to advance economic, environmental and social resilience. Modeling will consist of constructing a Resilience Index (RI) (as a companion to the VI) adapted to coastal communities that is associated with community adaptive policy (Briguglio et al. 2006) and applied to alternative policy options.

6. Development and assessment of policy options - spatial analyses are used to produce hypothetical cases of ecosystem shifts in local community ecosystems as the basis to project spatial and socioeconomic impacts. These models are based on credible scientific research projections using the Systems Dynamics (SD) baselines as a starting point. The SD projection models complement the delivery of participant-based SSM that is in turn used as a negotiation tool to identify areas of agreement in which to investigate future community environmental scenarios. SD is used as a dynamic simulation tool for presentation of the environmental scenarios and cumulative community effects and impact evaluations for group analysis (Forrester 1973). SD software, (e.g., *Vensim*) has advanced iconic capability making model visualisation, development and sharing accessible to participants. Evidence from research team members' recent work clearly indicates the usefulness of SD analysis in the delivery of SSM for community engagement in assessing complex issues such as environmental adaptation.

7. Evaluation of group decision making – evaluating and ranking alternative environmental mitigation strategies will be carried out using the Analytic Hierarchy Process (AHP, Saaty 1982). The Analytical Hierarchy Process (AHP) is adopted to evaluate community participants' perspectives on the important problem components that arise through community discussion in the SSM prioritization exercise. AHP provides a structured decision framework that breaks down complex decision problems by decomposition into explicit multiple criteria and sub-criteria in a hierarchical structure. The hierarchy identifies the community goal and key components of the physical ecosystem as well as its social and economic elements.Participants' feedback on the relative importance among the criteria and sub-criteria of the problem is used to determine trade-offs among problem objectives, e.g., reduce vulnerability and increase adaptive capacity, given evaluated policy alternatives (Michalowski and Szapiro 1992).

8. Implementation of local adaptation planning and action frameworks - consensus on action planning for mitigation of negative environmental impacts are developed and documented into a Community Adaptation Action Plan (CAAP). The CAAP is a coordinated set of documents for community sectors: (1) governance and local decision makers; (2) private and public infrastructure services; (3) business and economic activity groups; (4) citizens' groups; and (5) special interest and affected individuals for preparedness for a relevant range of environmental shifts and coastal community emergencies.

The research seeks to provide a lasting impact on coastal communities' preparedness for environmental threats that will influence existing policy at the regional and national levels in the small island states in the Caribbean and in coastal Canada. To this end, this project will make formal linkages between the communities and their respective financial offices and funding sources since it is recognized that measures and policy recommendations will require government authorization and budgeting including the application of new technology and the reinforcement of community infrastructure.

4. OUTCOMES

Significant results and impacts of this research on coastal communities, academic curricula and student training by the end of the five-year funding period will be made publicly available and include:

4.1 Creation and Communication of Knowledge – the collation and integration of existing and new knowledge on managing adaptation to environmental change in coastal communities. Communication tools include: periodic working papers and community workshop reports directed at community leaders, practitioners and policy makers and focused on practical adaptation of information to matters of direct interest to these groups. Papers and reports will also be widely distributed to the partners and community contacts and within the communities themselves via the project website. The website, already in place, will be the repository for draft and final documents, available for use by all project participants in Canada and the Caribbean. The website will include resources available to the general public. Further, a participatory comments ("blog") section will encourage public feedback and running commentary on the content and progress of the work. Within the academic community, research papers derived from the work will be submitted for publication in both disciplinary specific

academic journals and in journals that address broader interdisciplinary topics (e.g., *Journal of Ocean and Coastal Management*, *Journal of Sociology*, *Canadian Journal of Fisheries and Aquatic Sciences*, *Climatic Change*).

4.2 Co-Learning – an electronic database that forms the core resource for the identification, collation, analysis and dissemination of information in the communities and the impacts of pending climate change. Collected and generated information will address comprehensively the change in both spatial and temporal contexts, especially as it is expected to affect environmental, social, economic, and cultural characteristics of the study areas and their supported communities. The local area databases will build on existing and available sources and will afford opportunities for sharing of learned experience and knowledge, including collaboration with other climate change initiatives that are taking place in both Canada and the Caribbean. Emphasis will be placed on transferring knowledge gained from existing academic and government research initiatives to practical application within the coastal communities.

4.3 Decision Support Tools - integrated models and state-of-the-art methods for environmental scenario analysis and multicriteria decision support tools for communities to improve their capacity to model, evaluate, and assess strategies for adaptation to change.

4.4 Monitoring and Evaluation Indicators – the suite of performance indicators to assess the ongoing spatial and temporal status of coastal communities at risk from environmental change (including VIs and RIs). These indices allow coordinated and ongoing community-based monitoring and review for current and projected future conditions.

4.5 Training - training outcomes are twofold: (1) academic training, and (2) community-based training of both professional and non-professional participants. Formal courses will be introduced at the partner universities in the Caribbean and in Canada. Graduate students participating in academic research will receive experience in the communities and in practical application of theory and policy. Students will also be trained in the identification and measurement of relevant phenomena, policy prescription, and modeling and analysis of the effects of rising sea-level and storm surges.

4.6 Community Adaptation Action Plans (CAAPs) – community templates as outcomes for the development of CAAPs specific to each community that will respond to a range of climate change scenarios. CAAPs will reflect locally-specific conditions and threats including operational planning documents for practices and mechanisms for emergency response. The CAAP template includes the local database framework and decision-support and scenario analysis tools, and is developed so as to be applicable to other coastal communities within the Caribbean, and across coastal Canada.

4.7 Governance Institutional Advice – case studies as outcomes of the activities in and comparison among the participating communities in Canada and the Caribbean with respect to the successes and failures of local government institutional arrangements and the characterization of effective institutions for responding to the issues of pending environmental change.