Risk and Vulnerability Assessment
Methodology Development Project (RiVAMP)

Linking Ecosystems to Risk and Vulnerability Reduction

The Case of Jamaica

Results of the Pilot Assessment

UNEP

RiVAMP

March 2010

Division of Environmental Policy Implementation (DEPI)
Post-Conflict and Disaster Management Branch and
Division of Early Warning and Assessments (DEWA)

In collaboration with the Government of Jamaica through
The Planning Institute of Jamaica (PIOJ)

Cover photo: Berm scarp along Long Bay beach. The constrained length of scarps can indicate beach replenishment

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Executive Summary

Over 2.2 million people have lost their lives in natural hazard-related disasters (excluding epidemics) over the last three decades (1975-2008). While population growth and migration to areas of high risk, such as urban centres and coastal areas, raise the number of people affected by hazards, environmental change and degradation further contribute to disaster statistics. According to the 2009 Global Assessment Report on Disaster Risk Reduction, ecosystems degradation is one of the major drivers of disaster risk. As climate change is expected to magnify disaster risk, there is emerging global interest to better understand the role of ecosystems and environmental changes in influencing hazards and vulnerability.

Small Island Developing States (SIDS) such as Jamaica, with their limited territories and often heavily populated coastal areas, are at the front line of experiencing ecosystems decline, natural hazard-induced disasters and climate change impacts. SIDS are amongst the countries most at risk from tropical cyclones, with the highest proportion of their population exposed. Sea level rise and deteriorating storm conditions exacerbate impacts of storm surges and flooding associated with tropical storms and cyclones. While SIDS are not major contributors to climate change, they can play a proactive role in adapting to climate change and building resilience against the impacts of natural hazards.

Efforts to reduce the impact of natural hazards often require risk information to identify potential hazards and vulnerability of human lives, livelihoods and critical assets to the damaging impacts of those hazards. Although numerous risk assessments are available, common standards and guidelines have only been recently developed. Moreover, assessment methodologies do not yet adequately identify how environmental factors influence patterns of risk and vulnerability. As a result, these assessments fail to incorporate critical aspects of risk and thus do not consider the potential of developing ecosystem-based risk reduction options.

About RiVAMP

The Risk and Vulnerability Assessment Methodology Development Project (RiVAMP) was conceived to develop a methodology that takes into account environmental factors in the analysis of disaster risk and vulnerability. While there are different types of risk and vulnerability assessments, what is new about RiVAMP is that it recognizes ecosystems and climate change in the risk assessment process. The purpose of RiVAMP is to use evidence-based, scientific and qualitative research to demonstrate the role of ecosystems in disaster risk reduction, and thus enable policymakers to make better-informed decisions that support sustainable development through improved ecosystems management. In this regard, the targeted end-users of RiVAMP are national and local government decision makers, especially land-use and spatial development planners, as well as key actors in natural resource and disaster management.

As a pilot initiative, the RiVAMP methodology is intended mainly for application in SIDS or coastal areas, and focuses on tropical cyclones and their secondary effects (coastal storm surges, flooding and strong winds). Accelerated sea level rise (ASLR) associated with climate change is also considered as an important factor contributing to risk of storm surges and beach erosion.

Jamaica as a pilot country

Jamaica was selected as the first country for the RiVAMP pilot for several reasons, including: its high vulnerability to tropical cyclones and sea level rise; diverse ecosystems and rich biodiversity which are under pressure as a result of population growth, economic development and a strong international tourism industry; high-level government commitment to hazard mitigation and climate change adaptation; and strong partners through the University of the West Indies and UNEP's Caribbean Environment Programme (CEP) based in Kingston, Jamaica.

Following a consultative process at the national-level, Negril located in the western end of the country was chosen as the study area for the pilot assessment. Like many coastal areas around Jamaica, Negril's natural environment is under threat from growing urban and touristic development. The results of the pilot assessment are thus applicable to other coastal, particularly tourism-dependent areas in Jamaica.

The RiVAMP methodology

The initial framework and guidance material for the RiVAMP methodology have been developed through consultations with environmental and risk assessment experts from around the world (see Annex 4). The assessment framework is based on measuring four key components consisting of approximately ten indicators (see Annex 1). The four main areas that are assessed include the following:

- Ecosystems and ecosystem services;
- Environmental change, as a result of human activities and climate change;
- Local livelihoods and vulnerability; and
- Environmental governance.

These four areas aim to establish a systemic understanding of human and ecological interactions, and to identify the driving causes of ecosystem degradation and the potential consequences to increasing hazard vulnerability and exposure. By focusing on governance, RiVAMP seeks to determine opportunities for influencing policies and planning processes so that ecosystems-based approaches are integrated in land-use planning, livelihoods development, disaster risk reduction and climate change adaptation strategies.

The RiVAMP methodology combines the use of applied science, stakeholder consultations and interviews which allows for improved data triangulation, as the technical analysis is balanced with local knowledge and real experiences. The science-based component consists of satellite imagery analysis, and other remote sensing techniques (e.g. use of aerial photographs), Geographic Information System (GIS) mapping and analysis, statistical analysis and modelling the buffering effects of coastal ecosystems on the coastline under conditions of sea level rise and storm surges. Scientific analyses are complemented by stakeholder consultations that have been undertaken at the national and parish-levels and in two selected communities in Negril, namely Whitehall and Little Bay. (Further details of the pilot assessment process are provided in Annex 2).

This report details only the findings and results of pilot-testing the RiVAMP methodology in Jamaica. A separate publication of the RiVAMP methodology which will provide a detailed, step-by-step guide on how to apply the methodology is scheduled to be released in May 2010, following a formal evaluation of the pilot assessment.

Practical decision support outputs

Specific outputs generated from the RiVAMP pilot in Jamaica include the following:

- Satellite imagery analysis to determine the distribution of coastal ecosystems, specifically coral reefs and sea grasses, and to estimate beach erosion in Negril over the last 40 years;
- Hydrodynamic modelling using different offshore wave regimes (i.e. local wind waves, swell waves and extreme storm conditions) and sea levels to study the effects of coral reefs on shoreline protection;
- Statistical analyses (using multiple regressions) to establish the correlation between coral reefs and sea grasses and beach erosion, taking into account other factors (i.e. beach slope and nearshore wave regime) that may influence beach loss;
- Estimations of future scenarios or risk of beach erosion in Negril under rising sea levels and worsening storm conditions in the region;
- A theoretical model of exposure to storm surges and associated flooding in Negril based on a 10 and 50-year return storm period;
- Local community-generated maps to illustrate environmental degradation over the past 40 years and the corresponding increase of vulnerability to floods and storm surges, which validate the scientific analyses; and
- Reports of the national, parish and community-level workshops that provide an overview of ecosystem benefits, and the major drivers of ecosystem degradation as well as proposed solutions.

Key findings

1. **Ecosystems provide important services that support economic development, local livelihoods and hazard mitigation, but they are under significant threat from both natural and anthropogenic (or human-induced) sources.** Major types of ecosystems include coral

reefs, coastal vegetation such as sea grasses, mangroves, sand dunes and other types of beach vegetation, wetlands (peatlands), and forests. Each of these ecosystems is in overall decline in Jamaica, particularly in Negril. Natural drivers of ecosystem degradation include the increasing frequency and intensity of tropical storms and cyclones in the region that can cause major environmental damage, rising sea levels and ocean water temperatures due to climate change and variability, and invasive species. Human activities that contribute to ecosystem degradation primarily include land-based sources of pollution associated with crop cultivation, urbanization and coastal and touristic development.

2. **Coastal ecosystems, particularly coral reefs and sea grasses, play a crucial role in supplying beach sand material and protecting the shoreline.** Hydrodynamic modelling illustrates that the shallow coral reefs attenuate or dissipate nearshore wave energy and thus mitigate against beach erosion. On the other hand, sea grasses are a major source of beach sand supply in Negril. The observed rate of maximum beach erosion from 1968-2008 was found to be negatively correlated with the width of coral reefs and dense sea grass meadows. This means that beach areas shielded by coral reefs and thick sea grasses experienced less erosion, suggesting that these ecosystems provide protection to the beach. The degradation of nearshore ecosystems will therefore result in a diminished beach sediment supply, as well as increased vulnerability to beach erosion and storm surges caused by tropical storms and cyclones.

3. **Ecosystems degradation is a contributing factor to increased local vulnerability to flooding and storm surges.** Deforestation as a result of urbanization and housing development has increased flooding downhill affecting several sections of the Whitehall community. Hurricane impact on coral reefs, illegal sand mining activities and unsustainable resource practices (e.g. destructive fishing practices, removal of mangroves, sea grasses and other types of coastal vegetation, and agricultural runoff) have contributed to beach degradation and increased storm surge vulnerability in Little Bay.

4. **Scientific evidence shows that over the past 40 years, Negril's beaches have been experiencing severe and irreversible shoreline erosion and retreat.** Bloody Bay in the northern section of Negril has experienced lower erosion rates than Long Bay, with sections of Long Bay beach without coral reef cover showing higher rates of erosion. The highest erosion rates have occurred after 1991, when beach recovery after storms has been slower, and these trends are likely to continue. It is expected that long-term sea level rise, changing patterns of tropical storms and cyclones in the region (in terms of both frequency and intensity), diminishing sand supplies due to coastal ecosystem degradation as well as coastal development will exert an even higher toll on Negril's beaches.

5. **Estimations based on global projections of long-term or accelerated sea level rise (ASLR) together with local predictions of extreme storm waves and surges show that, by 2060, the combination of ASLR and extreme wave surges will have a devastating impact on Negril's beaches and the coastal infrastructure behind it.** Even under the lowest projections of ASLR for 2060, an extreme event (i.e. the 50-year return storm) will result in the total loss of approximately 35 percent of the beach (in terms of length), while another 50 percent of the beach will lose more than half of its present width.

6. **Taking into account sea level rise, exposure to storm surges and subsequent flooding is expected to put approximately 2,500 people or 14 percent of the total coastal population at risk during a 50- year return storm event**, affecting mainly the Long Bay coastline, the Great Morass environment, the West End cliffs and the New Savannah River area.

7. **Ecosystems degradation, together with beach erosion and the increasing impacts of tropical cyclones, may over time undermine resource-dependent livelihoods, such as fishing, farming and tourism, which are vital to the local and national economy.** For instance, declining fish stocks in Little Bay over the past decade have forced many women and men out of the fishing sector, contributing to unemployment

or underemployment and thus an overall reduction in household income. The tourism sector has provided *the* main source of alternative employment, but this sector is equally vulnerable to worsening environmental and climatic conditions. Ongoing beach erosion in Negril will therefore have drastic impacts on local livelihoods as well as the overall economy.

Proposed way forward

Given the importance of ecosystems to shoreline protection and livelihoods and taking into account the expected climatic changes, a "business as usual" approach is no longer viewed as a viable option. Significant corrective measures are required to avert not only the destruction of coastal ecosystems and infrastructure, but also to protect a critical resource that supports Jamaica's vital tourism industry. UNEP recommends that a longer-term strategy and integrated approach is necessary to establish a more sustainable development course in Negril.

Establishment of a comprehensive, cross-sectoral Negril Development and Management Plan should be a priority. The plan would guide the development of the area by establishing a framework that takes into account disaster risk and climate change and recognizes the critical role of ecosystems. The plan would inform land-use planning and development of infrastructure, human habitation and commercial buildings, thereby mainstreaming environmental and disaster risk management into local development planning processes.

An integrated strategic environmental assessment (SEA) process would provide the initial basis for establishing the development framework, which should be informed by a comprehensive understanding of the current status of ecosystems, disaster risk patterns and trends as well as the multiple stakeholders who need to be involved at the various levels (national, parish and community) including government, civil society, academia and the private sector.

Based on stakeholder consultation processes, three main pillars would constitute the Negril Development and Management Plan:

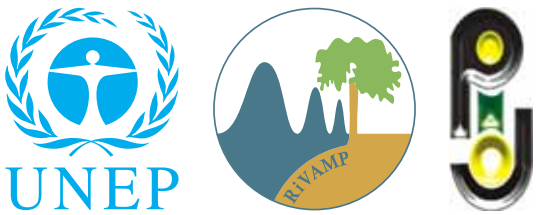
(i) strengthening environmental governance, (ii) identifying ecological-based solutions for risk reduction, and (iii) promoting environmental education for effecting behavioural change and local actions.

Key priority areas for action include the following:

- Initiate a multi-stakeholder, integrated SEA process to establish a sustainable development framework for the Negril area;
- Restore and rehabilitate coastal ecosystems, particularly coral reefs, sea grasses and other types of coastal vegetation, as a strategy for risk and vulnerability reduction and climate change adaptation;
- Assess and develop capacities of national and local authorities in mainstreaming environmental and disaster risk management in land-use and development planning;
- Develop alternative employment opportunities and skills that support sustainable resource management; and
- Enhance environmental awareness of beach dynamics and the role of ecosystems in beach protection and hazard mitigation, targeting vulnerable communities and the private sector.

The full list of proposed recommendations is summarized in Table 1, which are based on inputs from stakeholders who participated in national, parish and community-level workshops conducted during the RiVAMP pilot. Suggested recommendations should be regarded as a starting point for establishing meaningful dialogue between a broad range of stakeholders and for defining future development in Negril.

In conclusion, the RiVAMP pilot exercise has shown that a more comprehensive methodology for risk and vulnerability assessments can factor in ecosystem and climate change concerns, based on an evidence-based approach utilizing applied science and local knowledge and experience. RiVAMP can thus feed into development planning processes at the local and national-levels and help establish a more risk-sensitive and environmentally sustainable development course.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