Climate Change Action Plan:

Portland Bight Protected Area

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For:
Caribbean Coastal Areas Management Foundation (C-CAM)

June 2013

About this Document

This report will form the last of the deliverables of a consultancy awarded by the Caribbean Coastal Areas Management Foundation (C-CAM) to the Climate Studies Group, Mona (CSGM). It is an Action plan that integrates climate change adaptation and mitigation into management of the Portland Bight Protected Area.

The Action Plan was developed in part from review of literature and an assessment of gaps identified in socio-economic surveys done (CSGM, 2013a and b) of the area. The Action Plan primarily addresses gaps in the draft Management plan for the PBPA (CCAMF 2013) which were identified by the recently concluded climate change risk assessment (CSGM, 2013c) of the area. The Action Plan includes as annexes one page concept notes for projects that could be developed and undertaken to address issues raised and to successfully carry out actions proposed in the report.

In the context of the terms of reference, the report provides information on strategies which can be implemented to facilitate the development and implementation of the following:

1. A multi-year strategy for climate change adaptation, including species at risk, vulnerable livelihoods, vulnerable communities and vulnerable habitats
2. Educational programmes, climate change monitoring and modelling,
3. Land use and development zoning,
4. Aforestatation and reforestation initiatives including: forest and mangrove replanting
5. Good practice measures of relevance such as biodiversity conservation, rainwater harvesting and other demonstration projects and other practical approaches as necessary

Acknowledgements

This project was implemented by the C-CAMF with funding from the Critical Ecosystems Partnership Fund. The CSGM acknowledges the lead of Dale Rankine and Kimberly Stephenson with the oversight of Dr. Michael Taylor on this deliverable. Our sincerest gratitude is also extended to all the other individuals who participated in the compilation of this plan. They include:

Tannecia Stephenson

Rochelle Walters

Without the above mentioned individuals and agencies, this project would never have moved beyond its conceptual stage.

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1. INTRODUCTION

1.1 The Portland Bight Protected Area Climate Change Action Plan in the Context of the National Biodiversity Strategy and Action Plan (NBSAP)

The forests of Jamaica are critical systems on which residents and wildlife depend heavily. The natural resources they support provide livelihoods and food sources, and supply economically important materials for use in many sectors, including agriculture and tourism. They also support ecologically important organisms, many of which are endemic to the island or the region. They require protection and sustainable management to maintain equilibrium. The Portland Bight Protected Area (PBPA) is one such ecosystem and is ranked highly as a national conservation priority. Plans for conservation of the PBPA must coordinate with existing strategies being implemented for the island.

Jamaica has not completely incorporated environmental study and sustainability into legislation, and many conservation policies are localized within environmental sectors. There are currently 52 legislations that are geared towards protecting natural resources, but these are not comprehensive (NEPA, 2003). These shortcomings are being addressed through amendment and development of regulations to better enforce environmental protection, such as Wild Life Protection, the Endangered Species (Protection, Conservation and Regulation of Trade) Act and Biosafety parameters (NEPA, 2003).

The National Biodiversity Strategy and Action Plan (NEPA, 2003) was developed by NEPA as a means of ensuring that the value of Jamaica's biodiversity is recognised and considered in national planning. The plan aims to fulfil Article 6 of the Convention on Biological Diversity (CBD). It is still in the process of being implemented. The National Biodiversity Strategy and Action Plan (NBSAP) was formulated under a number of principles that promote the development of necessary policy framework for protection and rehabilitation of natural habitats, use of traditional knowledge and localised protection, sectoral integration, shifts in public perception of the environment and use of environmental output. The goals of the NBSAP are to:

1. Conserve Jamaica's biodiversity
2. Promote sustainable use of biological resources
3. Facilitate access to biological resources to promote developments in biotechnology and to ensure benefit sharing
4. Ensure safe handling and use of Living Modified Organisms
5. Enhance resource management capacity
6. Promote public awareness and education, and community empowerment
7. Promote regional and international cooperation and collaboration in support of the implementation of the CBD

The action plan being proposed in this document will adhere to the guidelines set out by the NBSAP in an effort to develop resilience in the sensitive ecosystems that comprise the PBPA. The need for this Action Plan, however, arises from the recognition that climate change could potentially put the PBPA and other critical Jamaican ecosystems at risk of modification or extinction. Climate change must therefore be considered in planning for environmental sustainability.

1.2 CLIMATE RISKS AND RESEARCH GAPS

The precursor to this action plan is the Climate Change Risk Assessment Report: Portland Bight Protected Area, which seeks to highlight the sensitivity of the PBPA to projected climate change based on current ecological and anthropogenic characteristics of the area and historical climatic conditions. In light of the physical vulnerabilities and high ecological importance identified in the risk analysis, particularly of the two forested areas (Hellshire Hills and Portland Ridge), seven points were put forward regarding the potential implications of climatic variation. The analysis also identified a gap in the research necessary to propel the conservation efforts needed at the site. These risks and gaps, along with a recommendation from the risk analysis, are stated below and will form the basis of this action plan.

1.2.1 Seven Things to Note

The following points are noted:

1. The PBPA represents the largest protected area in Jamaica. It includes the Portland Bight Wetlands and Cays Ramsar Site and is the proposed site for the Portland Bight Biosphere Reserve. It encompasses diverse ecosystems including dry limestone forests and hills, caves, coastland wetlands and mangroves, beaches, cays, sea grass and coral reefs as well as the anthropogenic lands and communities surrounding them. **Implication: The Bight's status as a protected area requires the implementation of diverse and innovative conservation initiatives given the diverse natural forms and systems and human activities and communities it encompasses. Adequate resources and personnel are needed to manage the extensive site and to enforce environmental legislation and zoning already in place or as may be required. The lack of resources contributes to the vulnerability of the region to climate and non-climatic stresses.**
2. The PBPA is one of high biological importance. The site is a habitat for more than 15 globally threatened species. Its mangroves are home to waterfowl and crocodiles as well as a nursery for fish and other marine wildlife. It is the site of one of the last remaining primary limestone forests in the Caribbean which is a habitat to over 300 species of standing plants (53 of which are endemic) and 11 endemic species of reptiles, including the critically endangered Jamaican Iguana. The species survive in the bioclimatic envelope unique to the region. **Implication: When climate varies outside of the bioclimatic norms sensitive ecosystems and species are threatened. There are, however, no studies of the direct and indirect sensitivity of species and ecosystems of the area to climate change. The magnitude of the impact of increasing climate extremes on flora and fauna can only be guessed at based on anecdotal evidence or research done on similar environments. The paucity of research including basic ecology and baseline information as well as data gathering/monitoring contributes to the vulnerability of the region to climatic and non-climatic stresses.**
3. The climate of the PBPA is warming, rainfall extremes (including droughts) and the frequency of intense storms and/or hurricane have increased in recent years. There is historical evidence of damage to coral reefs, mangroves and coastal infrastructure), with

storm surge and flooding being particularly devastating. The projection is that climate change will lead to further warming, more rainfall extremes (floods and droughts), a mean drying, higher sea levels and more intense hurricanes**. Implication: There is inherent climate sensitivity of the physical and natural environments within the PBPA. The changing climate is already posing a real risk to the PBPA which will only be exacerbated by projected climatic change. Climate change must be planned for in the PBPA due to its inherent vulnerabilities to climate threats.**

4. The natural resources of the PBPA support livelihoods of associated or bordering communities. Livelihood activities include fishing and fishing related activities, harvesting of wood and lumber including for charcoal, and mining for limestone. There are also planned human settlements and industrial developments for areas within the PBPA. **Implication: (i) There is economic value associated with the PBPA. Previous economic valuations of the PBPA have noted this. Conservation of the PBPA will require sustainable use of its resources to facilitate livelihoods while conserving its natural resources. At present there is evidence of unsustainable livelihood practices related to the natural resources e.g. over fishing or removal of forest cover for charcoal in old growth forests. These practices represent non-climatic stresses which exacerbate vulnerabilities already existent due to climate. (ii) In addition to the physical and biophysical, livelihoods will be significantly impacted by climatic variations of the future.**
5. According to the Social Development Commission, within the community of Hellshire, a third of the household heads have attained tertiary level education while three quarters of the heads of the households are engaged in professional occupations. In Portland Cottage it is estimated that 60% of the adult population is illiterate, and lack of nutrition may be inhibiting their learning. **Implication: There is variation in the socio-economic conditions of communities within or adjoining the PBPA. The existing socio-economic conditions point to different levels and/or manifestations of vulnerabilities to climatic threats in each community. The variation in socioeconomic conditions also point to different adaptive capacities to deal with climate change threat. Management plans being developed for differing communities must be tailored**

accordingly as vulnerabilities and risk to climatic threat differ due to socioeconomic conditions and 'one size' will not fit all.

6. Community perception is that the forests of the PBPA have been visibly degraded over time and that the effects have had an impact on climate and livelihood. The majority of respondents (60%) to a survey undertaken thought that the Hellshire Hills dry forest has undergone a negative change over the years. **Implication: There is already a sensitivity amongst stakeholders to climate variability, associated risks and vulnerabilities. Finding ways to capitalize and leverage this knowledge is crucial to reducing vulnerability and handling the associated climate risk.**
7. The UDC, NEPA and ODPEM (and other government agencies) all have or had activities ongoing in the PBPA. There are non-governmental agencies actively involved in the region, including CCAMF and PANOS. **Implication: Some systems, agencies, groupings are already in place which can be called upon to address the challenges and risks of climatic and non-climatic threats to the PBPA. The cooperative management plan being proposed represents a wise strategy. It must clearly define roles and responsibilities for key stakeholders and collaborators.**

1.2.2 A Gap

As previously noted, the adaptation strategies and programmes aimed at protecting the natural resources of the PBPA must of necessity target conservation of all the ecosystems, livelihoods diversification, regulation and/or restriction, and public education and awareness. Some attempts exist to address each of these areas within the PBPA. However, to appropriately target these options, to define their scope extent and reach, and to ensure their efficacy there is a need for supporting baseline data gathering and research, particularly with respect to the natural environment. For example, there are insufficient studies to adequately evaluate changes in forest ecology and to assess the need for and effectiveness of restoration and reintroduction of forests and associated biodiversity (Hammond, 1995; Khurana and Singh, 2000).

There is a gap with respect to monitoring, mapping, and modelling - including research associating climate with the ecosystems of the PBPA.

The following is noted about this gap:

- **Monitoring**. Recording and monitoring of atmospheric (rainfall, temperature, humidity, wind, etc.), terrestrial (soil moisture, pH, etc.), and marine (temperatures, salinity, etc.) variables, particularly within the most vulnerable ecosystems (e.g. the dry forests) is being done on a very limited scale, if at all. There is, for example, no meteorological station within the Portland Ridge forested area. This is important for defining the bioclimatic envelope for species survival and for establishing change as it is occurring. Relevant agencies including the Meteorological Service of Jamaica should be targeted for inclusion and review of the proposed Management Plan with respect to ensuring monitoring.

- **Mapping**. A comprehensive strategy for mapping and continuous monitoring of the ecosystems of the PBPA should be pursued, in particular for the fauna and flora of the forested hills. Maps are necessary for defining baselines and quickly identifying change. The strategy should identify and assign responsibilities to stakeholders with interest (including recognizing those who are already doing mapping and/or continuous species or resource monitoring). The strategy should identify specific gaps in mapping knowledge and outline strategies for filling them. Collaboration should include the Universities.

- **Modelling including climate-ecosystem research.** There are very few modelling related research efforts within the PBPA. This includes modelling of climate at the watershed or ecosystem scale, modelling climate species relationships, modelling of climatic hazards e.g. storm surge or fire potential. When coupled with monitoring, modelling provides the opportunity for instituting early warning systems (e.g. for onset of drought fire and exacerbation of fire potential) and for examining climate impact (e.g. on species composition or population) under hypothetical future scenarios. Modelling facilitates risk planning and the targeting of adaptation strategies. As for the mapping exercise a developed programme for modelling and research should identify specific gaps in knowledge and outline strategies for filling them. Collaboration should include the Universities.

1.3 Recommendation

It is proposed that a section of the management plan being drafted for the PBPA address explicitly the development of a strategy for addressing monitoring, mapping and modelling and research needs of the PBPA.

2. ADDRESSING CLIMATE RISKS AND RESEARCH GAPS

2.1 Ecological Protection

2.1.1 Monitoring

As shown in Figure 1a, most weather stations in the network of the Meteorological Service of Jamaica lie on the periphery of the forested areas, leaving the core areas without climatic monitoring (CSGM, 2013c). There is the exception of a weather station installed in the Hellshire Hills in 2010 through an initiative of the Jamaican Iguana Recovery Group (JIRG) based at the University of the West Indies, Mona Campus. This station measures rainfall, temperature, relative humidity, wind speed and direction, and pressure. Soil moisture sensors were also installed in 2011 as part of the same project (Stephenson, 2012).

Climatic records are required to identify the impacts that have occurred and may continue under climate change projections. Climate variations may directly affect species through mortality of individuals, breeding patterns, feeding patterns, sex ratios and other factors previously specified for vulnerable species in the PBPA (CSGM, 2013c). There will also be indirect impacts through the influence of habitat. For the dry, warm, coastal habitat of the PBPA, climate change will likely translate into exacerbated climate hazards such as storm surges worsened by sea level rise and forest fires driven by extended drought (Table 1). Given the PBPA's current susceptibility to such impacts, climate and habitat monitoring must be incorporated into any management plan that will be implemented in the area.

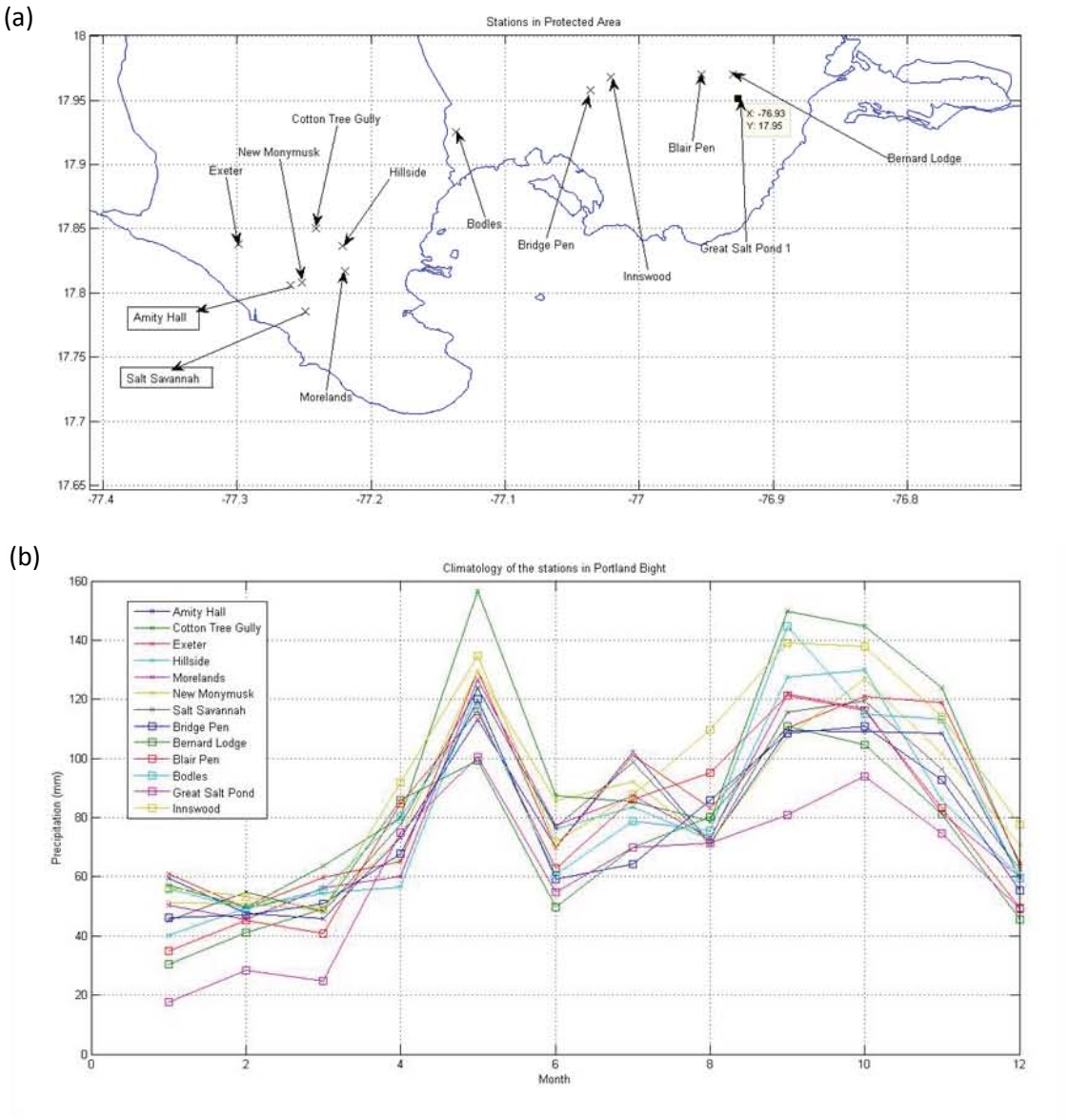

Figure 1 (a) Rainfall stations within the PBPA. (b) Mean monthly rainfall for 13 stations within the PBPA. Mean s calculated for 1992-2010. Data source: Meteorological Service of Jamaica.

Table 1 Summary of climate change impact on climate hazards to which the PBPA is prone. CSGM (2013).

Hazard	Projected climate change Impact
Flooding (Rainfall)	Risk enhanced at least through middle of century due to projected variability in rainfall extremes.
Storm Surge	Higher surge and farther fetch likely due to stronger hurricanes and higher sea levels.
Forest Fires	Increased incidence due to projected variability in rainfall extremes through middle of century. Extension of forest-fire season likely by end of century due to significant projected drying.
Inundation (Sea Level Rise)	Loss of low lying coastal land area due to higher projected sea levels.

Suggested Actions for Monitoring

The following are suggested actions for addressing perceived gaps in monitoring:

- Install real time (and where possible online) sensors and dataloggers for monitoring abiotic variables in ecologically valuable areas and for obtaining baseline environmental data. Portable sensors should be acquired for variables that require them. Variables to be monitored should include (but are not restricted to):
    - Atmospheric: Relative humidity, rainfall, barometric pressure, evaporation, wind speed and direction, temperature, solar radiation, aerosol content (may be obtained via automatic weather stations)
    - Terrestrial: pH, soil moisture, gas exchange (foliage), canopy light penetration
    - Marine: Salinity, conductivity, temperature, dissolved oxygen, bathymetry, tide gauges to monitor sea level rise and storm surges
- Form partnerships among research institutions, meteorological service and gun clubs for installation and maintenance of equipment in ecologically valuable areas.
    - Sensors can be installed in collaboration with the meteorological service, and monitored by students who can use the data for research projects. Association with gun clubs allows for monitoring and security of equipment and personnel.

- Install renewable energy sources for use by sensors to prevent dependence on and maintenance of batteries.
    - Energy sources should be selected based on suitability to the individual monitoring site, e.g. turbulence in wind caused by trees may reduce efficiency of wind turbines, height requirement for mounting solar panels to escape canopy cover may reduce feasibility.
    - These will also require protection from theft.
- Climate extreme indices should be calculated for core forested areas using data collected from newly installed weather stations. These indices will indicate tendencies towards droughts and other high risk climate hazards.
- Stakeholders: University of the West Indies, Mona Campus (UWI Mona); Meteorological Service of Jamaica; Monymusk Gun Rod and Tiller Club and the PWD Gun Club

2.1.2 Mapping

There is no comprehensive mapping of species in the PBPA, so that not all floral or faunal species are properly inventoried. Currently, research is primarily concentrated in the dry forest of the Hellshire Hills. Most of this work focuses on recovery of the Critically Endangered endemic Jamaican iguana (*Cyclura collei*) and is conducted by the JIRG along with a number of collaborators. Some on-going and recent research efforts in the Hellshire Hills are listed below. The list below is inclusive of and in addition to those stated in Table 2 (conducted by JIRG and collaborators unless otherwise stated) (JIRG, 2012):

- Recovering the Critically Endangered Jamaican iguana (*Cyclura collei*) population. This is done by means of:
    - Nest site monitoring
    - Collecting juveniles bred in the wild for headstarting at Hope Zoo
    - Genetic testing
    - Repatriation of headstarted individuals
    - Predator control
- Invasive Alien Species (IAS) predator control (JIRG), e.g. mongoose, cane toad, cat, dog, wild pig.
- Assessing ecology and monitoring activity of crocodiles in Manatee Bay.
- Monitoring abundance of terrestrial vertebrates and arthropods to assess the effects of predator trapping and climate change on population size. Species monitored include Critically Endangered endemic lizards and snakes (see Table 3).
- Assessing the effect of long-term anthropogenic disturbance and seasonality on tropical dry forest dynamics.
- Monitoring of sea turtle index beaches along the coastline.
- Sedimentary records of storms and tsunamis in Jamaica. (Manatee Bay and Coquar Bay are two of multiple sample sites undertaken by the Department of Geography and Geology, UWI Mona) (Caribbean Environments, 2013).

- Hellshire Hills botanical survey (undertaken by Botanical Research Institute of Texas (BRIT) in 2012 in collaboration with JIRG).

Though ecological monitoring is consistently being undertaken in the Hellshire Hills, the same cannot be said for Portland Ridge or the Braziletto Mountains. The latter areas have been assessed for the presence of ecologically important species, but no known research projects are in place for ecological monitoring. There are also no scientific research projects currently in place to focus specifically on marine species. Some ecological surveys are currently being carried out by C-CAM so as to obtain a comprehensive view of the species composition of the protected area.

Table 2 Summary of Key Activities in Biodiversity Conservation and Function of Principal Stakeholders in the PBPA. CSGM (2013)

Principal Stakeholder(s)	Initiative Details
C-CAMF	Monitoring of Seabirds on Cays. Conservation of Gamebirds-Increasing coordination among stakeholders and between enforcement agencies, Habitat improvement
C-CAMF with funding from WINDALCO	Artificial Reef Installation, marker buoys and signage at Three Bays Fish Sanctuary-Structures built encourage growth of corals and ultimately fisheries
C-CAMF, NEPA, UDC, ISCF, Fire Brigade	Crocodile protection: Removal of reptiles from flooded communities of Portland Cottage, Salt River, Rocky Point, Hellshire and Portmore. Community awareness raising
UWI and Forth Worth Zoo (Texas), UDC, NEPA	Crocodile Monitoring by tracking their movements of at Manatee Bay. Assessment of the Caymanas wetland and selected areas in Hellshire
Portland Bight Fisheries Management Council (32 member multiple stakeholders)	Development of fisheries management including: management of coral reefs, seagrass beds, the Portland Bight Cays, turtles, manatees, crocodiles and the wetlands, and has made recommendations re how the marine space of the PBPA should be zoned
Fisheries Division/C-CAMF	Fish Sanctuaries (three): Management of sanctuaries, enforcement of appropriates laws and monitoring of catch to help recovery of fish stocks.
NEPA-GEF Funded	Management of Alien Invasive Species: Control of mongoose and cats in Hellshire from preying on the Jamaican Iguana. Control population of lionfish in coastal waters.

Table 3 List of threatened reptiles of importance monitored in the Hellshire Hills. Compiled from Wilson and Vogel (2000) and CSGM (2013).

	Species	IUCN Status
Lizards	*Celestus duquesneyi* (Blue-tail Gallywasp) Endemic to PBPA.	IUCN Data Deficient. May be critically endangered (Blair Hedges)
	Sphaerodactylus parkeri (Parker's Banded Sphaero) Endemic – very restricted range.	IUCN Not Assessed. May be endangered (Blair Hedges)
	Anolis valencienni (Jamaican Twig Anole) Endemic.	IUCN Least Concern. May be endangered (Blair Hedges)
	Cyclura collei (Jamaican Ground Iguana) Endemic.	IUCN Critically Endangered. Only found in Hellshire Hills.
	Spondylurus fuligius (Jamaican Skink) Endemic form.	IUCN Not assessed, May be critically endangered (Blair Hedges)
Snakes	*Epicrates subflavus* (Yellow Snake). Endemic	IUCN Vulnerable. May be endangered (Blair Hedges)
	Trophidophis stullae (Portland Ridge Trope)	IUCN Not Assessed. May be critically endangered(Blair Hedges)
	Trophidophis jamaicensis (Jamaican Brown Trope) Endemic.	IUCN Not Assessed. May be endangered (Blair Hedges)

Suggested Actions for Mapping

The following are suggested actions for addressing perceived gaps in ecological mapping:

- Compile existing ecological data into one central repository that can easily be accessed by present and future researchers.
- Undertake a full inventory of flora and fauna, as well as obtain the extent of all major forested areas and hydrology of watersheds via comprehensive, continuous surveys.
    - These surveys will be on-going to allow for monitoring of community and habitat changes over time.
    - Surveys will document number of species and areal extent of species range where possible, with a special focus on threatened species.

    - Research opportunities can be made available for students.

- Evaluate population size of vulnerable species through approximate abundance, e.g. *Celestus duquesneyi*.

    - For smaller organisms, this can be done via transect, noose, pitfall traps (as in the case of the Hellshire Hills) or any method that is most efficient for the heavily forested sites. For larger organisms, populations can be assessed using camera traps installed at strategic points throughout the forest.

- Install IAS predator trapping grids throughout Portland Ridge and Braziletto Mountains.

    - Identify key areas in which most vulnerable species are most likely to occur and concentrate predator trapping in those sites.

- Identify options for rehabilitation of degraded forest.

    - This may involve restoration of previously forested areas or be relegated to absence of human disturbance.

    - Any steps identified will require policies protecting current forest from exploitation and incorporating prior forest into strictly protected zones.

- Stakeholders: UWI Mona; NEPA; Forestry Department; C-CAM; UDC

2.1.3 Modelling

Modelling has been done minimally, if at all, for the PBPA at any scale and for any variable (CSGM, 2013c). This means that there is limited knowledge about the adaptive capacity of the area and the likely sustainability of any system that may be put into place. With the area being highly valuable and at high climatic risk, it is imperative that any plan being implemented be guided by projections of both changes in climate and the impact of those changes on the ecosystem and surrounding anthropogenic communities. To achieve such projections, modelling techniques must be developed to define climatic modulation of watershed hydrology, species dynamics and natural disasters. This is particularly important for disaster management and in the development of early warning systems for hazards to which the PBPA is already prone, such as wildfires.

Currently very few research efforts include climate related modelling in the PBPA. The spatially distributed model SWAT (Soil & Water Assessment Tool) has been used to assess the combined effects of land use and climate change on the hydrology of the Rio Cobre watershed using projections from global climate models (GCMs) (Webber, 2012). This was conducted by UWI Mona under the Caribbean Coastal Scenario Project in collaboration with Florida International University. As previously mentioned, lizard and arthropod abundances are being monitored in the Hellshire Hills to evaluate the influence of climate change. This project is in the process of modelling future climate of the Hellshire Hills and the potential impacts of climate variables on these populations into the future (Stephenson, 2012).

Climate projections that are currently in use for other regions across Jamaica have been obtained from regional climate models (RCMs) or GCMs. No studies exist where the data have been further downscaled to a watershed scale or less (see CSGM, 2013). Notwithstanding, data at existing resolutions can be used as the basis of early warning systems for natural disasters and adaptation strategies for communities and ecosystems. Improvements to monitoring and mapping capacity will not only allow for increased data availability but will also remove inaccuracy and uncertainty brought about by sparse datasets used to validate models. Modelling also allows for long term risk planning, as projections can be made towards the end of the century.

Suggested Actions for Modelling

The following are suggested actions for addressing perceived gaps in modelling:

- Downscale GCM and RCM climate data to be specific to the PBPA using locally measured data.
- Identify influence of climate on species and watersheds using abundance and hydrology data gathered through mapping or already existing.
- Implement appropriate impact models to project future impacts of climate on ecosystems based on past impact.
    - Where a model of the necessary scale does not exist, one must be developed.
    - Historical data and data obtained from sensors will be used to build or train the models and RCM or downscaled climate data will be used for projections.
- Develop early warning systems for major climate hazards guided by ODPEM. These systems should be based on climate indicators that can be identified and flagged using data from installed sensors and extreme indices. Early warning systems should be developed for:
    - Flooding: Based on rainfall intensity, number of consecutive wet days, soil saturation
    - Storm surge: Based on sea level, wind
    - Fires: Based on temperature, smoke, length of drought, soil dryness, relative humidity, wind
    - Sea level rise: Based on bathymetry
- Once early warning systems have been developed, they should be accompanied by:
    - Software that can be installed on computers of environmental and community monitoring personnel and can be used to remotely notify the user of an impending disaster.

- Alarms installed in strategic locations around communities of the PBPA for timely notification of community members.

- Stakeholders: UWI Mona; NEPA; Forestry Department; Fire Department, C-CAM; UDC; ODPEM; CBOs/Citizens' Associations

2.2 Educational Programmes

Table 4 (below) gives a brief list of the major stakeholders in the PBPA who are currently involved in environmental education campaigns. Education is important as a strategy for adapting to climate change and there is strong supporting evidence (website, printed materials, community meetings and workshops, etc.) that it is being utilized within the PBPA (see also CCAMF 2013). Though progress has been made towards increasing awareness of the ecological value of the PBPA by the organizations noted in table 4, there is seemingly still some hesitation among community members to enforce environmental protection (CSGM 2013a, b). As stated in the accompanying risk analysis, this is heavily influenced by the fact that some of residents are economically challenged and many are illiterate or have long term illnesses (CSGM 2013c). As also suggested by the survey of forest users (CSGM 2013a,b), the issue of environmental protection involves not just older residents who use the site for income generation, but also younger residents who will later assume the roles of providers.

To combat this cycle, educational oriented efforts within the BPA must allow for wide inclusion of community groups – encompassing all ages - into co-management of the PBPA. This creates a vested interest in increased community participation in conservation and enhances awareness. New programmes must involve incorporation of environmental conservation into the school curriculum - particularly schools within and adjoining the PBPA region - in order to reach the youngest members of the community. To reach a broad enough audience, however, a range of non-traditional methods must be used to communicate the messages of environmental endangerment and climatic risk, such as those employed by the 'Voices for Climate Change' Project currently being conducted by Panos Caribbean (CSGM, 2013).

The surveys of forest users also noted the presence of users who journeyed from other parts of the island not immediately adjacent to the PBPA (CSGM 2013 a, b). In addition there are beneficiaries of the resources of the PBPA who are not resident within the communities geographically linked to the PBPA e.g. coal users, recreational bathers, hunters, etc. This suggests that in addition to an educational campaign geared at PBPA residents, a useful strategy would be to broadly target the entire country. Such a campaign would 'tell the story of the PBPA ecosystems' i.e. it would teach about the PBPA as an ecologically sensitive area of Jamaica while at the same time highlighting the services a protected area can and would offer. The

campaign should/would make the case for the PBPA's vulnerability and need for protection and delineate roles that can be played by ordinary citizens in ensuring its sustainability. There is at present no evidence of such a wider targeted campaign.

Table 4 Summary of Key Activities in Public Education and Outreach and Function of Principal Stakeholders in the PBPA. CSGM (2013)

Principal Stakeholder(s)	Initiative Details
Institute of Jamaica	Establishment of Biodiversity Centre-for Primary & Junior High level students
NEPA	Facilitate First Responders Programme in PBPA, promote mangrove replanting
UWI	Mainstream Conservation into School Curriculum
Panos Institute Caribbean and other partners	Using non-traditional methods to communicate conservation and Climate Change

Suggested Actions for Educational Programmes

The following are suggested actions for enhancing ongoing educational efforts:

Children and Teens

- Incorporate field assessments into curriculum.
    - Develop partnerships with schools for monitoring of climate and species.
    - This will include regular school trips to forests and wetlands for observation of native and invasive species.
    - This will include access to online databases for use in research projects.

- Develop classroom essentials for students that are geared towards ecological protection, such as reading materials, math problems, posters and recreational items.
    - These must be items that students will not discard quickly.
    - Include guides to Jamaica's natural resources that are simple enough to be understood by children, for example those produced by NEPA.
- Incorporate environmental activities into school routines to teach students the importance of natural resources and interaction with ecosystems and organisms. Examples of such activities include student grown school gardens, composting and production of biofuel.

Young Adults

- HEART training programme- suggested by residents (CSGM, 2013).
    - This would allow for young members of the community to gain skills that do not require destruction of the forest for income generation. It is also a means of teaching illiterate individuals how to read while developing these skills.
- Create openings for young volunteers in environmental organizations to expose them to working in conservation.
    - This is also a means of busying those who have no occupation, whether educated or uneducated, and would otherwise become hazards to the community.

Adults

- Establish Community Based Organisations and Citizens' Associations as training hubs for developmental and environmental programmes, which will require the participation of as many residents as possible.
    - The cooperation of Fishermen Cooperatives will be necessary to curb the current destructive and excessive fishing practices being used and to implement safer methods.

- Develop programmes that deliver the ecological message in creative ways, for example comedy, music, art, movies

General

- Establish sustainable sources of funding.
    - Agreement between stakeholders for small percentage of user fees from eco-tourism activities to be used to sustain public education and outreach.
- Document and tell the PBPA story through sustained renewal of information in pamphlets, websites, video documentaries, newspaper articles, decals, billboards, radio serials, social media, etc.

Stakeholders: UWI Mona; NEPA; Forestry Department; C-CAM; UDC; CBOs/Citizens' Associations; Fishermen Cooperatives, Ministry of Education, Communication entities.

3. STRATEGIES, POLICIES AND LEGISLATION

A number of policies and legislations have been established in Jamaica to allow for regulation of human interaction with and influence on ecosystems. The country is also a signatory to many international agreements, among them being the Convention on Biodiversity for which the NBSAP is an output. The numerous policies and legislation form a reasonable basis of sustainability and management of natural resources.

Existing laws, however, do not explicitly contain provisions for the direct effects of climate change on ecosystems. However, they will be pivotal in mitigating human influence on climate change and ecosystem resilience through their protection of natural resources. In addition, the country has taken steps to evaluate potential climate change risks and has been a party to both international and regional programmes relating to the issue. Systems have also been put in place to monitor local coral reefs.

The ensuing tables summarise the regulations and treaties that are relevant to the PBPA. Information was extracted from the Government of Jamaica (GOJ) Policy Register, NEPA, NBSAP and the Protected Areas System: Plan Legal Framework- Final Report (McCalla, 2004) put forward by the Forestry Department. The section below suggests some actions that can be undertaken in support of existing policy and legislation noted in the ensuing tables.

3.1 Suggested Policy Supportive Actions

The following are suggested actions for supporting existing policy and regulations. The actions are given in the context of those which support the monitoring, mapping and modelling programmes suggested.

- Signing of voluntary environmental agreements amongst communities in the PBPA. This would engender buy-in especially in areas where non-compliance with mandatory regulations is evident. There would however need to be established baselines. This points to the need for effective monitoring, mapping and modeling of climate conditions and existing resources.

- Coordination and collaboration between enforcement agencies. While environmental laws have long been in place, for example, to protect the area from trespassers, monitoring and enforcement is weak and inadequate. Pursuing collaborative activities amongst enforcement agencies might share the burden of inadequate resources of any one agency. Enforcement would also be necessary for ensuring that monitoring equipment is secured and for the protection of researchers carrying out proposed mapping and modelling exercises.

- Incorporating community-based groups into ranger-based and conservation activities. Studies have shown that there is considerable merit in engaging the resource user in monitoring and enforcement. Community based groups should be directly included in monitoring, mapping and modelling activities.

- Establishment of a hot-line for reporting of breaches.

- Active Review of setbacks and land use activities. The survey of forest users (CSGM 2013 a) notes that efforts should be made to limit further conversion of old growth forest to quarries or housing estates. There is a need for zoning of areas suitable for such uses, following updated baseline studies based on monitoring, mapping and modelling.

3.2 Policies

Table 5 Existing Jamaican policies directly and indirectly related to biodiversity. Source: GOJ (2012)

Policies that Currently Guide Operations	Purpose
Ministry of Agriculture & Fisheries	
National Plant Health Policy (Ministry Paper No. 4/11 dated 25 January 2011)	The Policy seeks to address the gaps and failures in the current plant health system in light of the requirements of international treaties and agreements of which Jamaica is signatory and food safety and phytosanitary standards of major trading partners.
Ministry of Foreign Affairs & Foreign Trade	
Ocean and Coastal Zone Management Policy	To provide a comprehensive framework for the management and development of resources in Jamaica's ocean and coastal zones. A National Council on Ocean and Coastal Zone Management was established in 1998 to coordinate the policy and is guided by terms of reference which include measures to develop an integrated marine policy for Jamaica.
Ministry of Finance and Planning	
National Population Policy (Revised 1995)	The policy establishes goals with respect to population growth and size; fertility; mortality; external migration; internal migration & urbanization; gender; children; the elderly; and the population in relation to the environment.
Ministry of Local Government & Community Development	
Integrated Solid Waste Management Policy	The policy covers the following issues in relation to solid waste management: · Regulatory Framework · Institutional Framework · Cost Recovery · Operational issues related to collection, transportation and disposal · Waste minimization · Waste processing · Hazardous and Medical Waste · Public Education · Relationship to other national policies and legislation · Enforcement
Ministry of Science, Technology, Energy & Mining	
National Energy Policy 2009-2030 (Ministry Paper No. 124 - tabled in the House of Representatives on 8	This policy seeks to, among other things: · Manage national energy base · Diversify the energy base · Encourage conservation and efficiency in energy production and use;

December 2009 and in the Senate on Friday, 11 December 2009)	· Promote the development of renewable energy resources; and · Make electricity available and affordable to customers
Ministry of Transport, Works and Housing	
National Transport Policy (2007)	To guide the overall development of the transport sector and to provide the framework for the development of environmentally-sound transport infrastructure and services in support of sustainable economic and social growth.
Ministry of Tourism and Entertainment	
Tourism Master Plan for Sustainable Development	The Master Plan recognizes that the greater diversification of our product offering is the key to improving our competitive position both regionally and in the global context. It acknowledges that sustainability requires: greater involvement of communities in the industry, whether as entrepreneurs, or as service providers, so that there will be a better spread of the benefits; incorporation of more opportunities to showcase Jamaica's culture and heritage; forging stronger linkages with sports and entertainment; forging stronger linkages with other productive sectors and greater focus on environmental management and protection by all players in the sector. Also, there has been increased effort in events led (including sporting events) promotion and in focusing more attention on marketing and promotions in Europe.
Ministry of Water, Land, Environment & Climate Change	
Jamaica Water Sector Policy, Strategies and Action Plan	The policy objectives are: · Water Resources Management – the management, assessment and regulation of Jamaica's' water resources. It will see the creation of a comprehensive database, water quality monitoring and assessment and a programme for public; · Urban Water & Sewerage – provision of the necessary quantity of potable water and minimum standard of sanitation services to all at an affordable price. It also envisions improvements in sewerage treatment and disposal, proper disposal of industrial effluent and the protection of the environment. Will seek to encourage private investments in new infrastructure through Public/Private Partnerships (PPP); · Rural Water Sanitation – by 2010 all households rural and urban will have full access to potable water through various modalities and that by 2020 all major towns will be sewered; · Urban Drainage – to be addressed as an integral part of the Water Sector; and · Irrigation – irrigation water to be provided in a cost effective and efficient manner with due regard to cost recovery. Promote formation and legalisation of Water Users Associations (WUA).

National Biodiversity Strategy and Action Plan on Biological Diversity in Jamaica	To ensure the most sustainable use and conservation of the country's biological resource in keeping with the Convention on Biological Diversity (to which Jamaica is a party).
Policy for Jamaica's System of Protected Areas	To support the establishment and maintenance of a comprehensive, ecologically representative and effectively managed national and regional system of protected areas.
National Forestry Policy (2001)	The Forestry Policy sets out primary goals and priorities pertaining to the conservation and protection of forests and the sustainable management of forest lands and watersheds. It also deals with strategies and tools for implementation of these goals, including community participation, promotion and regulation of forest industries, forest research, public education and forestry training, incentives, funding and monitoring. It also outlines the mandates and roles of Government agencies involved in forest land management.
National Land Policy (1997)	The goals and objectives of this Policy are to ensure the sustainable, productive and equitable development, use and management of the country's natural resources. The policy also aims to complement socioeconomic development initiatives of the country. It challenges and seeks to remove inefficient, onerous and outdated legal, administrative, management and other barriers that affect the planning, use, control, development, protection and conservation of Jamaica's physical resources.
Cabinet Office	
Strategic Environmental Assessment Policy	The Government of Jamaica commits to ensuring that all its policies, plans and programmes adequately consider potential environmental effects and impacts, and where these are adverse, incorporate appropriate measures to reduce or eliminate these effects and impacts. In accordance with the vision and strategy for the modernization of the public sector, environmental implications will be fully included and adequately addressed at the earliest appropriate stage of decision-making, on par with economic and social considerations.

3.3 Legislation

Table 6 Existing Jamaican legislation directly and indirectly related to biodiversity. Sources: NEPA (2003), McCalla (2004)

Legislation	Mandate or Impact on Biodiversity
	Direct Biodiversity Legislation
Country Fires Act, 1942	Prohibits the setting of fires to vegetation, particularly at night or unattended, and allows the entry of Police, Forest Officers or Agricultural Wardens to put out these fires.
Endangered Species (Protection, Conservation and Regulation of Trade) Act, 2000	Provides for the conservation, protection and regulation of trade in endangered species in fulfilment of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).
Exclusive Economic Zone Act 1991	Aims to preserve and protect the marine environment and to prevent and control marine pollution under the jurisdiction of the Crown.
Maritime Areas Act 1993	Establishes the maritime boundaries of Jamaica and allows for the Minister to enact regulations for the preservation of natural marine resources.
The Beach Control Act, 1956	Regulates use of foreshore and sea bed through monitoring of developmental, commercial and recreational activities, and protection of marine ecosystems.
The Fishing Industry Act, 1975 (Amended in Fisheries Bill, pending)	Protects fish through the establishment and management of fish sanctuaries and fishing seasons. Also allows for the control and licensing of fishing activities, and regulation of conch and lobster seasons.
The Forest Act, 1996	Ensures the management of forests and allows for establishment of forests on suitable land through the Forestry Department and the Conservator of Forests.
The Jamaican Constitution, 1962	The Constitution protects the rights of property owners in that all flora and fauna on a person's property belong to the owner and can be kept if caught by the owner (unless otherwise determined under the Wild Life Protection Act).
The Mining Act, 1947 (amended in 1988)	Regulates mining activities in and establishes that the rights to minerals belong to the Crown. Mined lands must be rehabilitated once a license/lease has expired.
The Natural Resources Conservation Authority Act, 1991	Developed the Natural Resources Conservation Authority (NRCA, now NEPA) to monitor and manage the environment, so as to provide protection from exploitation and unsustainable development, and to promote public awareness and considerate use of natural resources.

The Quarries Control Act, 1983 (amended in 1994)	Regulates established quarrying zones and issues licenses to operators through the Quarries Advisory Committee, while maintaining maximum preservation of the natural ecosystem.
The Watershed Protection Act, 1965	Manages watersheds in 26 units across the island, regulates land use, allows for watershed rehabilitation and requires voluntary participation.
The Wild Life Protection Act, 1945	Specifically protects individual wild species and regulates hunting.
Shipping Act, 1998	Gives the Maritime Authority the authority to inspect incoming ships to prevent marine pollution, and regulates entry of merchant ships.
Town and Country Planning Act, 1948 (amended in 1999)	Ensures the orderly development of land with consideration of environmental preservation as a priority.
Water Resources Authority Act, 1995	Developed to regulate and manage the abstraction and allocation of water resources, and to govern the preservation of water quality and the conservation of such resources through the establishment of the Water Resources Authority.
Biodiversity Related Legislation	
Animals (Disease) and Importation Act, 1969	Allows for controlling the spread and treatment of diseases within the island via importation controls on animals, and the eradication and disposal of infected animals or where such infection is suspected.
Clean Air Act, 1964	Makes provision for the prevention of the discharge of noxious or offensive gases into the air including fumes and dust from alumina, cement, lime, petroleum and gypsum works.
Harbours Act, 1874	Regulates activities within harbours through the Marine Board by regulating the movement of boats and vessels in harbours, channels or approach thereto; the placement of buoys and removal of sunken structures from harbours; penalties for depositing refuse and waste matter from vessels; and removal of sand, stone, ballast, etc., from harbours, reefs or shoals.
Institute of Jamaica Act, 1978	Promotes Literature, Science and Art, with responsibility for national museums.
Jamaica National Heritage Trust Act, 1985	Establishes a statutory body to protect Jamaica's national heritage, including any place, animal or plant species or object/building.
Litter Act, 1985	Defines what constitutes litter on private and public property and prescribes penalties for offences against the Act and the provision of receptacles for proper disposal.
Local Improvements Act, 1914	Governs all development of lands within Kingston or other such Ministerial prescribed areas via the requirement for subdivision approval from the relevant local authority.

Petroleum Act, 1979	Vets all petroleum in the State and makes provisions for the creation of Regulations which prevent pollution and orders remedial action where this takes place, as well as the protection of fishing, navigation, etc.
Plants (Importation) Control Regulation, 1997	Outlines the role of the National Biosafety Committee in monitoring and regulating the importation of Living Modified Organisms for research only.
Plant Quarantine Act, 1993	Provides protection for Jamaica's flora from imported diseases or pests transported via plants, plant products, and soil or via other means as well as the course of action to be taken when these are discovered within the island.
Public Health Act, 1985	Allows for the establishment of Local Boards to regulate activities carried out in private or public buildings or properties where such activities prove injurious to public health
Urban Development Corporation Act, 1968	Establishes the Urban Development Corporation as a statutory body, which has amongst its functions the duty to carry out construction, maintain public parks, car parks, etc. in such manner to ensure preservation of architectural or historical objects or sites.

3.4 International and Regional Agreements

Table 7 International and regional agreements into which Jamaica has entered. Source: NEPA (2003)

Instrument	Status
International Plant Protection Convention, Rome, 1951	Accession: 24 November, 1969
United Nations Convention on the Law of the Sea, Montego Bay, 1982	Ratification: 21 March, 1983
Convention Concerning the Protection of the World Cultural and Natural Heritage, Paris, 1983	Acceptance: 14 June, 1983
Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region, Cartegena de Indies, 1983	Ratification: 1 May, 1987
Protocol Concerning Cooperation in Combating Oil Spills in the Wider Caribbean Region	Entry into Force: 1 May, 1987
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (as amended), London, Mexico City, Moscow [Washington], 1972	Ratification: 22 March, 1991
International Convention on the Prevention of Pollution from Ships, London, 1973	Ratification: 13 June, 1991
Protocol of 1978 relating to the International Convention for the Prevention of Pollution from Ships, London, 1973	Ratification: 13 June, 1991
London Amendment to the Montreal Protocol on Substances that Deplete the Ozone layer, London	Ratification: 31 March, 1993
Vienna Convention for the Protection of the Ozone Layer, Vienna, 1985	Accession: 31 March, 1993 Entry into Force: 29 June, 1993
Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal, 1989	Instrument of Accession Deposited: 6 January, 1995 Effective: 5 April, 1995
United Nations Framework Convention on Climate Change, New York, 1992	Instrument of Accession Deposited: 6 January, 1995 Entry into force: 5 April, 1995
Convention on Biological Diversity, Rio de Janeiro, 1992	Instrument of Accession Deposited: 6 January, 1995

	Entry into force: 5 April, 1995
Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)	Accession: 23 April, 1997 Entry into Force: 22 July, 1997
The Copenhagen Amendment to the Montreal Protocol on Ozone Depleting Substances	Accession: 7 November, 1977 Entry into Force: 4 February, 1998
Convention on Wetlands of International Importance especially as Waterfowl Habitats (Ramsar Convention)	Accession: 7 October, 1997 Entry into force: 7 February, 1998
Convention to Combat Desertification	Accession: 12 November, 1997 Entry into Force: 16 March, 1998

4. Suggested Timeframes for Strategy Plan of Action

Action	Year 1	Year 2	Year 3	Year 4	Year 5
Monitoring	• Scoping activities for placement of equipment, establishment of monitoring protocols, etc. • Establishment of collaborative ventures. • Purchasing of equipment including hardware for data storage	• Installation and testing of monitoring equipment. • Development of online databases. • Development of supportive programmes e,g, programmes for schools, dissemination activities.	• On-going monitoring • Establishment of initial baseline dataset.	• On-going monitoring	• On-going monitoring • Updating of baseline dataset • Assessment of monitoring exercise.
Mapping	• Scoping activities for placement of equipment, establishment of mapping protocols, etc. • Establishment of collaborative research ventures. • Prioritizing mapping projects. • Funding proposals written and distributed.	• Purchasing and installation of equipment including hardware for data storage. • Development of online databases. • Onset of mapping projects.	• On-going mapping • Establishment of initial baseline dataset.	• On-going mapping	• On-going mapping • Updating of baseline dataset • Assessment of mapping exercise. • Research publications
Modelling		• Existing data scoping activities for creating baselines and supporting model validation.	• Initial modelling activities initiated.	• Use of initial datasets for model validation.	• On-going modelling. • Production of initial downscaled

		• Engagement of research collaborators for climatic and bioclimatic modelling. • Prioritizing modelling efforts. • Funding proposals written and distributed.		• On-going modelling. • Conceptualised early warning systems using data captured.	maps of change and impact. • Research publications • Dissemination of initial results. • Implementation of early warning systems.
Education	• Development of specific education campaigns/proposals geared at adults, children, communities and general public. • Prioritizing education projects. • Funding proposals written and distributed.	• Engagement of collaborators. • Start of education programmes.	• On-going education programmes.	• On-going education programmes.	• On-going education programmes. • Evaluation of effectiveness.

5. Conclusion

This document proposes possible actions to address gaps identified by a climate change risk assessment of the PBPA. The proposed actions include monitoring of climatic and biophysical variables; developing strategies for baseline and continuous mapping of the flora and fauna of the area; suggestions for the inclusion of climate and ecosystems modelling in the process of determining future vulnerability; and expansion of education initiatives beyond the boundaries of the PBPA. An indicative timeline for refining and implementing the proposed strategies, actions, suggestions and ideas is also provided. It is noted that in many instances a proposed strategy can be the basis for multiple funding proposals e.g. targeting separately measures for mapping and protecting terrestrial versus marine species, or pursuing climatic modelling versus ecosystem modelling, or developing drought versus forest fire early warning systems. The development of all possible proposals is beyond the scope of this project. Three one-page proposal concepts are, however, provided in the annex of this document which can be further developed for submission to a relevant funding agency.

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Annex: Project Proposal Concepts for Implementation of Action Plan

Project Information

Title: Enhanced monitoring for Building Climate resilience in the PBPA

Budget: USD150, 000
Duration: 2 Years (2013-2015)
Proposed Project Stakeholders:

- National Environment and Planning Agency (NEPA);
- The Forestry Department;
- C-CAMF
- Meteorological Service, Jamaica
- UDC
- Ministry of Agriculture and Fisheries
- University of the West Indies, Mona

Summary

The PBPA is very climate sensitive in that a number of the resident and migratory species rely on a finite range of key weather parameters for their survival. The area is however not serviced by an adequate network of weather stations with the most relevant ones being sited on the periphery of the area. As such key assessments of climate change are limited and can only be carried out currently through extrapolation of data from neighbouring locations. This is less than ideal and limits the accuracy of current assessments and the ability of making future ones. Strategically placed weather stations and tide gauges must be installed with capabilities for real-time monitoring of data and for facilitating continued assessment of climatic changes in the PBPA.

The stations should be linked to the network of the Meteorological Service to ensure data quality and to facilitate required station maintenance. Communal participation will be sought to ensure continuity of data collection and awareness. The project will allow for the identification of most vulnerable areas also the determination of remedial measures for effective adaptation to climate change. Crucially it will allow for assessment of sea level rise and continued review of setback requirements.

Objective
To establish a real time network of climate observing stations to improve climate resilience in PBPA.

Main Outputs

1. Network of real-time sensors and weather stations

2. Protocols for data dissemination and quality control.

3. Establishment of baseline assessment of weather parameters including: temperature, rainfall, pH, Salinity

4. Climate change assessments of Sea level rise and storm surge

5. Site specific storm surge analysis to determine storm surge levels for 10, 25, 50 and 100 Year Return Period; and Category 4 and 5 hurricanes on worst-case track (as in PIOJ, 2012)

Project Information

Ecological mapping for species protection and conservation in PBPA-A Climate Change adaptation initiative

Budget: USD300, 000
Duration: 3 Years (2013-2016)
Proposed Project Stakeholders:

- National Environment and Planning Agency (NEPA);
- The Forestry Department;
- C-CAM
- Portland Bight Fisheries Council
- UDC
- Ministry of Agriculture and Fisheries
- University of the West Indies, Mona
- Ministry of Land, Water, Environment and Climate Change

Summary

Several species resident in the PBPA are endemic to Jamaica. Their existence in the PBPA is in part tied to the characteristics of the dry forest ecosystem which makes up significant portions of the PBPA. Increasing temperatures, and more variable rainfall (as evidenced by national trends) *inter alia* are altering the ideal living conditions for various species. Further given the lack of one comprehensive repository of species data, it is difficult to assess species distribution, distinguish between natural and anthropogenic interferences, and determine the full range of potential climate change impacts.

This project seeks to develop an online registry of species in the PBPA that will be categorised according to their 'threatened' status. This will also allow for prioritizing rehabilitative measures particularly for species that are critically endangered and provide the basis for conservation moratorium where needed. Moreover it will display through a series of interactive maps the species distribution, migratory patterns and well as the habitat status. Existing databases can be updated via an interface with the project outputs.

The end result will be an active and continued assessment of species and the facilitation of adaptation planning in the context of projections of more intense weather systems by mid to end of century.

Objective
To develop a framework for mapping of and accounting for resident and migratory species in the PBPA

Main outputs
The main outputs of this project include the following:

1. Comprehensive online inventory of species in the PBPA

2. Interactive maps of species distribution

3 Climate resilient rehabilitative measures for the species conservation and regeneration

Geographic Scope
Port Royal and Port Royal Cays (Kingston), Port Antonio (Portland), Old Harbour Bay, Hellshire Hills (St. Catherine), Rocky Point, Portland Ridge (Clarendon),

Project Information:

Title: Climate Modeling for PBPA-An Imperative for effective adaptation

Budget: USD280, 000
Duration: 3 Years (2014- 2017)

Implementing Agencies:

- 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
- Caribbean Community Climate Change Centre (CCCCC)-Belize
- C-CAMF
- Meteorological Service, Jamaica

Summary

Jamaica and by extension, the PBPA is extremely sensitive to variations in climate. All major socio-economic sectors and chief infrastructure development exhibit vulnerability to variations of and changes in climate, particularly those associated with rainfall and temperature extremes. Recurrent damage has resulted from a number of severe weather events, including-but not limited to- hurricane Gilbert (1988), hurricane Ivan (2004) and hurricane Dean (2012). While it may be necessary to totally abandon certain regions within the PBPA, it is not feasible to relocate all the resources, especially certain species and livelihoods and therefore accommodations must be made for same, even in the face of projections for more intense systems under climate change.

Global climate models do not provide results of scale that are useful at the national and local levels and as such regional models are needed that can provide downscaled results. A welcomed result of initiatives of the last decade is the emergence of both a Caribbean Modellers Group (CMG) and a regionally defined modelling agenda. The CMG comprises a consortium of regional institutions pooling efforts to provide downscaled climate change science for the Caribbean from within the Caribbean. Through shared experience and effort, the capacity to answer climate change questions and provide climate change information at the scale of the Caribbean islands has dramatically increased. The initial science results of the CMG (utilising the PRECIS regional model) have formed the basis for many of the reports and studies related to Caribbean climate change which have appeared in the last few years.

This modelling initiative proposed for the very important PBPA seeks to expand on the work of the CMG through the pursuit of a locally articulated modelling initiative. The modelling initiative will derive its components out of consensus and consultation within the Jamaica (and the wider Caribbean) and the PBPA in particular (including both scientific and societal stakeholders). It is premised on a need to enhance the capacity to assess local climate change impacts within sensitive coastal ecosystems and propose remedial measures in an anticipatory manner.

Objectives

The modelling initiative will facilitate the pursuit of the three two main objectives.

Objective 1: To increase the range of analyses performed including the examination of extreme events and hurricanes. This includes an increase in the number of additional climate variables.

Objective 2: To provide new and additional climate change projections of scale that are harmonized with other regional projections. This will facilitate comparative and validation studies and will reduce uncertainties by provide a range of model results for use in local and national adaptation strategies to climate change.

Main Outputs

The modeling initiative will accomplish its objectives through the implementation of five distinct tasks. These will yield specific outputs and deliverables, the chief ones are listed below:

- Multi-model analysis (under different scenarios) of climate change at the scale of the Caribbean.
- New model outputs, including maps and graphs differentiating the results by sub-regions.
- Validated methodology for detecting and projecting changes in tropical cyclone frequency and intensity in Jamaica and the PBPA under climate change.
- A completed down-scaled analysis of climate extremes.
- Early warning system for informing adaptation planning