
WORLD BANK GROUP
PROFOR
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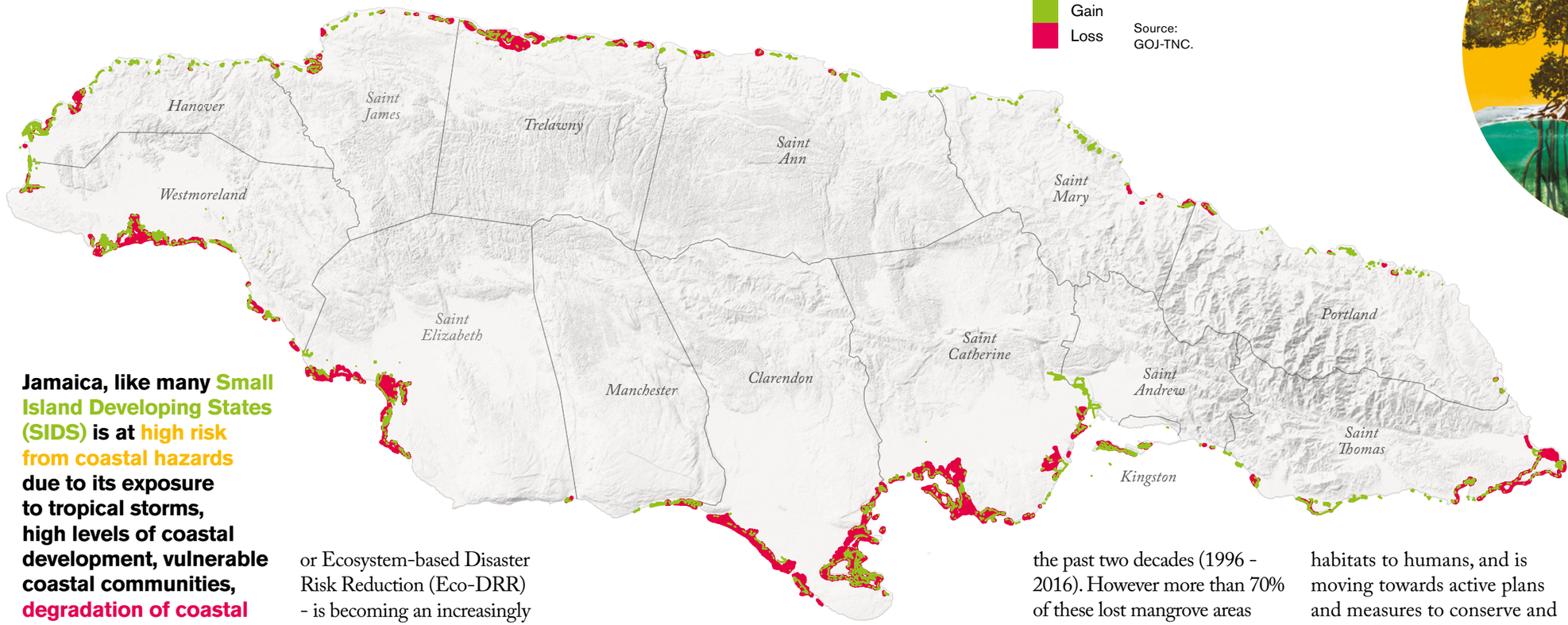
Executive Summary
FORCES of NATURE
Assessment and Economic Valuation of Coastal Protection Services Provided by Mangroves in Jamaica

Introduction

FIGURE 1
Change in Mangrove Extent in Jamaica from 2005 (baseline GOJ data) to 2013 (TNC data).



Jamaica, like many Small Island Developing States (SIDS) is at high risk from coastal hazards due to its exposure to tropical storms, high levels of coastal development, vulnerable coastal communities, degradation of coastal ecosystems and the predicted impacts of climate change.

For example, Hurricane Ivan in 2004 caused over US$0.5 billion in damages, i.e., nearly 6% of national Gross Domestic Product (GDP). Utilizing mangroves or other natural ecosystems to mitigate, prevent, or buffer against disasters - termed Nature-Based Solutions or Ecosystem-based Disaster Risk Reduction (Eco-DRR) - is becoming an increasingly popular and beneficial approach to Disaster Risk Management (DRM). Mangrove coastlines offer a first line of defense, acting as natural barriers, mitigating flooding by reducing wave energy and slowing down storm surges, and providing stabilization of soils and mudflats. They also provide numerous other co-benefits such as fisheries maintenance, carbon sequestration, ecotourism and water purification. It is important to be able to quantify the economic benefits of mangroves, to better value and conserve these ecosystems, and mitigate the impacts of climate events.

In 2013, there was 9,800 hectares of mangrove in Jamaica, mostly on the south coast. Limited data suggests that more than 770 hectares of mangroves have been lost in Jamaica over the past two decades (1996 - 2016). However more than 70% of these lost mangrove areas could be potentially restorable. Currently mangroves in Jamaica are threatened by extraction (for timber, small-scale farming and fishing uses), coastal squeeze from developments, human sources of pollution, changes in land use leading to clearing and land degradation, and climate change.

However, the Government of Jamaica (GOJ) has recognized the value of these habitats to humans, and is moving towards active plans and measures to conserve and protect Jamaica's remaining mangroves through becoming signatories to important conventions, establishing protected areas, developing several national plans or guidelines, and international partnerships supporting the conservation or sustainable use of coastal resources.

This analytical product, the 'Assessment and Economic Valuation of Coastal Protection Services Provided by Mangroves in Jamaica' is an important product that supports the GOJ's 'National Development Plan Vision 2030', through efforts to secure a healthy natural environment, reduce hazard risk and adapt to climate change. This product is linked to the ongoing World Bank Jamaica Disaster Vulnerability Reduction Project (DVRP), and will also provide value to Jamaica's Resilience Agenda.

This product examined the current status and risks of mangrove habitats in Jamaica, identified and assessed ecosystem services - especially coastal protection - and looked at the costs and benefits of mangrove conservation.

The Flood Protection Benefits of Mangroves in Jamaica

National level assessments on the coastal protection provided by mangroves in Jamaica was carried out by a team from University of California Santa Cruz (UCSC), IH Cantabria, and The Nature Conservancy (TNC).

At present, coastal flooding from storms in Jamaica is estimated to result in US$136.4 million in damages every year, in the presence of mangroves. If these mangroves were lost, the expected damages from flooding would increase to $169 million annually. Thus, mangrove forests in Jamaica provide over US$32.7 million in annual flood reduction benefits to built-capital (more than US$2,500 per hectare per year). This represents a nearly 24% annual reduction in flood risk. The loss of Jamaica's mangroves would further result in a 10% increase in the total number of people flooded every year. Mangrove benefits are most apparent for higher intensity storms events.

The risk reduction benefits against tropical cyclones from mangrove forests can be significantly higher in more populated areas. For example, in Hunts Bay, the average annual value exceeds US$5,000 per hectare per year, which translates to avoided damages of more than US$30 million in a 1 in 100-year storm. In general, mangroves reduce flooding extents and heights across all storm frequencies, but are particularly important for the areas of Black River, Falmouth and the parish of Westmoreland. In other sites where mangroves are more coast aligned, the reduction of the flood height is less evident, with an average reduction of about 0.5 to 1 meter for the 50-year return period.

Damages over built capital can be separated into different stock categories - residential, industrial and service. The annual protection offered by mangroves translates into a protection of US$16.6 million over residential stock (50% of total stock protected), US$4.5 million over industrial facilities (14% of total stock protected) and US$11.4 million protection over services stock (35% of total stock).

The costs of mangrove restoration vary greatly due to many different factors, but in the wider Caribbean range from about US$14,000 to US$45,000 per hectare. Recent mangrove restoration projects in Jamaica had an average cost of US$63,000 and US$250,000 per hectare, which included the very high cost of barriers for solid waste management that other regional estimates did not. Mangrove restoration in Jamaica, and globally, is much cheaper than coastal protection structures. In Jamaica, limited data indicate that sea-dykes and levees to protect the Kingston Harbour can cost over US$11 million per kilometer.

Old Harbour Bay

CASE STUDY

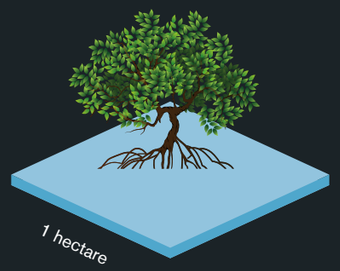
For Old Harbour Bay, the benefits from mangrove presence is most evident during more intense tropical cyclone events and are less apparent during smaller wave-driven flood events.

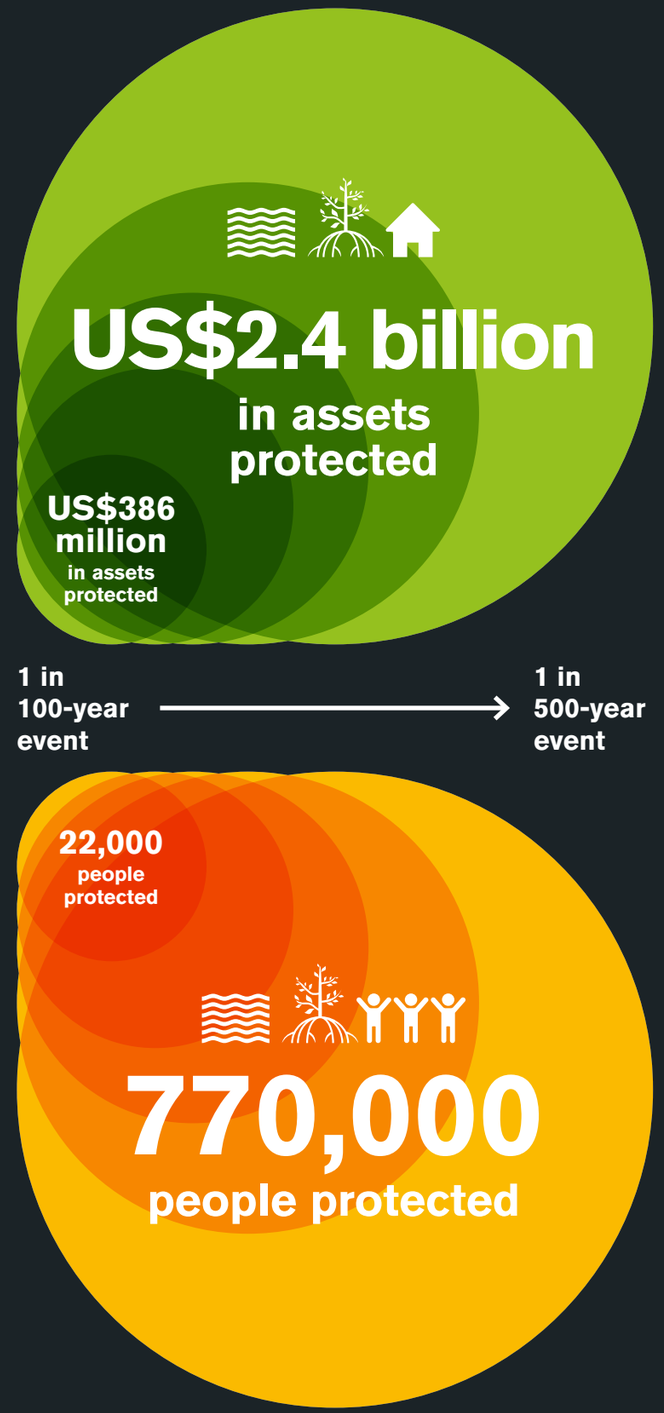
FIGURE 2

Mangrove benefits are most apparent for higher intensity storm events.

Source: UCSC-IHC-TNC.

More than US$2,500 per hectare protected annually.





Mangroves in this area protect some US$3.5 million in built stock every year. Results show that during Hurricane Dean (2007), mangroves were able to reduce water levels around 0.3 and 0.6 meters. This apparently small contribution was responsible for Mitchell Town remaining safe against the storm surge thanks to the protective role of the mangroves, otherwise, a 1 meter water layer would have covered the streets of the village.

Site Level Ecosystem Services

Three sites - Bogue Lagoon (Montego Bay, St. James), Salt Marsh (Falmouth, Trelawny), and Portland Cottage (Portland Bight, Clarendon) – were assessed by a team from the UWI Mona for ecological, physical and socio-economic factors. And Dr. Peter Edwards conducted the economic valuation.

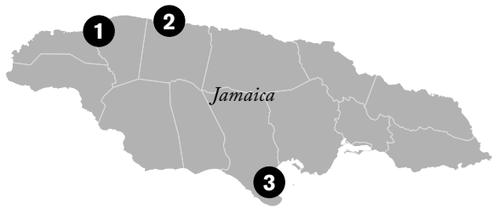
SITE DESCRIPTIONS

BOGUE LAGOON

Bogue Lagoon has mixed land-use dominated by commercial and industrial activities. The area was found to have low sensitivity to coastal flooding.

SALT MARSH

Salt Marsh is a low-lying coastal town in northern Jamaica that has moderately low levels of social and economic blight. Although exposed to numerous coastal hazards, it has had relatively little devastation.



PORTLAND COTTAGE

The Portland Cottage community is located along the island's southern coastline and is characterized by the highest levels of social and economic blight in the study. The area is highly exposed to the effects of coastal inundation. Portland Cottage's adaptive capacity can be considered low. The majority of respondents in all three communities have not implemented any measures to reduce future flooding event impacts.

In all communities mangroves were seen to be most important for their shoreline protection services, and least important for timber services. In Bogue Lagoon and Salt Marsh, the community mostly reported a decrease in mangroves (due to clearing of trees), whilst in Portland Cottage most respondents saw an increase (due to among other things, restoration activities). In all sites respondents showed a willingness to participate in restoration activities. Fishing was an important activity for Portland Cottage and less so for Salt Marsh, and Bogue Lagoon.

Site Comparisons

Some broad associations between sites and assessments can be made. Only red mangrove parameters as well as fish eggs and larvae were found to vary significantly between the three sites.

The changes support the theory that the Portland Cottage forest is affected by disturbance, and so the forest would be in a state of regeneration. Bogue Lagoon, while having the lowest red mangrove density is the healthiest forest, indicating a mature forest with little or no disturbance. Only Salt Marsh had all three mangrove species represented.

The physical properties of the mangroves can be considered to be unique for each study area - for example the textural composition of the substrate after the removal of all organic components was different for each site. Geological studies imply tectonically driven subsidence has occurred recently or is still occurring. Elevation results suggest that the forests are keeping pace with the subsidence and rise in sea level. Subsidence seems to be playing an important role within the sites and coupled with sea level rise will increase the vulnerability of communities and infrastructure associated with these systems. Bogue Lagoon was identified as the most stable and resilient forest system. Due to the sedimentation patterns at Salt Marsh this forest fringe is considered suspect to increased risk from over sedimentation, however it is not as degraded as the Portland Cottage site. Lateral (horizontal) accretion was greater at Bogue Lagoon and Salt Marsh, but lateral erosion was more predominant at Portland Cottage, possibly as a result of recent hurricanes. This may result in higher disaster risks to coastal communities.

Comparisons at all 3 sites indicate that more wind was attenuated for largest trunk diameters in red mangroves and most density of trees. In some sites the tree density was considered to be most important. No clear pattern was derived for the relationship between prop root densities and wave attenuation.

It was felt that Bogue Lagoon should offer the greatest protective services followed by Salt Marsh, with Portland Cottage mangroves offering the least. Bogue Lagoon offers the most ecosystem service in protection of the coastline as it protects critical road infrastructure and contributes to the viability of mainstream and alternative tourism industries. Portland Cottage has the least critical infrastructure and connection to mainstream tourism, but the population here are most at risk and vulnerable so it could be argued that the greatest protection to life and livelihood is offered at Portland Cottage and cost to the government in the event of serious disasters.

Ecosystem Services Beyond Coastal Protection

FIGURE 3
Annual Carbon sequestration values for the estimated total mangrove area in Jamaica.
Note: These estimates are based on a value of US$48 per tonne of Carbon.

Blue Carbon

On average, mangroves contain 3 to 4 times the mass of carbon typically found in boreal, temperate, or upland tropical forests. Results from the site studies show a significant positive relationship between white or red mangroves and total vegetative carbon, and a smaller positive relationship between black mangroves and total vegetative carbon.

Using global estimates, the value of annual sequestration for Jamaica is US$179.9 million with Net Present Values (NPV) calculated for a 100 year time span, showing estimated values for keeping carbon sequestered at US$17.8 billion.

The site-specific results confirm that based on the carbon stocks at these three sites there is significant carbon sequestration economic value. UWI's estimates of soil carbon stock for each location showed higher averages for carbon stock when compared to the global average. It should be noted that carbon value estimates are influenced by the choice of discount rate and represent the avoided costs to society of not releasing this stored carbon to the atmosphere.

Nearshore Fisheries

Mangroves are particularly effective as nursery grounds for juveniles of species that later move offshore or to adjacent habitats such as coral reefs.

Using a global estimate of US$213 per hectare per year for mixed species fisheries, the estimated annual economic contribution of mangroves for Portland Cottage, Bogue Lagoon and Salt Marsh was US$54,145, US$14,101 and US$5,218 respectively.

The estimates indicate that the economic contributions from these sites are relatively modest in comparison to other systems. However, these are comparatively small areas and thus limited in their ability to contribute more significantly to fishers' incomes. There are also potential economic benefits from the development of a local-based, high-end recreational fishery focused on catch and release based on species associated with mangroves.

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Limitations

The availability and quality of data was a common limitation throughout all studies. Where current, high resolution data was not available, estimates or broad scale data for analyses was obtained from secondary sources and previous related studies. The site-specific studies generated accurate, detailed data but was limited in scale and length of study. Global economic estimates were used for carbon and fisheries values which restricts the accuracy of the results. The study was able to generate a number of important data gaps that can be addressed in future studies to improve analyses of this nature.

Conclusions

Jamaica faces substantial flood risk from coastal storms and mangroves provide considerable flood risk reduction benefits. Annually, the average of Jamaica's mangrove forests for flood risk reduction to the nation's built capital is more than US$2,500 per hectare. During the 1 in 500-years storm, mangrove forests protect 177,000 people, and nearly US$2.4 billion or 50% of the total affected population and built capital. This translates to economic benefits of more than US$186 million per hectare of mangroves.

This Report supports the growing interest within the development agenda to include nature-based solutions for disaster risk management (DRM), and provides vital information for discussions on adaptation, insurance, hazard mitigation and disaster recovery decisions. It has advanced existing knowledge on current health status of Jamaican mangroves, improved understanding on how the loss of mangroves can increase coastal flood risk, and has identified potential risk reduction measures. This Report shows that mangroves offer significant benefits for flood risk reduction and overall coastal resilience, and identifies key areas affected by floods for where mangrove management (including restoration) may yield the greatest returns.

The Report also presents important data on benefits beyond coastal protection such as fisheries provision, carbon sequestration, erosion control, and ecotourism which can have significant implications on poverty reduction.

It has presented its results in economic terms which allows it to be utilized on important decision-making platforms. Incorporating ecosystem services and benefits can assist DRM and climate resilience strategies, through e.g. the re/insurance sector, or incorporating environmental degradation in risk models. The Report can be used by public agencies to inform hazard mitigation, disaster recovery, and resilience financing funding decisions, and to incorporate mangrove conservation and restoration activities as part of build-back-better strategies.

Finally, this effort funded by the Program on Forests (PROFOR) through the World Bank was able to involve sixty-two Jamaicans (two thirds of the total project workforce), ranging from government officials, to professors, and university students. This has important repercussions on capacity building at the local scale, as the country is now more capable of replicating this effort, and to explore new opportunities in which coastal ecosystems can help reduce climate risks.

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