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Forests and Climate Change Working Paper 13

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Foreword

This document is part of the publication series of FAO's Forest and Climate Change Programme. The programme works to strengthen countries' capacities to mitigate and adapt to climate change through actions consistent with sustainable forest management and to promote regional cooperation and international policy development related to forests and climate change.

The Food and Agriculture Organization of the United Nations' (FAO) Global Resources Forest Assessment 2010 estimated the area of forest in the Caribbean region to be 7 million hectares, representing 30 percent of the total land area. Forests play diversified roles in the Caribbean region, depending on the size and economic and ecological importance of these resources in each country. Even where forests constitute a very scarce resource, they support the livelihoods of the people in the area and are particularly important for the well-being of rural communities and people living at or below the poverty line. In addition to their extractive uses, forest ecosystems provide a number of critical ecosystem services that support non-extractive functions including, among others, watershed protection, soil protection and erosion control, landscape beauty, disaster risk reduction, carbon sequestration and climate regulation. The supply of water for domestic, industrial, agricultural and recreational uses is an especially important service provided by forests in the region. Forested landscapes have also contributed to shaping national identity and national heritage, as illustrated in cultural traditions and religious practices.

Climate change is further compromising the structure and functions of forests that are currently already under threat of deforestation and degradation. Consequently, forest-based livelihoods are being increasingly affected by the loss of: ecosystem services from degraded forests; materials (food, wood fuel, medicines, construction material) destroyed by forest fires, storms, disease and drought; and revenues from tourism and the sale of forest products and recreational services.

The primary objective of this document is to provide an overview of the actual and potential impacts of climate change on forests and forest dependent people in six Caribbean countries - Dominica, Grenada, Jamaica, St. Lucia, St. Vincent and the Grenadines and Trinidad and Tobago. The paper also examines the major issues and developments related to climate change impacts and responses in the region as regards forests and highlights related opportunities for regional action to address gaps and needs.

FAO is working through its Regional Forestry Commissions as well as other regional and sub-regional processes to encourage regional cooperation in the area of forests and climate change.

This publication is intended to provide a point of departure for identifying and catalysing regional action to complement and enhance national efforts. The publication will be of interest to specialists and policy-makers in forestry and climate change in the Caribbean as well as forest managers, students and general audiences interested in learning more about forests and climate change in the region.

The key findings for the six target countries are:

- Throughout history, Caribbean forests have been cleared and degraded. Although many threats still persist, the abandonment of agricultural lands is leading to a trend of increasing forest cover (albeit of secondary forest) in some countries.
- Climate change is exacerbating the existing threats to forests, but little or no information is being documented on the impacts on forest structure and function or on forest-based livelihoods.
- Forest loss and degradation are compromising the role that forests could play in climate change mitigation and adaptation and is reducing forests' resilience to climate change.

- There is a need to include adaptation and mitigation objectives into forest management plans and into forest management practice everywhere, regardless of whether management plans exist or not,.
- Information on forests and the impact of climate change on forests does not exist for all countries, although national forest assessments and mapping have been undertaken in some countries. Forest management practice, including specific actions for climate change adaptation, is constrained by inadequate information.
- The legal, legislative and policy framework for forest management in general is weak, outdated or absent.
- The legal, legislative and policy framework does not adequately address the impacts of climate change on forest and forest-based livelihoods.
- The potential of forests to play an important role in climate change adaptation and mitigation is clear, for example through slope stabilisation and soil protection by hillside forests and coastal protection by mangroves.
- There are very few explicit examples of proactive actions specifically targeting climate change adaptation and mitigation as an objective. However, actions under programmes, work plans and projects can contribute to climate change adaptation and/or mitigation.

Based on these findings, the following recommendations are proposed for strengthening of the forestry sector in addressing climate change:

- Core forest management needs to be strengthened to address existing threats as well as anticipated additional threats from climate change.
- More information, based on both scientific and local/traditional knowledge, is needed to fully understand the impacts of climate change on forests and forest-based livelihoods to guide management
- Forest management institutions[1] need to be strengthened to be able to effectively respond to climate change. Specific action is needed to link legal and policy frameworks of forest management to climate change adaptation and mitigation.
- Forest management plans need to be developed, and these should address climate change.
- Formal mechanisms need to be established for inter-sectoral coordination to ensure success in addressing climate change within the forest sector.
- Analysis of mitigation potentials and adaptation options and the costs and benefits of carrying out REDD+ and adaptation actions need to be conducted to inform forest management planning.

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[1] An institution is the set of arrangements for making decisions about the development, management, and use of a natural resource, including the stakeholders, as well as the laws, formal and informal policies, plans and structures that guide how these stakeholders interact with each other and with the resources (CANARI, 2011).

1. Background

Legal, legislative framework and forest policy

Dominica, Grenada, Jamaica, St. Lucia, St. Vincent and the Grenadines and Trinidad and Tobago have long established systems of legal protection for their forests (see Table 1) with most states choosing to declare state land as forest reserves. All project countries reported that the various forest types are represented in protected forests, with the exception of Saint Lucia where deciduous seasonal forest is noted as being mainly occurring on private lands (Daltry, 2009).

Table 1: Forest management arrangements in the six Caribbean nations

Country	National forest policy	Forest with forest management plan[2]	Forest management arrangements	% Forest land owned by the State
Dominica	Yes (1949, new policy drafted)	No	Forest Reserves, National Parks, State Lands, the Carib Territory and Privately Owned Land (CANARI and FAO, 2006)	25%
Grenada	Yes (1999)	No	Forest Reserves. Management arrangements for forest lands other than Crown lands hardly exist except for privately owned lands that practice agro forestry.	With the exception of the Grand Etang Forest Reserve, Mt. St. Catherine and a few agricultural estates, most of the land in Grenada is privately owned[3]. (Government of Grenada, 2000).
Jamaica	Yes (2001)	6 Forest Management Plans. (4 for state owned forest reserves; 1 privately owned Forest reserve and 1 privately owned Forest management area) One plan in final draft.	Forest Reserves (26.5%), other protected areas (7.5%)[4]	Approximately 66.6% is privately owned, approximately 33.4% is publicly owned[5])
St. Lucia	Yes (2008)	No	Forest Reserves are managed by the State (Daltry, 2009).	Approximately 33%
St. Vincent and the Grenadines	None	No	3 Forest Reserves	More than 90% (Providence, 2013)
Trinidad and Tobago	Yes (2010)	Some	There are 35 proclaimed Forest Reserves and 8 un-proclaimed Forest Reserves.	80% (Government of Trinidad and Tobago National Forest Policy 2011)

[2] Data in this column taken from FA0 2010
[3] There is insufficient data to report on this table. The collapse of the banana industry and the passage of Hurricane Ivan and Emily, have caused an increase in privately owned forest lands (FAO 2010a).
[4] Based on 2005 data provided by the Forestry Department of Jamaica
[5] Based on 2005 data provided by the Forestry Department of Jamaica

Dominica

In Dominica, the Forest Act became law in 1958, the National Parks and Protected Areas Act in 1975, and the Forestry and Wildlife Act in 1976. A Forest Management Plan was last developed in 1975 but was never formally adopted and a Management Plan for the Morne Trois Pitons National Park was developed several years ago but has yet to be put into effect. There is a consensus among stakeholders that the laws and policies need to be brought up-to-date[6]. Dominica has no national land use policy; however a water policy has been drafted.

The Physical Planning Act contains fairly comprehensive authority for managing land development, including the authority to designate areas as "environmentally sensitive", but the Act has not yet been fully implemented[7]. Development of privately owned forested lands in Dominica is not subject to regulation by the Division of Forestry, Wildlife and National Parks but is instead subject to approval by the Physical Planning Division in accordance with the Physical Planning Act of 2002. There is no formal mechanism for the Division to consult with the Division of Forestry, Wildlife and National Parks on developments that affect forest resources although this does happen occasionally on an informal basis (Commonwealth of Dominica, 2010). The Carib Territory is owned by the indigenous Carib or Kalinago people. The Territory has little remaining forest, the land having been used heavily for agriculture. Forestry does not have authority to protect or manage these lands[8]). Although Dominica engaged in the participatory development of National Forest Policy Statement in 2010 this is yet to be formally approved.

Grenada

In Grenada, the policy and legal framework for the management of forests is constituted of the Forest Policy and Strategic Plan, the Soil and Water Conservation Ordinance and other acts, and the Millennium Development Goals (MDGs) and Multilateral Environmental Agreements (MEAs). The 1999 Forest Policy in Grenada takes into consideration the social, economic and environmental factors for effective and efficient management of forest resources in collaboration with key and strategic stakeholders. In this regard, the policy seems adequate. However, professional foresters feel that the strategic plan and associated documents for implementation are inadequate and now out of date and need to be urgently reviewed. A revised plan should consider emerging issues surrounding climate change and its impact on the environment, with a special emphasis on inland forests and wetland ecosystems (Paterson, 2013). Forest legislation also needs to be reviewed and Statutory Rules and Orders (SROs) developed for its enforcement (Paterson, 2013). There are three major forest reserves in Grenada: the Grand Etang Forest Reserve, the Mount St. Catherine Forest Reserve and the Belair Forest Reserve. The Grand Etang Forest Reserve has been fully protected by legislation, since 1906, from any change in land use and from hunting. There are National Parks at Levera (123 hectares of primarily mangrove) in the north east of the island, Mt. Hartman in the south west, and Perseverance Estate on the west coast which is dry forest. In Carriacou, 136 hectares of forested area is protected at High North (Government of Grenada, 2000).

Jamaica

In Jamaica the Forestry Department has the lead responsibility for the management and conservation of Jamaica's state-owned forests and the 1996 Forest Act provides the legal basis for the organisation and functioning of the Forestry Department. This Act is in the process of being amended as the State recognised the need for an updated legislation (Headley, 2013). The Forest Act 1996 does not cover privately owned land, however a tax incentive is provided to private forest owners who declare their

[6] http://www.da-academy.org/agropage_forest.html
[7] http://www.da-academy.org/agropage_forest.html
[8] http://www.da-academy.org/agropage_forest.html

forested lands as a forest reserve or forest management area, after having met the stipulated criteria (Headley, 2013).

Saint Lucia

Almost half of the forested lands in St. Lucia are within the network of government Forest Reserves (Daltry, 2009). The Central Rainforest Reserve of Saint Lucia is home to predominantly rainforest, cloud forest, Elfin woodlands[9], but no protection is afforded to dry coastal forest. The legal framework for the establishment and management of protected areas is complex and complicated, with five institutions (Forestry Department, Fisheries Department, National Trust, National Conservation Authority and Ministry of Physical Development) having legal mandates in this domain (CANARI 2007).

Saint Vincent and the Grenadines

In St. Vincent and the Grenadines, the Forestry Department is mandated to manage forested lands; however this is done in collaboration with other government entities. The government is in the process of developing a forest policy which will address climate change impacts and influence on forests in the country. All forest types represented in the country can be found in the forest reserves (Providence, 2013).

Trinidad and Tobago

The Government of Trinidad and Tobago from 2007 to 2010 coordinated the participatory development of a National Forest Policy which was subsequently approved in 2010. Plans are currently underway for implementation but the current institutional arrangements for forest management are still complex with many departments of the state with conflicting management objectives. The Forestry Division is the primary state agency responsible for forest management in Forest Reserves in Trinidad. It uses an administrative system that divides the island into six geographic areas called conservancies. The Department of Natural Resources and the Environment in the Tobago House of Assembly (THA) is responsible for management of forests on state lands in Tobago. Forests on other state lands are the responsibility of the Commissioner of State Lands (Government of Trinidad and Tobago National Forest Policy, 2011). The Tobago Main Ridge Forest Reserve, reputedly the oldest in the Western Hemisphere, totals 3,937 hectares in size. In Trinidad there are 35 proclaimed Forest Reserves with a total area of 131,430 hectares and 8 unproclaimed Forest Reserves (state land that is managed by the Forestry Division but not legally designated as Forest Reserves) totalling 11,650 hectares (Government of Trinidad and Tobago National Forest Policy, 2011).

Forest cover and diversity

The percentage of forest cover varies across the region but the area of land under forest is significant and may be increasing. Recent studies noted that of the six countries being studied, all report forest cover exceeding 30 percent of the land area (see Table 2). However Dominica, Jamaica, St. Lucia and Trinidad and Tobago report a trend of decreasing forest cover from 1990 to 2010, while Grenada reports no percentage change in the extent of forest for the same period.

[9] http://www.stlucia.org/activity/ rainforest.asp

Table 2: Percentage change reported in the extent of forest 2005 - 2010 (FAO, 2010)

Country	Extent of forest cover (% of land area)	1990-2000	2000-2005	2005-2010
Dominica	60	-0.55	-0.57	-0.59
Grenada[10]	50	0	0	0
Jamaica	31	-0.11	-0.10	-0.12
Saint Lucia	77	0.64	0.13	0
St. Vincent and the Grenadines	68	0.27	0.23	0.30
Trinidad and Tobago	44	-0.30	-0.31	-.32

A recent "greening" of the Caribbean has been reported where natural succession and self-organisation is occurring due to abandonment of agricultural lands, development of urban areas, and movement of species across islands and continents. This is leading to an increase in secondary forests (or wooded areas) and the development of novel mixed forests with both native and introduced species, none of which were planned (Lugo *et al*, 2013).

The extent of forest that has been disturbed and degraded differs across islands. For example, in Jamaica the majority of forest lands have been disturbed and degraded, and only about 8 percent of the island remains as natural forest showing little evidence of human disturbance (Government of Jamaica, 2001). This is in contrast to the island of Tobago where much of the island's mountainous ridge was declared a Forest Reserve in the 1700s so that a substantial portion of the uppermost watershed was not significantly disturbed by human activities (CANARI and FAO, 2006b) although the impact of hurricanes and storms is likely significant.

Forests in the six countries harbour significant natural biodiversity, some of which is under threat, as well as valuable timber and non-timber species.

In *Grenada*, with respect to the types of forest, there is little formal scientific data available on Grenada's forests (Government of Grenada, 2010). There are three known endemic species of plants, the Grand Etang Fern (*Danaea sp.*), the Cabbage Palm (*Oxeodoxa oleracea*) and one endemic tree species (*Maythenus grenadensis*) (Grenada Biodiversity and Action Plan, 2000). Commercial production of blue mahoe (*Hibiscus elatus*) which occupied 75 percent of the area under plantation was seriously damaged during an infestation of the pink mealy bug from 1994 to 1997 (Government of Grenada, 2000). Other plantation species include pine (*Pinus caribaea*), mahogany (*Swietenia sp.*) and *Cupressus lusitanica*. Although the initial reasons for plantation establishment were to reforest and stabilise forest areas with serious hurricane damage, local demand presented an opportunity for income generation. The dry forest found in the south and north of the island is considered prime habitat for two endangered and endemic species of birds - the Grenada Dove (*Leptotila wellsi*) and the Grenada Hook-billed Kite (*Chondrohierax uncinatus murus*). Grenada is also home to four bird species which are endemic to the Lesser Antilles (CCA/GOG/USAID, 1991) - the Grenada flycatcher (*Myiarchus nugator*), the Scaly-breasted thrasher (*Margarops fuscus*), the Lesser Antillean bullfinch (*Loxigilla noctis*), and the Lesser Antillean tanager (*Tangara cucullata*) (Government of Grenada, 2000).

[10] Although these figures are quoted from the Assessment other sources suggest otherwise.

An assessment of *Jamaica's* forest cover was done based on LANDSATTM satellite imagery acquired in 1996 and 1998, combined with aerial and ground reconnaissance. This classification identified forested areas comprised of closed and disturbed broadleaf forests, open dry forests, swamp and mangrove as well as bamboo areas. Mixed forest areas were also identified where anthropogenic activities take place, which included disturbed broadleaf forests, pine plantations, and areas with bamboo and fields. Forests are important for Jamaica's biodiversity, as it "is home to about 3,200 known species of flowering plants, 600 species of ferns, and 256 known species of birds, together with other faunal groups like bats, lizards and butterflies. A high proportion of these species are found only in Jamaica and a growing number are listed as vulnerable to extinction, critically imperilled, or rare. Many are dependent on forest or woodland habitats thus conservation of these habitats is essential for their survival." (Government of Jamaica, n.d.)

In *St. Lucia* much of the forest is mature but secondary, including extensive tracts of deciduous seasonal forest that are reclaiming abandoned cotton plantations at lower elevations (Daltry, 2009). St. Lucia is home to 1,147 native terrestrial vascular plants including 11 new national records in 2009 (Daltry, 2009). Most of the native species are forest plants. At least ten species are endemic to St. Lucia (*Acalypha elizabethiae, Bernardia laurentii, Cuphea crudyana* [possibly extinct], *Chrysochlamys caribaea, Daphnopsis macrocarpa, Gonolobus iyanolensis, Lobelia santa-luciae, Miconia luciana, Miconia secunda,* and *Siparuna sanctae-luciae*) and many more have only a restricted range within the Lesser Antilles (Daltry, 2009). An additional 289 non-native species have also become established in natural habitats (i.e. outside of farmland and residential areas) from plants deliberately or accidentally imported to the island. One hundred and fifty seven native terrestrial vertebrate animals have been confirmed on St. Lucia, the majority of which are forest birds. Endemism is high, with 14 species and at least 19 recognised subspecies that naturally occur only on St. Lucia. The number of alien vertebrate animals is also high and growing, however, and has driven some of the native fauna to extinction (Daltry, 2009).

St. Vincent's forests are rich in biological diversity but little research has been done to determine the actual levels of endemism of the herbaceous plants associated with primary and secondary rainforests. In total, there are more than 1,150 species of flowering plants, 163 species of ferns, 4 species of amphibians, 16 species of reptiles, 111 species of birds, and 15 species of mammals have been identified. However, it must be noted that local biodiversity listings are incomplete and are in many respects outdated and consequently, current data only partially represents the biodiversity of the island state. Primary and secondary rainforests in St. Vincent are also rich in many other national and regional endemic species. These include the Whistling Warbler, *Catharopeza bishop* (endemic); the Black Snake, *Chinorinus Vincenti* (endemic); the St. Vincent House Wren, *Trologlodytes aedon (endemic); Rufous-throated Solitaire,* Myadestes genibarbis (endemic sub-species), Hooded Tanger, *Tangara cucullata* (regional endemic shared with Grenada); the Congo snake, *Mastigodryas bruesi* (regional endemic) and the Piping frog, *Eleutherodactylus shrevei* (endemic) (Government of St. Vincent and the Grenadines, 2010).

Trinidad and Tobago's continental origin has contributed to a rich natural heritage, and the country has the highest biodiversity of all of the Caribbean islands, with over 420 species of birds, at least 600 different species of butterflies, over 95 different mammals, 85 different reptiles, 30 amphibians and 54 species of freshwater fishes (Government of the Republic of Trinidad and Tobago, 2011). There are also over 2,100 different flowering plants, including over 190 species of orchids. Approximately 2 percent of these flowering plants are thought to be endemic. Much of the forest in Trinidad is secondary forest, with the last substantial vestiges of natural primary forest found at the uppermost elevations of the mountain ranges and in the north-east and south of the island (Government of the Republic of Trinidad and Tobago, 2011).

Tenure

Most forested land in the six countries is privately owned, as shown in Table 1, although percentages vary across the six countries from 65% in Jamaica to less than 10% in St. Vincent. Private forested land is therefore significant, but in some cases, such as Grenada, land has been sub-divided among family members and passed on through generations (Government of Grenada, 2000). This has led to the development of very small holdings and difficulty in tracking the ownership of properties.

In Saint Lucia much of the private forested land located on the east and north east of the island has been already promised to developers (Daltry, 2009) and in general much of the coastal and flat forested lands have already been developed or there are plans for development in the six countries.

Practices in the management of forest

Arrangements for the practice of forest management among the islands are complex and reactionary. Project countries with relatively current, formal national forest policies report using these policies to guide their daily decisions and operations. However, most of the countries are guided by what might be called a "coherent policy patchwork"; that is, a combination of plans, programme documents, and related policies that provide reasonably clear guidance for the operational management and use of forests and development of the forestry sector.

Of the six project countries, *Trinidad and Tobago* and Jamaica are the only countries that report any of their forested area is managed with a plan (FAO, 2010 and Headley, 2014). However, in Trinidad and Tobago there is a multiplicity of agencies with responsibility for managing the majority of forest resources and this has led to overlapping and conflicting responsibilities and philosophies and practices in the management of forest. Many other government agencies and civil society stakeholders are also involved in managing forests on State lands, including development and environmental management authorities, national projects, various government departments, numerous multi-sectoral committees and community- based organisations. Inter-sectoral communication and coordination among these various entities remains mostly informal (Government of the Republic of Trinidad and Tobago, 2011).

The Forestry and Wildlife Park Division in *Dominica*, reportedly works in collaboration on matters of mutual concern with other government departments and ministries to manage forest owned by the state, but there is no formal arrangement in place to coordinate operational management. Forest in the Carib Territory is owned in common by the Carib, or Kalinago, people. The Territory has little remaining forest, the land having been used heavily for agriculture. Forestry does not have authority to protect or manage these lands. In addition, no entity is responsible in general for management of watershed areas as many of these are located outside of the protected areas managed by Forestry. There is no national land use policy or plan, which means management of watersheds, which are privately owned forest, is largely unregulated (CANARI, 2007).

In *Grenada*, the Forestry and National Parks Department is hampered in implementing its forest policy by a number of capacity issues. Other government partners appear insufficiently interested and involved in forest management, and this contributes to weakening the capacity of the Forestry Department. Several civil society organisations at both national and community levels are actively involved, but their involvement is dependent on project-specific funding and they do not have the resources they would need to remain involved in these issues on an on-going basis. In the private sector, most small-scale operators in the forestry sector do not have the entrepreneurial skills required to sustain and expand their businesses, and the main private sector users of forest goods and services (especially water) are not sufficiently aware of the contribution of forests to their businesses and of the need for them to contribute

to the sustainability of the essential goods and services that the forests provide. Beyond the specific domain of forest management, the implementation of forest policy is seriously hampered by the absence of a land policy, and by the fact that important decisions related to land and resource use actually contradict the provisions of the forest policy.

In 2010, the Forestry Department in *Jamaica* was designated as an executive agency. As an executive agency, the new Forestry Department has additional staffing, infrastructure, tools and methodologies to more fit the needs of the forest sector. The new agency, with the authority of the 1996 Forest Act, maintains the central role of government in the management of forest reserves and resources and provides some spaces for the involvement of a wider range of actors in forest management and decision-making. It requires the Conservator to prepare a National Forest Management and Conservation Plan (NFMCP), and makes provision for consultation with non-governmental stakeholders (in the form of private conservation organisations) in the development of the plan and for public comment on the draft[11]. The NFMCP was prepared and approved in 2001 and the Forestry Department will be reviewing and updating it in 2014/15 to realign it to the National Development Plan -Vision 2030 and climate proof the strategies for the sector.

In *St. Vincent* the main body responsible for the implementation of forest policy is the Forestry Division. However, many of the policy and management decisions that have been made in the forestry sector in the country over the past two decades have been motivated by the need to address the negative impacts caused by deforestation, especially on watersheds due to clearing for agriculture and marijuana cultivation. In recognition of the complexity and sensitivity of the issues, the Forestry Department has adopted an approach based on the promotion of alternatives to damaging forest uses and on collaboration with forest users (CANARI 2007).

The overall management of forest resources, including wildlife, rests with the Ministry of Agriculture, Forestry Department in *St. Lucia*. The Forestry Department has a clear and legitimate mandate for policy formulation and coordination and for programme implementation. The Forestry Department has extensive experience in establishing and operating management partnerships for forest resources, as in the case of the Talvan Water Catchment Group or the Aupicon Charcoal and Agricultural Producers Group (co-management of the Mankòtè mangrove). However, the practice of forest management is hampered by the absence of a comprehensive land policy, the absence of a formal forest policy statement, an updated forest management plan and the lack of formal mechanism and instruments to ensure the sustainability of collaborative management arrangements to devolve management authority whenever appropriate. The activities of the Forestry Department are guided only by the corporate plans, annual work plans and budgets of the Ministry of Agriculture. In 2006, the Ministry completed a national agricultural policy, but it does not provide extensive guidance on forestry issues. The Forest, Soil and Water Conservation Act (1946, amended 1983) is the main legal instrument to guide forest management. It provides for partnerships with private landowners and for the declaration of protection areas, but it would benefit from a review and an update to reflect current concerns and priorities (CANARI, 2007).

Participatory approaches to forest management

Community forestry has been identified as a key strategy in addressing challenges of forest management in the region and suggested that it can play an important role in developing sustainable livelihoods for rural communities, adapting to climate change, and reducing risks from natural disasters. National forest programmes in the Caribbean islands have included participatory forest management (PFM) to varying degrees via a wide range of initiatives ranging from informal involvement of communities and other

[11] http://www.forestry.gov.jm/

stakeholders in forest management, to formal partnerships and agreements with the government agencies responsible (usually some form of forestry department) detailing specific responsibilities in the management of forests (CANARI, 2010b).

Dominica has engaged in participatory development of a forest policy which highlights PFM and acknowledges it as the traditional mode of management of forest on the island. Grenada has a comprehensive national forest policy that creates favourable conditions for PFM. Grenada was very successful in integrating PFM techniques for the management of forests. Users worked in close collaboration with the forestry department for the sustainable harvesting of forest resources, such as harvesting of fish from the Levera Pond, even in the absence of a co-management arrangement (Paterson, 2013). In 1999, the Jamaica Forestry Department launched a pilot programme to organise local forest management committees (LFMCs) as instruments through which communities would become involved in the utilisation and management of nearby forest reserves[12]. This proved to be a huge success and currently 18 LFMCs exist (Headley, 2014). In St. Vincent and the Grenadines, projects are being implemented that use PFM, for example the Integrated Forest Management and Development Programme (IFMDP). Forest management stakeholders in the country recognised the need for integration and more work will be done to apply PFM approaches (Providence, 2013). In Trinidad and Tobago, the National Reforestation and Watershed Rehabilitation Programme (NRWRP), initiated in 2003, falls under the purview of the Ministry of the Environment and Water Resources. NRWRP works through registered community groups and local private contractors to restore, preserve and protect the nation's forests, watersheds, wetlands, flora and fauna.

Utilization

Overall use of forest lands in the insular Caribbean can be distinguished into several distinct phases. Initially, the indigenous Caribbean inhabitants had low population densities concentrated along the coasts, and did not practice intensive agriculture (Brown *et. al*, 1981), so their impact on forests was minimal. Following the pre-Columbian settlements of Amerindians in the 16th century the Caribbean islands were colonised by European settlers and often changed hands between different colonial powers until they became independent states. Following these early years, three main phases of forest development took place. In the first phase, forests were used as land reserves for agricultural production and as unregulated sources for timber. This phase started with colonisation of the islands by Amerindian settlers and accelerated with the arrival of the European colonists in the 16th century. The second phase was the emergence of forest management and silviculture; the first regulations to protect the forest were issued in the 17th century. Among the first steps was the definition of forest reserves: areas where trees and timber could be harvested, but the reserve itself remained under forest cover. Silvicultural systems, such as the temporary use of forests for agriculture or the Trinidad Shelterwood System, were developed during this period. With the general decline of agriculture in the Caribbean, phase three is emerging. Following a general policy of trade liberalisation, traditional agricultural exports, such as sugar and bananas, can no longer compete with world market prices. The salaries paid in the tourism industry are higher than those for agricultural labour; this contributes to the decline of agriculture. Most Caribbean islands are now net importers of food. As a consequence, areas of agricultural land are increasingly abandoned and are naturally reverting to secondary forest. Hence, forest cover in the region is increasing (ETFRN, 2010).

Over these phases, forests on the islands have been used for housing and infrastructure development, commercial timber production, harvesting of non-timber forest products, agriculture (particularly clearing of lands for intensive monoculture cultivation of bananas and sugar cane), nature tourism and recreation,

[12] http://www.fao.org/docrep/fao/006/ y5189e/y5189e07.pdf

quarrying and cultivation of marijuana. Some of these uses have resulted in deforestation and forest degradation.

Commercial timber production varies across the six islands. In Dominica, there has not been commercial lumbering over the past decade. Individual sawyers continue to operate, but their activity is limited and not seen as threatening to the forest. Timber production from natural forests has declined considerably over the past decade due to poor stocking depleted by more than 100 years of logging activities, clearance for agriculture and hurricane destruction (Draft Forest Policy for the Commonwealth of Dominica, 2010). While the decentralised nature of the sawmilling industry in Jamaica makes it difficult to collect lumber production figures, one report approximated total production by estimating the capacity of approximately 120 permanent sawmills and adding the estimated output from numerous portable sawmills[13]. In 1993, annual production was estimated at 59,000m^3 of hardwoods and 3,000m^3 of softwoods[14]. In Trinidad and Tobago in 2000 domestic log production was 71,994m^3, while sawn timber was 29,800m^3, and exports were approximately 1,000m^3. Half of the industrial timber originating from natural forests comes from private forests. Significantly, this proportion of natural timber from private land is growing. Most production from tree plantations comes mainly from state lands. Trinidad and Tobago has a dispersed small industry including small scale processing, furniture making and use of timber for construction. There are also over 80 sawmills, at least two of which are in Tobago, but many are only operated intermittently and most are old and inefficient (Government of the Republic of Trinidad and Tobago, 2011).

Use of non-timber forest products is also important across the six islands but not well recorded in many islands. A major non-timber forest product extracted from the forests in Dominica is the larouman reed (*Ischnosiphon arouma*), used by the Kalinago (indigenous Carib tribe) people for basket-making. There is concern that this has been over-harvested and that not enough re-planting has been done. The Draft Forest Policy for the Commonwealth of Dominica (2010) identifies two other threatened tree species as the bwa bandé (*Richeria grandis*) and the gommier (*Dacryodes excelsa*). The bark of the bwa bandé is used to make a drink that is thought to be an aphrodisiac. It is reported that rather than taking small amounts of bark that would allow the tree to survive, individuals take the entire tree and strip it. The gommier trees are damaged when they are tapped for gum, which also has commercial value (Commonwealth of Dominica, 2010). In Grenada, primarily screw pine (*Pandanus utilis*) and bamboo (*Bambusa vulgaris*) are harvested and utilised for making baskets and other handicraft. Many naturally occurring herbs believed to have medicinal properties are also harvested (Government of Grenada, 2000). Although demand has generally decreased in recent decades, charcoal continues to be an important source of domestic fuel and income in St. Lucia. Charcoal is produced in covered pits, which can be seen scattered around the country, often utilising wood from secondary forests outside of the Forest Reserve (Daltry, 2009). In St. Vincent, it is well known that many forest plants are utilised for traditional medicinal purposes and in handicraft creation but there is no existing inventory of specific uses for different species (Government of St. Vincent and the Grenadines, 2010). In Trinidad and Tobago, non-timber forest products include small-scale wood products, such as stakes, charcoal, wood for sculpting, raw materials for handicraft, and non-wood products, including: food and food additives; fibres; resins, gums, and plant and animal products used for medicinal, cosmetic or cultural purposes; and plants for landscaping and horticultural use (Government of the Republic of Trinidad and Tobago, 2011).

Housing development has been identified as one of the major pressures on Dominica's forest resources according to the Draft Forest Policy for the Commonwealth of Dominica (2010). Similarly, more than one-third of forests in reserves or other protected areas in Jamaica have also been significantly disturbed by human encroachment (Government of Jamaica, 2001). Such disturbance has adversely affected timber

[13] http://www.forestry.gov.jm/PDF_files/ PlanForestProducts.PDF
[14] (http://www.forestry.gov.jm/PDF_files/ PlanForestProducts.PDF

and water production, and caused accelerated soil erosion, flooding and siltation, and other environmental degradation such as loss of biodiversity, wildlife habitat and aesthetic values.

The importance of forests to support nature tourism in the islands is being increasingly recognised. Forest resources and, in particular, the National Parks and eco-sites are key components of Dominica's tourism product. Commonly called the *nature island*, Dominica boasts of its *unspoilt* and *untouched* natural environments and their tourism packages cater especially for naturalists and eco-adventurers[15]. St. Lucia's appeal to tourists owes much to its natural beauty, with the forests in particular adding to its tropical paradise label. A large number of tourists visit the forest reserves or hike up Petit Piton every year, or experience the forests through driving, birding tours, aerial flights, and horse-back riding (Daltry, 2009).

In the past three decades, tourism has become the main component of the economy in St. Vincent and the Grenadines as the country also sells eco-tourism packages highlighting their forested islands to nature-seeking tourists. In Trinidad and Tobago, forests are also important to the nature tourism industry. The lush tropical forest is a direct attraction, contributing to scenic beauty, and also playing a vital role in maintaining healthy near-shore coral reefs, a key attraction in Tobago. Tourism is especially important in Tobago, where its contribution to GDP grew from 46 percent in 2005 to 56 percent for 2006. In 2005, tourism accounted for about 13.8% of total GDP in Trinidad and Tobago (Government of the Republic of Trinidad and Tobago, 2011). While Trinidad's focus is on culture and business tourism, Tobago's focus is on culture and leisure tourism.

Forests also perform significant social and cultural functions, and are essential for human health and well-being. Traditional strong spiritual connections with the environment and related cultural practices still exist today in the Caribbean. This is especially important in rural communities and to the people living within or adjacent to forests. The 'cultural and spiritual linkages to forest in the Caribbean have a lot to do with the traditional community, and will be the same in the indigenous communities throughout the region' (Uzoma-Wadada, 2013). For example, forests are the focal points for several of the religions practiced in Trinidad and Tobago and are also landscapes that have contributed to shaping national identity and national heritage, as illustrated by the tradition of Papa Bois[16] and other cultural practices (Government of the Republic of Trinidad and Tobago, 2011).

Economic contribution

Despite all of these uses, the value of forests in the Caribbean is largely unrecognised or undervalued. For example, Jamaica's forests are known to play a vital role in protecting and conserving water, soils and biological diversity, and are recognised as crucial to national development and to meeting international commitments. Owing to the mountainous and rugged nature of the country, a large proportion of the forest estate has a primarily protective function, conserving water supplies and reducing erosion and flooding. However, these services are often not valued in the market place (Government of Jamaica, 2010). In Trinidad and Tobago, forestry is included as part of the agricultural sector and is estimated to contribute approximately 0.69% to the GDP, approximately TTD 85.7 million (Government of the Republic of Trinidad and Tobago, 2011), although it is uncertain if this figure estimates forestry alone or the agricultural sector as a whole. Currently, ecological services and added-value and downstream industries are not recognised in national accounting in Trinidad and Tobago and the economic value of these services remains largely un-quantified (Government of the Republic of Trinidad and Tobago, 2011) although efforts to address this are underway through a project by the United Nations Environment

[15] http://www.dominica.dm/images/stories/brochures/Dominica_ English_Generic.pdf
[16] A character from local folklore

Programme (UNEP), the University of the West Indies (UWI) and the Cropper Foundation[17]. In 2011, agriculture, livestock and forestry contributed 13.42% to Dominica's annual GDP (CEHI, 2013).

Threats and vulnerability

As previously noted, in the Caribbean, extensive deforestation and forest degradation has taken place, primarily driven by legal and illegal clearing of land for agriculture. However, clearing for human settlements (including for squatting), infrastructure, commercial activities (including the illegal cultivation of marijuana), bauxite mining, quarrying, charcoal burning, illegal timber harvesting, and damage by hurricanes are among the factors currently contributing to deforestation and forest degradation in the region. The present health and maturity of forests among the countries is varied and deforestation and degradation are reducing ecological and economic functions and causing major impacts on other ecosystems through erosion and siltation.

In Grenada, deforestation has been linked to the high level of private land ownership in Grenada (CEHI, 2013) where forests are being cleared for development. In Jamaica, deforestation can be attributed to an increase in coffee plantations. More recently, increases in bauxite mining, squatter settlements, illegal use of timber, and forest fires have also contributed to deforestation (USAID, n.d.). St. Vincent's forests are threatened by deforestation from squatting (Government of St. Vincent and the Grenadines, 2010) and illegal marijuana cultivation.

In St. Vincent and the Grenadines, marijuana cultivation has become a livelihood option, albeit illegal, for a significant number of the country's unemployed and underemployed workforce (Cottle *et al.*, 2002). Money from marijuana production is an important source of foreign exchange and has helped support the nation's commercial sector through a decade of economic turmoil. The crops are grown in high elevations in the reserve compromising the quality and quantity of water collected from the island's watersheds (Cottle *et al.*, 2002). There is growing concern in Dominica about the clearing of forest in remote areas for the growing of marijuana and the impact on the supply of potable water (Commonwealth of Dominica, 2010). No information on marijuana cultivation and forest cover removal in Jamaica was available, but the Forestry Department indicated that this was not currently a problem (Headley, 2013).

With increasing development across the islands, quarrying for construction materials has taken place within forested lands and often resulted in significant forest loss and degradation. In Dominica, this has taken place primarily in coastal areas where the number and size of quarries has expanded over the past ten years and has created a number of environmental concerns such a siltation of rivers. The largest quarries are along the west coast and affect the dry woodland areas. While no information on illegal quarrying was found for Jamaica, the Forestry Department indicated that illegal limestone quarries were also common in Jamaica (Headley, 2013). The negative impact of many illegal quarries located in the forested Northern Range Trinidad and Tobago is a frequent topic of discussion. Reported impacts on the natural environment include indiscriminate clearing of forested lands, however no analysis of the overall impact on forest cover was found.

In some islands, for example Carriacou in Grenada, a major obstacle to the regeneration of natural vegetation, other than the conversion of land for development, is the effect of overgrazing by livestock. Many animals are tethered or allowed to roam freely in forest or scrub land to graze which prevents regeneration of trees and shrubs. Grasses, sedges and unpalatable plants seem to dominate the ground

[17] http://proecoservtt.weebly.com/index.html

cover in favourable conditions. Where grazing is intense, particularly in the dry season, soil erosion becomes more severe (Grenada Biodiversity and Action Plan, 2000).

Forest fires also pose a severe threat to the regeneration of natural vegetation and current forest cover. The extensive forest fires seen in the late 1990s, not only in Latin America and the Caribbean, but also in the rest of the world, took the issue off the back burner and brought fire to the world's attention (Cochrane, 2002). Concern about tropical forests now extends beyond deforestation to forest degradation, including the widespread consequences of forest fires (Cochrane, 2002). The causes of forest fires are many, mostly linked to direct and indirect human impacts. Forest fires happen as a result of new forest clearance, pasture and land maintenance, logging and hunting, fragmentation, previous fires, rubbish, cooking or waste burning, arson, and accidents (Cochrane, 2002). From 2011 to March 2014 there were 45 forest fires in Jamaica destroying about 57 hectares of forest[18]. In the report on the Global Forest Resources Assessment 2000, FAO reported information about forest fires in 52 countries around the world, but only two of these countries were in the Caribbean[19], and only one -Trinidad and Tobago - is included in this paper. According to this website, during the period 2000-2003, Trinidad and Tobago reported 964 forest fires and an area of 11,232 hectares were burnt.

Invasive species are also on the rise, presenting much challenge to forest biodiversity in the region. Invasive plant species, particularly bamboo, are responsible for serious forest degradation and loss. Invasive animal species are also having negative impacts. One example of this is the Cattle Egret (*Bubulcus ibis*) whose roosting habits have been linked to loss of mangrove at the Brighton Beach area in St. Vincent. It appears that toxins caused by build-up of faecal deposits have polluted wetland soil, destroying plant roots. St. Vincent also reports that the introduced Armadillo (*Dasypus novemcinctus*) has done considerable damage to the ecosystem in the Vermont watershed, undermining trees, accelerating erosion and thereby threatening native biological resources (Government of St. Vincent and the Grenadines, 2010).

[18] http://www.forestry.gov.jm
[19] http://www.fire.uni-freiburg.de/GlobalNetworks/Panamerica/Oct%2004%20Conference/PAWFC-07-Caribbean Report-English.pdf

2. Impacts of climate change and adaptation options

Climate change and variability

Moisture is important in determining the extent of forests. Forests generally flourish best in warm, wet environments and do progressively less well as temperature and moisture decrease. Thus, forests would be expected to respond to changes in temperature and to increases or decreases in precipitation (Sedjo and Brent, 1998).

The following projections have been made for the climate change impacts in the Caribbean:

Warmer and drier with changing rainfall patterns

The climate of the Caribbean islands is broadly characterised by distinct dry and wet seasons with topography and elevation being significant modifiers on the sub-regional scale. The International Panel on Climate Change (IPCC) Fourth Assessment report predicts that temperatures in the Caribbean will rise between 1.4 ^{0}C and 3.2 ^{0}C by the end of the 21st century (Mimura *et al*., 2007). For the Caribbean, Indian Ocean and Mediterranean regions, analysis shows warming ranged from 0 to 0.5 ^{0}C per decade for the 1971 to 2004 period (Trenberth *et al*., 2007). In the Caribbean, the percentage of days having very warm maximum or minimum temperatures has increased considerably since the 1950s, while the percentage of days with cold temperatures has decreased (Peterson *et al*., 2002). These changes were found to be similar to the changes reported from global analysis (Trenberth *et al*., 2007).

It is estimated that there is a two-thirds probability of drought in the Greater Antilles in June, July and August (Day, 2009). In general, rainfall is anticipated to decrease throughout the Caribbean, particularly in the summer (wet) season, except in the southern Bahamas and western Cuba. Water-scarce islands like Antigua and Barbuda, Barbados and St. Kitts and Nevis could be faced with severe drought and water shortages because of longer dry seasons. Climate change also causes more intense wet seasons and so in recent years, heavy rainfalls have caused catastrophic flooding and landslides.

More intense hurricanes

Clear evidence exists that the number of storms reaching categories 4 and 5 globally has increased since 1970 (Emanuel, 2005). Beginning with 1995, all but two Atlantic hurricane seasons have been above normal (Mimura *et al*., 2007). Hurricanes are predicted to become more severe with increased precipitation and higher peak wind speeds. Although some of this increase is due to natural variations in weather, warmer seas help form the stronger storms that have devastated many islands in recent years (Day, 2009).

Rising sea levels

The Caribbean region experienced, on average, a mean relative sea-level rise of 1 mm/yr during the 20th century. Considerable regional variations in sea level were observed in the records; these were due to large-scale oceanographic phenomena such as El Niño coupled with volcanic and tectonic crustal motions of the Caribbean Basin rim (Mimura *et al*., 2007). Similarly, recent variations in sea level on the west Trinidad coast indicate that sea level in the north is rising at a rate of about 1 mm/yr, while in the south the rate is about 4 mm/yr; the difference being a response to tectonic movements (Miller, 2005). Projections of sea-level rise in the Caribbean range from 0.18 to 0.59 m (Day, 2009) to 0.5 to 1.4 m by the end of the 21st century (Day, 2009). These projected elevations could make the coastal zones disappear and all or most of some low-lying islands like Barbuda and Anegada in the British Virgin

Islands. Damage to the coastal zone has disastrous effects on economies and the industries that rely on coastal resources. Most people in the Caribbean (approximately 70%) live and work in the coastal zone and it is also where much of the infrastructure (like roads, airports, and sea ports) is found.

Climate change and related challenges

Hurricanes Ivan in 2004 and Emily in 2005 caused severe damage to the forests in Grenada (FAO, 2010a). There has been significant forest loss especially in the dry forest areas close to the coast where human settlement is focused. The passage of Hurricane Ivan in 2004 had an impact on the amount of forest with estimates of 90 percent of the forest vegetation primarily in the Grand Etang Forest Reserve being destroyed (Williams, 2010).

While climate change can affect forest pests and the damage they cause by directly impacting their development, survival, reproduction and spread; altering host defences and susceptibility; and indirectly impacting ecological relationships such as changing the abundance of competitors, parasites and predators (http://www.fao.org/docrep/013/i1960e/i1960e00.pdf), no cases of widespread diseases were found for the six countries. In 1982, Trinidad participated in an international providence trial with *Cedrela odorata*. Decades after the establishment of the sample plots in Trinidad the variety from Columbia was recognised as the fastest growing variety of *Cedrela* (Trinidad and Tobago Forestry Division, 2013). Under the private forestry programme of the Forestry Division, the planting of Columbian cedar was promoted as a viable investment for small and medium size landowners and as a lucrative investment in forestry. However, from 2005, there were reports of die-back of Columbian Cedar trees. Despite research work conducted by the University of the West Indies (UWI), Saint Augustine, it was not possible to identify an individual pathogen as the root cause for the sudden die back of Columbian cedar. However it was suggested that the cause may be a combination of pathogens together with stress associated with particular site conditions. The research confirmed that the sudden death phenomenon is only affecting the Columbian Cedar and the local variety of *Cedrela odorata* did not seem to be affected. It was recommended that the propagation and plantation establishment of Columbian cedar be stopped (Trinidad and Tobago Forestry Division, 2013).

Impacts on forests and forest-based livelihoods

Climate influences the structure and function of forest ecosystems and plays an essential role in forest health. Some analysts suggest that climate change could also cause "dieback" - a high incidence of decline and individual tree death because the change in climate conditions would make them vulnerable to disease and insect predation. Alternatively, weakened or non-adaptive species might simply be overwhelmed by competition from tree species or vegetation more suited to the site in the wake of climate change. Most models suggest that temperature increases are likely to be gradual and would lead to relatively orderly natural transition of vegetation. Some ecological models predict a difficult transition because of the unavailability of seeds from appropriate species. However, most forests consist of many species, which overlap each other's natural range. Thus, while climate change may seriously impact some species, all the forest's species are unlikely to be impacted negatively and seed sources may be available (Sedjo and Brent, 1998). This analysis is in line with the predictions of regional experts in a 2008 study that proposed that on some islands, such as Dominica, where the mountainous interior has a pronounced altitudinal zonation, changes in climate are likely to affect vegetation. Scientist proposed that assuming a cooling rate of 1^{o}C per 150 metres of altitude, a projected increase of 1.7^{o}C (low IPCC scenario) would elevate vegetative zones by 260 metres. In the high IPCC scenario (3.5^{o}C), the elevation would be elevated by 530 metres. Under this high temperature scenario, elfin woodlands could completely disappear from Dominica, and some species unique to the Caribbean would likely be lost (Day, 2009).

Current research suggests that climate change can affect forest pests and the damage they cause by: directly impacting their development, survival, reproduction and spread; altering host defences and susceptibility; and indirectly impacting the relationships between pests, their environment and other species such as natural enemies, competitors and mutualists. Conversely there are some indications that the interrelated effects of climate on tree hosts and the direct influence on natural enemies may make the overall effect difficult to predict and it is considered by some that not all climate change scenarios will be detrimental. However, globally there is a lack of information on the impacts of temperature, precipitation and other climatic factors on forests and pests and the interaction between the different climate change factors, and how climate change impacts disturbances and vice versa (FAO, 2008).

The intensity of damage from the projected increase in storm and hurricane intensity would be more magnified when they occur in ecosystems that are already vulnerable, due to human factors such as pollution, land clearing and over-harvesting. Storms and hurricanes themselves reduce the quality of forest by breaking branches, defoliation, debarking, loss of crowns and complete uprooting of trees. The resulting openings cause the forest to be less resistant to strong winds and therefore less resilient to natural disasters. Strong winds can also have negative effects on wildlife when faced with the additional pressures of droughts, floods, or increased hurricane frequency. Many species may suffer from the loss of feeding grounds, nesting and roosting areas. Hurricane David, for example, caused the devastation of feeding and nesting sites of Dominica's two endemic parrots. The populations of these endangered parrots reached critically low levels (Day, 2009).

Scientific studies of the impacts of climate change on forests among the six project countries are scarce. CANARI's assessment of the impacts of climate change on terrestrial biodiversity revealed that many impacts from climate-related phenomena and weather patterns were already affecting forest resources. However, it is unclear in all instances if these changes have been observed over several decades. These impacts are reducing the resilience of forests in the Caribbean to adapt to the continued cumulative impacts of climate change and other threats. These observed changes are consistent with IPCC global and regional climate change projections for the Caribbean.

Reported changes included:

- *Forest thinning* resulting from: breaking branches and defoliation from strong winds associated with storms; loss of crowns from storm activity and extended drought conditions; and completes uprooting of trees during hurricanes or soil loss associated with flooding.
- *Changes in plant flowering seasons* caused by changes in temperature and rainfall patterns that alter the microclimate of forest ecosystems. These can also cause disruptions in mating and feeding habits of birds and insects, and on farmers' growing seasons.
- *Changes in forest composition* influenced by the degree of warming, altered precipitation and transpiration rates, particularly if natural forest adaptation is slower than the rate of climatic change.
- *Reduction in tree and wildlife populations* caused when forest fires during droughts destroy forest biodiversity and unfavourable climatic conditions cause biodiversity to die back or migrate.
- *More landslides* are occurring with heavy rainfall events and flooding, particularly in instances where forests are already stressed and less robust. Of all the impacts on forests, landslides have the ability to cause significant loss of life and long periods of inaccessibility to forest resources.
- *Receding mangrove forest* as sea levels increase and the natural response of mangroves to higher sea levels is to move back and re-establish themselves further inland. However, in the region barriers such as roads, seawalls and other construction prevent them from doing so, they become submerged or drown, and the protective fringe of mangroves along the coastline gets smaller.

The Caribbean is one of the regions that are most vulnerable to the effects of climate change. The small size of the islands and their economies, and the extent to which the main industries of many islands - tourism, fisheries, and agriculture - rely directly on natural resources mean natural disasters and other threats to the environment can be devastating for the region. The consequences are not only felt in the environment. They also affect our economies, livelihoods and lives (CANARI, 2010a).

There have been no specific studies on the effects of climate change on forest-based livelihoods in any of the countries studied. However, it can be expected that the impacts being currently observed will be exacerbated as climate change continues. Forests that are already suffering from non-climate stresses will be even less resilient to climate change. Climate change impacts include:

- loss of ecosystem services from degraded forests;
- the loss of subsistence materials (food, woodfuel, medicines, construction material) from forest fires, storms, disease or drought;
- the loss of revenues from tourism, the sale of forest products and recreational services:
    - when vast areas of dead or dying forests reduce scenic appeal;
    - when access into forests is closed off or becomes difficult;
    - when degraded forests are unable to support wildlife attractions; and
    - when income opportunities are lost from the sale of forest products due to limited resources or poorer quality of forest products (for example, seeds for jewellery-making being washed away in heavy rains, low plant productivity in drought conditions).

3. Mitigation and adaptation options and issues

Mitigation options and actions

In the context of global change and sustainable development, forest management activities play a key role through mitigation of climate change. Tropical forests are currently net absorbers of carbon dioxide (CO_2), a major greenhouse gas (GHG), but this function is increasingly threatened by growing deforestation and forest degradation, which also accounts for about one-fifth of the world's GHG emissions, second only to fossil fuels (Hall, 2011). Mitigation options recommended for forests globally include:

- maintaining or increasing the forest area through reduction of deforestation and degradation and through afforestation/reforestation;
- maintaining or increasing the stand-level carbon density (tonnes of carbon per ha) through the reduction of forest degradation and through planting, site preparation, tree improvement, fertilization, uneven-aged stand management, or other appropriate silviculture techniques;
- maintaining or increasing the landscape-level carbon density using forest conservation, longer forest rotations, fire management, and protection against insects; and
- increasing off-site carbon stocks in wood products and enhancing product and fuel substitution using forest-derived biomass to substitute products with high fossil fuel requirements, and increasing the use of biomass-derived energy to substitute fossil fuels[20].

The REDD+ initiative has had little attention in the islands of the Caribbean. The prevailing view is that the individual small island forest, by virtue of their small area, are not sufficiently attractive for carbon market investment from developed countries. A 2010 report prepared for the United Nations Forum on Forest indicates that small island developing states have not received commitments to carbon- related forest funding because of their investment climate. Components of the Investment climate include factors which make it easy to do business such as the enabling policy environment, the quality of training and education on climate financing (INDUFOR, 2010). Indexes exist which rank countries readiness for business by aggregating various indicators/factors. The World Bank's index *Doing Business* for 2010 indicated that almost half of the SIDS rank in the bottom half, indicating a business environment that is not conducive to investments. For 2013, the index has ranked all the six project countries just around the middle[21] indicating that that almost half of the other countries in the ranking have more attractive environments for investment. So it may be that there are a number of contributing factors to the lack of investment in REDD+ inclusive of size and the enabling environment. Although the project countries have not engaged in REDD+ initiatives, participatory forest management strategies being utilised have likely helped with the maintenance and restoration of forested areas, although supporting data is weak or absent.

Governments throughout the Caribbean have been developing and improving policies for forest management and climate change mitigation which, if properly implemented, will address pressing environmental issues and will promote mitigation options and sustainable development. In Trinidad and Tobago, implementation of forest related policies such as protected area policies, National Parks and other Protected Areas Bill and the planning and development of Land Bills will enhance climate resilience through conservation and preservation of forest as well as build synergies with community livelihoods and watershed management. Properly designed and implemented, forestry mitigation options

[20] http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter9.pdf
[21] http://www.doingbusiness.org/rankings

will have substantial co-benefits in terms of employment and income generation opportunities, biodiversity and watershed conservation, provision of timber and fibre, as well as aesthetic and recreational services (Nabuurs *et al*., 2007). Additionally, most programmes, work plans and projects do not specifically target climate change mitigation as an objective yet actions under programmes, work plans and projects can contribute to climate change mitigation. For example, the NRWRP in Trinidad and Tobago originally had the objective of replanting over 33,000 acres of denuded lands which undoubtedly would contribute to climate change mitigation. The Jamaica Forestry Department has undertaken several mitigation and adaptation activities with external grant funding.

Adaptation options and actions

In terms of adaptation to climate change there are three possible approaches: no intervention, reactive adaptation and planned adaptation. Unfortunately, most current management belong to the first or at best the second category[22]. No intervention means business as usual, with management targets and practices based on the premise that the forest will adapt more or less as it has in the past. Reactive adaptation is action taken after the fact. Planned adaptation, on the other hand, involves redefining forestry goals and practices in advance in view of climate change-related risks and uncertainties.

Adaptation to climate change in forest management involves monitoring and anticipating the change and undertaking actions to avoid the negative consequences and take advantage of potential benefits of those changes. Adaptation actions may include measures targeted to reduce vulnerability to climate change that aim to reduce forest sensitivity to adverse climate change impacts or increase adaptive capacity to cope with changing environmental conditions (Keenan, 2012).

Globally, at the government level, forest related policies are being developed which involve deliberate, anticipatory interventions at different levels and across sectors. Implementation of these policies will also take specific adaptation issues into account including agro-forestry approaches such as changes in land use choice (Kabat *et al*., 2005), management intensity, hardwood/softwood species mix, timber growth and harvesting patterns, changes in rotation periods, salvaging dead timber, shifting to species more productive under new climatic conditions, landscape planning to minimise fire and insect damage, providing connectivity and adjusting to altered wood size and quality (Spittlehouse and Stewart, 2003). Policy responses in the region do not specifically focus on forest-based livelihoods (CANARI, 2010a).

Similarly, there are few interventions that specifically address climate change impacts on forest-based livelihoods, but there are many initiatives related to the development of sustainable forest-based livelihoods, including development of alternative livelihoods (that seek to change current unsustainable practices), which have direct potential for adaptation of livelihoods to the impacts of climate change (CANARI, 2010a).

Community forestry and PFM have been readily accepted by the governments and people of various Caribbean countries as an opportunity for climate change mitigation as well as adaptation via building the resilience and reduce the vulnerability of forests to climate change while also enhancing the adaptation of forest-based livelihoods and ensuring continued provision of essential ecosystem services. For example, CANARI has been engaging communities throughout the Caribbean region in an attempt to address adaptation from the community level. CANARI supported adaptation planning and action by the community in the Caura Valley in north Trinidad, using a combination of techniques including problem analysis, participatory video, photo-journaling, and a small grant. CANARI also facilitated Participatory

[22] http://www.fao.org/docrep/011/i0670e/i0670e02.htm

Three-Dimensional Modelling (P3DM) of the island of Tobago, pioneering this methodology in the Caribbean. Community members were invited to build and populate this model with information as it related to resources on the island. This assisted members of the community to analyse how climate change could impact on natural resources (including the forests) and their livelihoods, and what measures could be taken at various levels to address this pressing issue. The model was then used by members of the community to develop a civil society agenda to prepare and deal with the impacts of climate change in Tobago. CANARI is also assisting 14 women from rural parts of Trinidad and Tobago who utilise forest products and other forms on natural resources in their micro-enterprises to 'climate proof' their businesses and to communicate to policy-makers how to develop or strengthen enabling mechanisms to support rural women entrepreneurs.

At the community level, planned adaptation may also include diversification of forest-based and non-forest based income sources, better local governance of forest resources and capacity building for planning, monitoring and coping with possible unplanned events.

Climate change adaptation and mitigation are often considered separately but should be linked to provide a more coherent approach to managing the impacts of climate change. In all project countries, mitigation actions such as afforestation or curbing of deforestation need to be planned in a participatory manner and linked to local adaptation policies and practices in related sectors to help local people maintain or improve their livelihoods and withstand the negative effects of climate change.

4.Climate change policy and strategy

Policy responses to climate change impacts on forest resources are addressed to some degree in some policy statements, but these do not particularly address issues of forest management or forest-based livelihoods. The policies highlight policy responses in other sectors which impact forest management, such as land use planning, but do not address modifying forest management practice to deal with the impacts of climate change. Examples of such policies include the National Biodiversity Strategies and Action Plans (NBSAPs), particularly in Dominica where there is a chapter on climate change impacts on biodiversity, and environmental policies such as the Cabinet-approved policy in St. Lucia.

However, most national policies relating to forest management are out of date and therefore take no account of climate change. In Trinidad and Tobago, a National Climate Change Policy was approved in 2011, along with the updated Trinidad and Tobago National Forest Policy. While the National Climate Change Policy document mentions the role of sinks, as they absorb carbon dioxide, no further discussion or plan on utilising local forests was mentioned. Other relevant policies that exist for Trinidad and Tobago that should address forest management and climate change responses are the National Environmental Policy (2006), National Policy and Programmes for Wetlands Conservation in Trinidad and Tobago (2002), National Protected Areas Policy (2011) and the National Tourism Policy for Trinidad and Tobago (2010). However, these provide little information on the Government's plans.

Participation of local communities and other stakeholders in natural resource management is a strategic response to manage the impacts of climate change. Residents in rural communities and users of natural resources have extensive periods of observation (often in one locality) and interaction with the environment and have tested practices in managing the impacts of climate change. In the Caribbean region, where there is often an absence of location-specific scientific data, knowledge from rural communities can provide a sound source of information to advise on action for climate change. However, community and stakeholder participation cannot be effective without an enabling policy environment, not just in areas with obvious linkages such as land use planning, land tenure, agriculture, forestry and fisheries but also in terms of those relating to finance and economic development, social development, community development, civil society capacity building, and heritage and culture, among others (Borrini-Feyerabend *et al.*, 2004).

Currently, top-down decision making is still quite prevalent in the Caribbean where local communities and other stakeholders are informed of some decisions made by the government agencies, although steps are being taken in each country to integrate forest management so that the approach is more participatory. There is a need for an improved policy environment and framework to support community forestry in the Caribbean. Such a framework would be characterised by:

i. an explicit statement of forest policy (vision, objectives, programmes and actions);
ii. strong and functional linkages between forest policy and the other components of the national development policy framework, especially in relation to social development, poverty reduction, water management, rural development, and tourism;
iii. the translation of forest policy statements into effective and efficient policy instruments (laws, regulations, guidelines, codes of conduct, standards, etc.); and,
iv. an explicit inclusion of the principles, goals and tools of participation and devolution within policy statements and instruments (CANARI, n.d.).

Some action is being taken to put in place an enabling policy and institutional environment. For example, the Government of Trinidad and Tobago has recognised the need for appropriate institutional arrangements to be put in place to facilitate the coordination of input from various sectors required for the

preparation of national communications. The Cabinet of Trinidad and Tobago has approved the appointment of a Focal Point for multilateral environmental agreements with particular focus on climate change in all government ministries, agencies, statutory bodies, academia, the private sector, including the banking and insurance sector, industry, non-governmental organisations, and community based organisations and the appointment of a Ministerial Coordinating Committee to provide oversight at the ministerial level with a view to addressing barriers to implementation and providing overall oversight to the implementation of the National Climate Change Policy (Government of the Republic of Trinidad and Tobago, 2013). In Jamaica, a national climate change policy has also been approved by the Cabinet and the updated Jamaica Forest Policy addresses climate change.

Mainstreaming climate change responses into the national policies and sectoral plans of Caribbean countries must be considered a pillar of Caribbean climate policy. Additionally, some existing national policies will need to be reviewed to incorporate the different aspects of climate change (ECLAC, 2011) into their guidance so that the policies are relevant to climate change.

There have been few national climate change specific interventions among the project countries and these were implemented mainly under the Caribbean Community (CARICOM) Special Programme on Adaptation to Climate Change (SPACC) project. These include:

i. Implementation of adaptation measures in the Morne Diablot National Park and its neighbouring communities in Dominica;
ii. Morne Trois Pitons National Park integrated ecosystem management in Dominica; and
iii. Sustainability of water resources and supply of the Vieux Fort region of St. Lucia.

5. Overview of costs and financing mechanisms available to support climate change adaptation and mitigation in the forestry sector

Studies have suggested that the costs of addressing climate change through reducing forest loss would be relatively modest (Hall, 2011). Sources of financing have emerged to support forest-related mitigation efforts, including the Clean Development Mechanism (CDM) under the Kyoto Protocol and voluntary carbon markets, and, more recently, the REDD+ Partnership, the Forest Carbon Partnership Facility (FCPF) and the Forest Investment Program (FIP) of the Strategic Climate Fund. REDD+ activities are also actively supported by bilateral and NGO funding[23]. Various funds managed by the Global Environment Facility, as well as other support - through multilateral, bilateral and NGO channels - provide financial assistance for climate change adaptation of forests, forestry and forest-dependent people.

Historically, there have been attempts to harness market policies and economic solutions to achieve conservation goals. These experiments have resulted in the widespread emergence of markets and payment schemes for forest ecosystem services - such as watershed protection, biodiversity protection and carbon sequestration (Khare *et al.*, 2005). The many different types of market and payment schemes can be organised into four categories:

i. public payment schemes to private forest owners to maintain or enhance ecosystem services;
ii. open trading under a regulatory cap or floor;
iii. self-organised private deals; and
iv. eco-labelling of forest or farm products, an indirect form of payment for ecosystem services (Khare *et al.*, 2005).

The literature currently promotes three approaches for the quantification of the economic potential of future mitigation by forests. These are: a) regional bottom-up assessments per country or continent; b) global forest sector models; and c) global multi-sectoral models (Nabuurs *et al.*, 2007). The important role in climate change mitigation that forests play is the basis for recent efforts by the region to be financially compensated for protecting their forest resources (CANARI, 2010). Funding for forests could be substantially enhanced via compensation for the preservation of standing forest as part of carbon offset and cap-and-trade arrangements. This proposed mechanism, or REDD, subsequently modified to REDD+, which includes enhancement of forest carbon stocks as well as avoided deforestation. Under the first commitment period (2008-2012) of the UNFCCC, only reforestation and afforestation projects are eligible for carbon offsets in official markets. However, in 2005 at the eleventh Conference of the Parties (COP 11) to the UNFCCC held in Montreal, the Coalition for Rainforest Nations, which comprises more than forty countries, led by Papua New Guinea and Costa Rica, proposed including REDD to provide compensation for standing forest within official carbon trading after 2012.

In parallel with international negotiations over the shape of climate change policies, official aid organisations have been laying the groundwork by financing pilot REDD+ type programs. Although still relatively few, they nevertheless number in the hundreds and are highly important in terms of their experimental role in testing the viability of REDD procedures (Hall, 2011). Caribbean countries are

[23] http://www.fao.org/docrep/013/i1960e/i1960e00.pdf

already recognising the need for integrating mitigation efforts and promoting low carbon economies, while focusing on the design and implementation of adaptation policies and strategies. The Caribbean Development Bank (CDB) hosted a roundtable panel discussion of technical climate change specialists to discuss the region's climate finance needs and to increase awareness among its Borrowing Member Countries (BMCs) and shareholders, of the ongoing efforts to elaborate the Implementation Plan (IP) of CARICOM's Climate Change Strategy: "The Regional Framework for Achieving Development, Resilient to Climate Change (2009- 2015)." The panel made a range of recommendations for the Bank's engagement in addressing climate change in the BMCs and some of these have been incorporated into the IP as areas for CDB's intervention under the proposed strategy (CDB, 2011). CDB also financed two technical assistance initiatives to improve the technical capacity of the Caribbean Institute of Meteorology and Hydrology (CIMH) and the Caribbean Community Climate Change Centre (CCCCC) to enable them to support the development and implementation of climate resiliency programmes in BMCs. The Bank secured a USD 67 million Climate Action Line of Credit from the European Investment Bank (EIB) to support CDB's efforts in increasing the resilience of its BMCs to the impacts of climate change (CDB, 2011).

6. Regional and international collaboration

The environment is an integral part of the long-term social and economic well-being of the people of the Caribbean and, as such, in addition to being an environmental issue, climate change must equally be seen as a developmental issue (ECLAC, 2011). The CDB, in its 2011 Annual Report stated that the bank, "continued to participate in and support the Regional Coordination and Harmonisation Council that oversees the governance of the CARICOM Comprehensive Disaster Management (CDM) Strategy." This strategy seeks to strengthen regional, national and community capacity for the mitigation, management and coordinated response to natural and technological hazards, and the effects of climate change (CDB, 2011). Jamaica is party to the three major environmental conventions emerging from the United Nations Conference on Environment and Development (the Rio Summit) in June 1992. Forest management and conservation activities are essential components for meeting the objectives of all three, by: reducing the rate of biodiversity loss (Convention on Biological Diversity); maintaining and measuring the role of forests as carbon sinks (Framework Convention on Climate Change); prevention of land degradation and drought (Convention to Combat Desertification).

A Regional Partners Forum hosted by the Caribbean Public Health Agency (CARPHA), formerly the Caribbean Environmental Health Institute (CEHI), in 2013 noted that there are a number of relevant initiatives in the Caribbean including:

i. The Global Environment Facility (GEF) integrating water, land and ecosystems management in Caribbean SIDS (GEF-IWEco) project being managed by CARPHA. This is a four-year multi focal area project with action areas such as water pollution, strengthening water, land and ecosystems monitoring and indicators framework, strengthening policy and legislative and institutional reforms and capacity building for water, land and ecosystem management and networking.
ii. The initiative by the Organisation of Eastern Caribbean States (OECS) and the Caribbean Environment Programme with three areas of focus which are ocean governance, energy and climate change.
iii. The Caribbean Aqua-Terrestrial Solutions (CATS) CEHI/CARPHA/GIZ/ CARICOM Programme on improving the adaptive capacity of rural economies and natural resources to climate change, and improving the management of natural resources and conservation of marine biodiversity in Caribbean countries, where strengthening resilience to climate change is the major theme.
iv. The CDB Community Disaster Risk Reduction Fund which is a joint grant financing from the Canadian International Development Agency (CIDA) and finances projects in community-based disaster risk reduction and climate change adaptation at the local level in CDB BMCs.
v. The GEF UNDP Small Grants Programme (SGP) where the focal areas climate change and land degradation and sustainable forest management provide opportunities for non-governmental organisations to undertake projects with funding up to USD 50,000.

CANARI, in developing its *Climate Change and Disaster Risk Reduction Programme* within the context of its 2011-2016 Strategic Plan, has initiated a partnership with key regional academic/research institutions, such as the Centre for Resource Management and Environmental Studies (CERMES) at UWI Cave Hill campus, the climate modelling group at the UWI Mona campus, key departments at the UWI St. Augustine campus, and the University of the Virgin Islands (UVI), with support from the CCCCC, to develop a long-term regional programme of work on climate change adaptation building on strengths, experience and interests among the different partners (Chariandy, 2013).

7. Summary and issues for consideration

The key findings of the review for the six target countries are:

- Caribbean forests were historically cleared or degraded. Although many threats persist, an important trend of abandoning agricultural lands is leading to trends of increasing forest cover, although this is largely secondary forest, in some countries.
- Climate change is exacerbating the existing threats to forest (deforestation and degradation), and little or no information is being documented on the impacts on forest structure and function or on forest-based livelihoods.
- Forest loss and degradation are compromising the role that forests could be play in climate change mitigation and adaptation and is reducing forest resilience to climate change.
- The majority of forests are not managed with management plans and there is a need to include adaptation and mitigation objectives into forest management practice.
- Accurate information on forests and the impact of climate change in forests does not exist for all countries, although national forest mapping and assessments have been undertaken in some countries. Forest management practice, including specific actions for climate change adaptation, is also constrained by inadequate information.
- The legal, legislative and policy framework for forest management in general is weak, outdated or absent.
- The legal, legislative and policy framework does not adequately address the impacts of climate change on forest and forest-based livelihoods.
- The potential of forests to play an important role in forest mitigation and adaptation is clear, for example through slope stabilisation and soil protection by hillside forests and coastal protection by mangroves.
- There are very few explicit examples of proactive actions specifically targeting climate change adaptation and mitigation as an objective. However, actions under programmes, work plans and projects can contribute to climate change adaptation and/or mitigation.

There are several potential forest management strategies that can be explored.

- *Participatory and community approaches to forest management*: In the Caribbean islands, forest resources tend to be limited in extent, largely accessible to the human population, and under constant pressure for conversion to other uses. In the absence of a strong surveillance and enforcement capacity, which none of the countries of the region can financially or politically afford, stakeholder participation provides the only avenue for effective management (CANARI, 2002). The potential of community forestry in climate change mitigation and adaptation efforts, including carbon offsets and markets, should be further examined and Caribbean countries should continue to improve PFM strategies. Particularly if properly supported, community forestry will contribute to poverty reduction, climate change mitigation and adaptation, disaster risk reduction, conservation of forest biodiversity and improved wellbeing of Caribbean people (CANARI, n.d.). Strengthening the enabling policy environment and building or strengthening institutional mechanisms and capacity for participatory approaches to forest management are essential.

- *Forested protected areas in land use planning*: While many forested protected areas exist, these often are considered as islands within the landscape. Land use planning needs to consider how protected areas can be used as a key strategy for climate change adaptation, and how land use and infrastructural development needs to be planned and managed so as not to negatively impact on the ability of forests and other ecosystems to contribute to climate change mitigation and adaptation.

- *Strengthening legal and policy frameworks to specifically link forest management to climate change mitigation and adaptation*: Forest management plans need to be developed or strengthened to adopt ecosystem-based approaches that recognise the complex interactions among ecosystems and with human systems. An integrated cross-sectoral approach is needed and climate change needs to be mainstreamed across sectoral policies and actions. This includes strengthening the link between forests and agricultural and fisheries production for food security in the face of climate change, mainstreaming climate change adaptation and mitigation and disaster risk reduction policies in development planning, and ensuring harmonisation with sectoral polices for reducing deforestation, improving the efficiency of water use, and protecting biodiversity.

- *Adaptive forest management*: Forest management plans and practices will also need to be adapted to modifications caused by climate change, both gradual and abrupt. Adaptive forest management will be essential to address arising challenges and reduce forest vulnerability. Adaptation measures might include, for example, selection of pest-resistant or drought-tolerant varieties; use of stocks from a range of provenances, under planting of genotypes of species adapted to expected new climate conditions, or assisted natural regeneration of functional species. The measures need to be adapted to forest condition (primary, secondary, degraded) and the specific site[24].

- *Engaging stakeholders*: Most efforts in the Caribbean have focused on regional national policy development, and to some extent planning, but much more attention needs to be paid to engaging stakeholders across sectors and translating policies and plans to action on the ground. This will require more effective communication of how climate change will impact Caribbean islands and their people. All stakeholders will need to be engaged in developing concrete and practical actions to address climate change impacts by building resilience and, where possible, taking advantage of new opportunities created. Cross-sectoral policy development and planning will enable more integrated and holistic approaches. As the policy and institutional framework is strengthened, bottom-up climate change adaptation will require facilitated processes to engage communities and support them to identify priorities and take action. Caribbean people will become more active participants in directing how they respond to climate change and advocating for what support they need from international partners.

Key recommendations for development of a project on forests and climate change in the six Caribbean countries are:

- Core forest management needs to be strengthened to address existing threats as well as anticipated additional threats from climate change.
- More information, based on both scientific and local/traditional knowledge, is needed to fully understand the impacts of climate change on forests and forest-based livelihoods to guide management.
- Forest management institutions[25] need to be built and/or strengthened to be able to effectively respond to climate change. Specific action is needed to link legal and policy frameworks of forest management to climate change adaptation and mitigation.
- Forest management plans need to be developed, and these need to address climate change.

[24] http://www.fao.org/docrep/013/i1960e/i1960e00.pdf

[25] An institution is the set of arrangements for making decisions about the development, management, and use of a natural resource, including the stakeholders, as well as the laws, formal and informal policies, plans and structures that guide how these stakeholders interact with each other and with the resources (CANARI, 2011).

- Formal mechanisms need to be established for inter-sectoral coordination to ensure success in addressing climate change within forestry.
- Analysis of mitigation potentials and adaptation options and the costs and benefits of carrying out REDD+ and adaptation actions need to be conducted to inform forest management planning.

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