Mangrove Management in Guyana: A Case of Climate Compatible Development?

Dissertation Submitted in Partial Fulfillment of the Requirements for a Master of Science Degree in Climate Change and Development from the University of Sussex

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ABSTRACT

In the context of limited financial resources to invest in climate change, the notion of triple-wins, also known as Climate Compatible Development (CCD), is rapidly progressing up the development agenda. However, there remains an absence of robust, empirical evidence of what triple-win initiatives may look like in practice, and more importantly, whether such options may generate concurrent, negative impacts and tradeoffs. In an attempt to address this research gap, the present study critically examines the potential contribution of mangrove restoration in promoting CCD in Guyana. Following an in-depth analysis of an existing mangrove restoration initiative in Guyana, this study demonstrates that, although this particular option is capable of delivering a triple-win opportunity; such a strategy comes packaged with a spate of regrets and challenges which undermine the long-term achievement of the triple-wins. It is by this very nature that this study concludes that, while the notion of a triple-win using mangrove restoration is appealing and optimistic, as a panacea for addressing coastal protection under a changing climate, it remains highly contentious and context specific.

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CCD	Climate Compatible Development
EVN	Economic Value to the Nation
EVW	Economic Value to the World
EU	European Union
GoG	Government of Guyana
GMRP	Guyana Mangrove Restoration Project
IPCC	Intergovernmental Panel on Climate Change
LCDS	Low Carbon Development Strategy
NMMAP	National Mangrove Management Action Plan
REDD+	Reducing Emissions from Deforestation and Forest Degradation
UNFCCC	United Nations Framework Convention on Climate Change

PREFACE

This thesis is submitted in partial fulfillment of the requirements for a Master of Science Degree in Climate Change and Development from the University of Sussex. The following report presents the findings resulting from the research entitled, *Mangrove Management in Guyana: A Case of Climate Compatible Development?* The objective of this research was to critically examine the potential contribution of mangrove restoration in promoting Climate Compatible Development in Guyana. In so doing, this study has not only provided a theoretical and anecdotal perspective of the realities in using 'soft' coastal protection measures, but it has also unpacked the synergies and underlying tradeoffs between adaptation, mitigation, and development associated with such interventions. Hence, the findings supported by this study may contribute to the broader discourse surrounding the unifying concept of Climate Compatible Development.

This report has benefitted from the significant inputs and support of various individuals, whose expertise in the field of mangrove management played a critical role in the execution of this study. To this end, the researcher extends deep appreciation to the management and staff of the Guyana Mangrove Restoration Secretariat for their valuable contributions of information, time, and commitment to this project. Sincere gratitude is also extended to the supervisor of this research, Mr. Terry Cannon, for his continuous and unwavering support, guidance, and inputs in making this study a successful and complete one. Last but certainly not least, the researcher wishes to thank the Caribbean Catastrophe Risk Insurance Facility, for without whose financial sponsorship, this research would not be possible.

1.0 CHAPTER 1: INTRODUCTION

1.1 Context and Background

Developing countries are at the front line of climate change impacts, especially those with low-lying coastal zones and climate sensitive economies (Ackerman, 2009). As such, responding to the projected impacts is critical; but one which requires access to and availability of adequate finance. While the international donor community has been a catalyst in assisting developing countries to meet their sustainable development priorities, climate change now threatens to exacerbate the already stressed and vulnerable conditions within these countries (Blavier, 2010 and Orellana 2010). To this end, there has been a call for separate finances (new and additional to developmental assistance, to support the incremental costs of climate change) to be provided for developing countries to facilitate their adaptation, which must occur now. Within the current climate change discourse, both mitigation and adaptation have long been treated as separate entities, priorities, and responsibilities by different actors; let alone separate from development (Grist and Jones, 2012; Urban and Nordensvärd, 2013:202). Such disparities are based largely on the notion that the North created the problem of climate change, and should thus take responsibility for greenhouse gas (GHG) emission reductions, while adaptation is seen as a priority for the South. However, a growing body of literature now suggests that developing countries should not only prioritize adaptation needs, especially since their business-as-usual development pathways may also contribute to increased GHG emissions if left unabated (Bowen and Fankhauser, 2011; Egelyng et al., 2009). In this regard, it is imperative that developing countries move beyond adaptation, and in so doing, adopt necessary measures to reduce current and future emissions across respective sectors. Hence, the urgency and relevance of adequate climate finance to balance both mitigation and adaptation demands in developing countries.

According to estimates provided by United Nations Framework Convention on Climate Change (UNFCCC), additional investments and financial flows of US$200-210 billion would be required by 2030 to address global mitigation demands, with approximately US$75 billion needed in developing countries alone (Ackerman, 2009; Parry and Tirpak, 2009:3-5; Haites, 2011). Similarly, the incremental costs of adaptation vary by tens of billions, to as much as US$200 billion globally, with an estimated US$67 billion required in developing countries. Although developed countries have committed towards providing new and additional financial resources,

various authors posit that these pledged commitments are well below the projected needs in developing countries (Ayers and Huq, 2009; Bradlow et al., 2011). Added to this, the current funds under the UNFCCC's financial mechanisms also remain grossly inadequate (Oxfam, 2012). As reported by Ayers and Huq (2009), such shortcomings in pledged commitments is rooted in an alleged lack of adequate and accountable mechanisms in developing countries for receiving and disbursing financial resources. Furthermore, in light of the global economic recession, developed countries now face even greater financial constraints in meeting not only climate finance obligations, but also broader development assistance.

In response to the current dilemma between limited available finance and its ever-increasing demands, the donor community has developed a new agenda; one which emphasizes greater accountability, transparency and cost-effectiveness, using an integrated approach known as Climate Compatible Development (CCD). First coined by Maxwell and Mitchell (2010:1), Climate Compatible Development is:

> '*development that minimizes the harm caused by climate impacts, while maximizing the many human development opportunities presented by a low emissions, more resilient, future'.*

In effect, CCD transcends beyond the historical separation of adaptation, mitigation and development, by merging together these strategies which have tended to work to date in isolation. This new development paradigm encourages the adoption of triple-win strategies designed to deliver multiple benefits that can support lower emissions, build resilience and promote development simultaneously (Maxwell and Mitchell, 2010). While the genesis of CCD hinges upon the theoretical synergies between adaptation, mitigation and development, various authors opine that there is a lack of empirical and theoretical evidence of what CCD may look like in practice, and more importantly, whether the possibility of concurrent, adverse impacts linked to such an approach exists (Blackford et al., 2011; Tompkins et al., 2013). Despite its inadequate articulation and adoption in practice, advocates of CCD maintain that various mechanisms can enable this vision to be realized, specifically through individual projects and programmes, or priorities balanced across sectors. In particular, Tompkins et al. (2013) suggests that 'soft' coastal protection approaches including mangrove restoration may provide a unique

opportunity for the triple-wins, and consequently, a useful lens through which the knowledge gaps of CCD can be further explored across diverse contexts.

The Intergovernmental Panel on Climate Change (IPCC) has confirmed that sea levels are rising globally as a result of climate change. As such, ensuring coastal protection has become critically important for many low-lying developing countries; and Guyana, a tropical country located on the northeastern coast of South America is no exception (Mason, 2011:38; GoG, 2012a). The impacts of climate change induced sea level rise present a formidable challenge in Guyana for many reasons. According to both Ackroyd (2010) and EPA (2000:1), the coastal zone (reclaimed wetland) of Guyana extends 430 km along the Atlantic Coast, and varies in width from 26 km to 77 km wide. This zone is considered one of the most important natural regions in the country, especially since it hosts over ninety percent of the population (750,000), as well as main livelihoods, economic activities and critical infrastructure. Furthermore, the entire zone lies between 0.5 and 1.0 m below the Atlantic spring high tides, and is protected along its coastal boundary by an elaborate sea defense network which includes: 100 km of masonry walls (approximately 4 feet high), 145 km of mangrove forests with earthen embankments, 80 km of natural sand banks and 15 km of rip-rap (stone rubble) (EPA, 2000; GINA, 2004; GoG, 2010:5). However, in recent years, the lack of adequate maintenance of existing sea defenses, and the gradual destruction of mangrove forests (natural and anthropogenic) have drastically reduced coastal protection, thus increasing the country's exposure to frequent inundation and shoreline erosion (Dalrymple and Pulwarty, 2006). Guyana's vulnerability is made even more acute following projections of sea level rise of as much as 0.88 m by the end of the century (GoG, 2012a; Persaud, 2011:6). Added to which, accompanying increases in storm surges of 5 m are expected to affect more than 22,000 hectares of the coastal zone, through further inundation and erosion, which can significantly cripple the country's agriculturally driven economy (GoG,2012a).

In light of Guyana's vulnerability to sea level rise, coupled with limited financial capacity to respond to its impacts, the Government of Guyana has prioritized investments in low-cost, no-regret adaptation options which can reduce infrastructure deficit, while at the same time strengthen the country's adaptive capacity (Mason, 2011; GoG, 2012a). One such priority option which has gained recent consideration in Guyana is the restoration and protection of mangroves

as a soft, low-cost option for augmenting the country's sea defense system. To demonstrate this commitment, the Government of Guyana formulated a Sea and River Defense Policy in 2009 which called upon the inclusion of mangroves as a coastal defense option alongside existing hard structures (GMRP, 2010). Similar interests in mangroves were also enshrined in the country's Low-Carbon Development Strategy (LCDS), wherein there is a central focus on forest conservation; specifically aimed at supporting Guyana's REDD+ model. Such efforts to align mangrove protection within the country's sea defense and broader climate change policies became even more tangible following the implementation of the Guyana Mangrove Restoration Project (GMRP); a project funded with joint support from the Government of Guyana and the European Union (EU) in September, 2010.

In light of the current knowledge gaps associated with CCD, and the growing recognition that mangrove restoration may deliver a triple-win opportunity; an investigation into the extent of the potential merits and challenges of such an approach with reference to an existing restoration initiative is a timely research. It is on this premise that the current study aims to critically examine the potential contribution of mangrove restoration in promoting Climate Compatible Development in Guyana; with acute focus on the experiences and lessons learnt from the GMRP. In so doing, this study has adopted a qualitative research approach using various methodologies as outlined in Chapter 3.0.

1.1.1 Overview of the Guyana Mangrove Restoration Project

The GMRP sought to implement Guyana's National Mangrove Management Action Plan (NMMAP) over the triennial period, 2010-2013. The overall objective of the NMMAP was to:

> *'respond to climate change and to mitigate its effects through the protection, rehabilitation and wise use of Guyana's mangrove ecosystems through processes that maintain their protective function, values and biodiversity, while meeting the socio-economic development and environmental protection needs in estuarine and coastal areas'* (GoG, 2010:6).

The GMRP was implemented using specific performance criteria and verifiable indicators established by the EU. The two overarching criteria outlined in the Project's Financing

Agreement included: the development of a mangrove monitoring system (Year 1), and the protection of 11 km of coastline for the remainder of the Project's duration (GoG, 2012b). The latter criterion was met using a combination of efforts which included mangrove planting, coastal engineering structures, and the protection of existing mangrove swaths. Under the project's restoration program (2010-2012), an estimated 336,000 mangrove seedlings (*Avicennia germinans*) were planted across nine (9) coastal sites concentrated within three (3) of the six Administrative Regions which comprise Guyana's coastal zone; these being, Regions #4, #5 and #6 respectively (See Figure 1). The intervention sites included: (*Region # 4*) - Mon Repos, Triumph/Betterverwagting/ La Bonne Intention, Chateau Margot/ Success, Section C Enterprise, Hope, Greenfield, Victoria/Belfield, (*Region # 5*) – Village #6-8, and (*Region # 6*) – Wellington Park (GoG, 2012b).

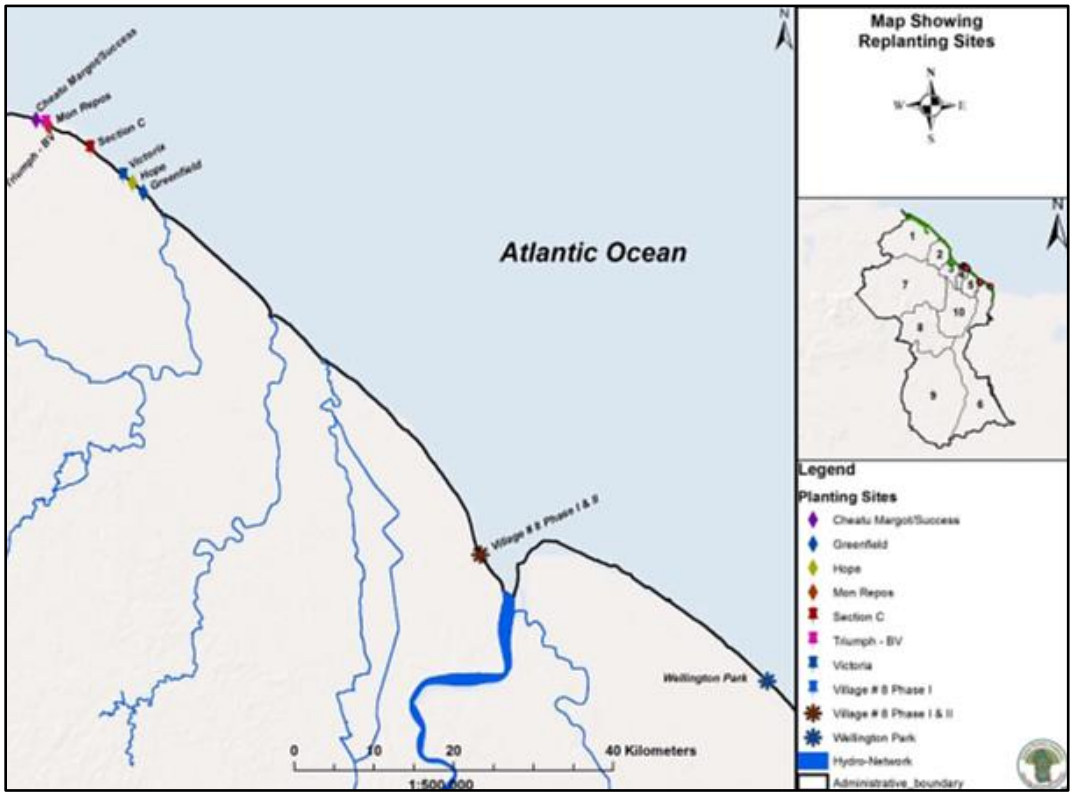

Figure 1: Map of Guyana's Coastline showing the GMRP's Intervention Sites (Source: GoG, 2012b)

Additionally, to pave the way for the implementation of the GMRP, the Government of Guyana in January, 2010, boldly declared all mangroves on State lands as 'Protected Trees', following an

amendment to Regulation 17, of the Guyana Forest Act. In keeping with this declaration, any unauthorized removal of mangrove forests on State Lands is now considered illegal, and any contravention to this regulation is subjected to prescribed penalties, including monetary fines and/ or imprisonment. In an effort to support the above regulation, the GMRP from its inception engaged Mangrove Rangers to monitor the project's nine intervention sites along the coast, and report on incidents of unauthorized harvesting/ disturbances.

1.2 Research Questions

The following specific research question and sub-questions were designed to guide the present study:

I. Can mangrove restoration/ protection deliver a triple-win opportunity for climate change adaptation, mitigation and development in Guyana?

- What synergies between adaptation, mitigation and development potentially exist through mangrove restoration/ protection in Guyana?

- What are the potential barriers that may hinder the achievement of the triple-win goals in Guyana?

1.3 Significance of the Study

The recent emergence of Climate Compatible Development as a unifying concept and new development landscape remains contentious and inconclusive. This is largely due to the paucity of empirical evidence to adequately justify the assumed synergies between adaptation, mitigation and development as touted by this approach. While previous studies (Bood, 2012 and Tompkins, et al., 2013) of a similar nature have evaluated coastal zone management policies and projects for their contributions to CCD, analyses have been limited to the identification of triple-wins and tradeoffs, rather than the full extent of these gains and losses in the explored contexts. In an attempt to address this research gap, the following study goes one step further by critically examining the potential contribution of mangrove restoration/ protection in promoting CCD in Guyana. In so doing, this study moves beyond the identification of the triple-win benefits, and

thus explores the depth of the identified synergies and challenges associated with mangrove restoration in Guyana. Consequently, the findings which emerge from this study may provide a meaningful contribution to the ongoing discourse surrounding Climate Compatible Development.

1.4 Structure of the Thesis

In the first section of this report (Chapter 1), the research theme (Climate Compatible Development), context and respective knowledge gaps were identified, before highlighting the significance of the present study and its corresponding research questions. In Chapter 2, a literature review is outlined, which serves to guide and inform the present study. In Chapter 3, an overview of the methodology employed in this study is presented, as well as the limitations encountered in the process. In Chapter 4, a summary of the research findings is presented in a matrix format which highlights the benefits and challenges associated with mangrove restoration in Guyana. Chapter 5 provides a detailed analysis and discussion of the research questions. Chapter 6 culminates the study by highlighting the implications of the findings in relation to the research theme and identifies key areas which warrant further research.

2.0 CHAPTER 2: LITERATURE REVIEW

2.1 Climate Compatible Development: A Conceptual Model

Climate Compatible Development is an emerging and ambitious concept which builds upon the earlier concepts of adaptation and mitigation, as well as the newer approaches of climate resilient development and low carbon development (Blackford et al.,2011). Where these three themes overlap, CCD is the binding element, as shown schematically in Figure 2.

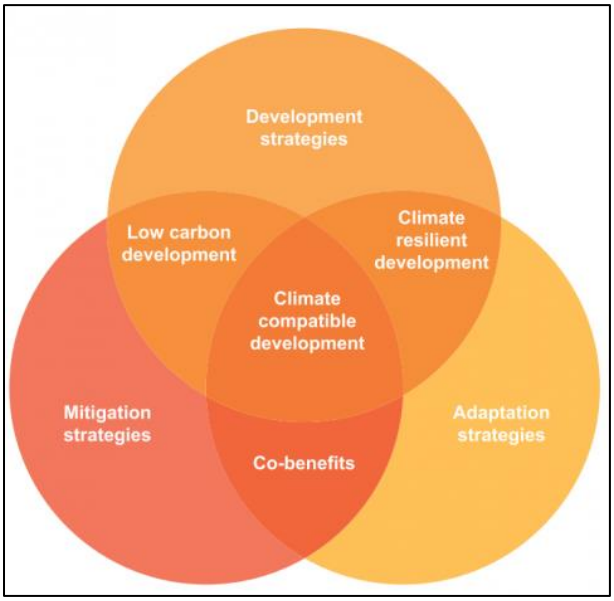

Figure 2: Schematic representation of Climate Compatible Development and associated terms. Source: Maxwell and Mitchell (2010:1)

According to Smit et al. (2001:881), adaptation is defined as '*adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities*'. Mitigation is defined as '*an anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks*' (IPCC, 2001:379).

While no universal definition exists for development, traditionally it has be quantified in terms of economic growth, but more recently, it has been broadened to reflect other factors including human development and well-being (Blackford et al., 2011). Based upon the conceptual model, low carbon development sits at the interface between mitigation and development, and aims at

promoting development while reducing emissions. Where adaptation overlaps with development, activities in this zone are better known as climate resilient development, which is defined by Maxwell and Mitchell (2010:4) as '*development that has the capacity to absorb and quickly bounce back from climate shocks and stresses'*.

Climate compatible development fuses the above concepts together. As defined by Maxwell and Mitchell (2010:1), climate compatible development is '*development that minimises the harm caused by climate impacts, while maximizing the many human development opportunities presented by a low emissions, more resilient, future'*. It can be illustrated as the space where adaptation, mitigation and development aims overlap, as depicted in Figure 2. This conceptual model of CCD portrays and elaborates the notion that mitigation, adaptation and development can mutually coexist with each other to generate 'triple wins' which can support lower emissions, build resilience, and promote development simultaneously (Blackford et al., 2011). Through its conceptual articulation and emphasis on creating synergies, CCD is now perceived as a useful means of improving cost-effectiveness (Klein et al. 2007; Ayers and Huq, 2009). This is of particular importance given the limited financial resources currently available to balance adaptation, mitigation and development demands. To this end, the approach of CCD has gained increasing recognition at the global level, specifically by the donor-community which now prioritizes investments in CCD- related initiatives.

Though ambitious and optimistic as a conceptual model, at present, there is inadequate, robust empirical evidence which demonstrate concrete examples of climate compatible development at work (Tompkins et al., 2013). As a result, the current evidence offers little guidance of what CCD may look like in practice across diverse contexts and scales. Added to which, it remains unclear whether CCD interventions may generate concurrent, negative impacts and tradeoffs at the same time of producing triple-wins (Blackford et al., 2011; Tompkins et al., 2013). Bearing in mind the above research gap, the present study will therefore serve to add clarity and understanding of this conceptual model, by examining CCD through the lens of mangrove restoration in Guyana.

2.2 Examples of Climate Compatible Development in Practice

Though inadequate, practical applications of CCD have been observed at the project, district and national levels across the world covering a range of examples including: renewables, conservation, disaster management, climate accords, REDD+, market mechanisms for sustainable development, climate resilience policy and clean energy investment (Maxwell and Mitchell, 2010; Grist and Jones, 2012; Urban and Nordensvärd, 2013). However, limited studies have examined the contribution of coastal protection strategies such as mangrove restoration in promoting CCD.

In fact, only two studies (Bood, 2012; Tompkins et al., 2013) have to date explicitly assessed existing mangrove restoration policies/ programmes for their contribution to CCD. Tompkins et al. (2013) in particular, demonstrated that in Vietnam, Belize, Ghana and Kenya, mangrove restoration is capable of delivering the triple-win benefits of: storm buffering/ shoreline stabilization, carbon sequestration and development benefits (improved livelihood options, increased fisheries, and possible REDD+ financial benefits). Similar findings were highlighted by Bood (2012) who also examined mangrove restoration specifically in Belize. As reported by Tompkins et al (2013), the main tradeoff/ regret involved using this approach is a loss of land for alternative development. However, as emphasized by this study, the governance context and local conditions in the recipient country will determine whether mangrove restoration can be delivered without such regret. While both studies identified potential synergies between adaptation, mitigation and development using mangrove restoration, neither study explored the magnitude of the benefits in relation to the tradeoffs derived from this particular approach. As such, the present study will therefore attempt to address this research gap by examining the extent of the synergies and tradeoffs linked to this option by drawing on the experiences of an existing mangrove restoration initiative in Guyana.

2.3 Drivers and Challenges of Climate Compatible Development

According to Cambray et al. (2013), in order to successfully promote CCD at the project, district or national level, depends on several interconnected socio-political drivers, as well as the ability of countries to navigate around significant constraints and challenges (See Table 1). However,

there remains a weak evidence base (concrete examples) to demonstrate how these drivers and challenges may resonate in practice.

Table 1: Drivers and Challenges of CCD (Adapted from: Cambray et al., 2013)

Driver	Challenge
• A recognised need at the national level to adapt to climate change in order to bolster resilience, achieve growth and reduce poverty • A need for energy security and natural resource efficiency • A desire to capitalise on new economic opportunities • A desire to improve access to climate finance and aid • Strong government leadership	• Costs associated with change • Interest groups opposed to change • A lack of awareness or trusted information about uncertainties, risks, opportunities and trade-offs • Short-termism • A lack of state capacity to respond to and implement strategies • Institutional constraints • Technological constraints and uncertainties

Despite the growing recognition that CCD is essential if developing countries are to address the impacts of climate change, while continuing to develop (Ayers and Kaur, 2010:1; Maxwell and Mitchell, 2010), several critics outright oppose the adoption of synergetic opportunities. In particular, Fegenhauer (2009) and Dessai et al. (2005) suggest that, since adaptation and mitigation are dissimilar approaches, the implementation of synergetic opportunities are likely to encounter difficulty in practice. Both studies underscored that the above climate policies are temporally and spatially different; the extent to which their benefits can be determined, compared and aggregated vary; and they also appeal to different actors in implementation. In light of such significant differences, Tol (2007) argues that this makes integration difficult, and in most cases, meaningless. Moreover, Dessai et al. (2005) also posits that focusing too heavily on creating synergies will encounter greater institutional complexity, which could limit the efficacy of the measures. Added to which, it remains unclear whether synergetic opportunities represent a wise investment in terms of the mitigation and adaptation benefits accrued, as oppose

to investing in more efficient mitigation/ adaptation options separately. Dessai et al. (2005) also cautioned that synergetic opportunities could lead to projects that are cost-ineffective, or produce insufficient mitigation and adaptation benefits. Furthermore, Grist and Jones (2012:12) supported the above view to some extent, noting that triple-wins and synergetic opportunities are rare in reality, and in many cases may not be the most effective solution. This study also added that the practicalities of how CCD is applied are highly context specific; hence, synergetic solutions, though appealing, are likely to vary from country to country. Against this backdrop, the present study will determine whether mangrove restoration in Guyana is in keeping with the above-mentioned insights.

3.0 CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

The purpose of this study is to examine the potential contribution of mangrove restoration/ protection in promoting Climate Compatible Development in Guyana. To achieve this objective, the present study sets out to determine whether a triple-win opportunity for climate change adaptation, mitigation and development is possible through mangrove restoration, and if so, what is the extent of the synergies and challenges linked to such an approach. To this end, a qualitative research design was considered most appropriate for deducing answers to the specific research questions. In particular, gaining deeper insights from key informants and documented evidence was deemed more appropriate for examining the potential contribution of mangrove restoration in delivering the triple-win benefits, rather than a quantitative analysis. As such, the following research techniques were employed in this study:

3.1 Data Collection Tools

- **Desk Study (Secondary Sources)**

An in-depth desk-based assessment was conducted as the principal means of data collection. The desk study involved the survey of locally available literature, with relevance to mangrove restoration efforts in Guyana. Among the most pertinent documents reviewed included: management plans, consultancy reports, GMRP's annual progress reports, newspaper articles, and other publically available literature, which provided a useful means of understanding the relative benefits (adaptation, mitigation and development) and challenges associated with mangrove management in Guyana.

- **Personal Communications**

Personal interviews were conducted via e-mail, telephone, and in-person with several key informants selected for their first-hand knowledge and perspectives related to the current study. The rationale for choosing this method of data collection was to gather information with as much detail, complexity and nuance as possible, which would allow the researcher to gain a deeper understanding of the benefits and challenges associated with ongoing mangrove restoration efforts in Guyana. The key informants included individuals whose affiliation with the GMRP such as: Project Coordinator, Chairperson, Community Development Officer, and Technical

Assistance Consultant, were able to offer the desired perspective on the benefits and challenges in implementing mangrove restoration/ protection efforts in Guyana.

Bearing in mind that this study focused heavily on examining the potential of mangrove restoration in delivering a triple-win opportunity for Guyana; sourcing accurate information related to adaptation benefits was critical, but one which presented an initial challenge. This was mainly due to the fact that documented empirical evidence to justify the adaptation benefits afforded by mangroves was inadequate in the local context. As a result, the researcher was advised to contact each of the eight (8) Community Mangrove Rangers engaged under the GMRP for their first-hand, anecdotal accounts of observed changes in wave activity, and events of overtopping/ inundation, following restoration efforts at the nine (9) intervention sites, which were being monitored by these individuals. For each of the interviews conducted, a guiding list of questions, specifically designed to help identify and explain the potential benefits and challenges of mangrove restoration/ protection were used throughout this study (See Appendix 1 for Interview Schedule).

- **Direct Observation (Site Visit)**

In an effort to better understand the local conditions under which mangrove restoration/ protection efforts were implemented along the coastal zone of Guyana, site visits to seven (7) of the nine (9) intervention sites were conducted on July 02, 2013. The seven sites visited were concentrated in the Administrative Region, #4. Due to the spatial distribution of mangroves along the coast, the researcher was unable to visit the two (2) sites found in Regions #5 and #6. Photographic evidence and field notes of the local conditions at each of the sites were collected.

3.2 Ethical Consideration

All participation in this study was voluntary. Interviews with key personnel were conducted after respondents were informed about the nature of the research, and verbal/ written consent was provided by each respondent. Interviewees were made aware that all responses would be treated with confidentiality, and refusal to answer a question or to discontinue the interview would be acceptable without penalty.

3.3 Research Limitations

- This study was restricted to the availability and accessibility of accurate and relevant literature found within the local context.

- Anecdotal accounts are known to possess embedded subjectivities. Therefore, the personal views highlighted hereafter are not to be generalized.

- The short timeframe allocated for this research did not facilitate a more comprehensive analysis of the issues discussed.

- CCD is still in its infancy stage and remains largely understudied. As such, the analysis presented was restricted to the limited available literature on this topic.

3.4 Data Analysis Plan

In order to organize, analyse and interpret the data gathered through qualitative research methods; interview recordings were transcribed into a spreadsheet format, and where necessary, unique codes (categories) were assigned to the texts. The entire data analysis procedure was done with the intention of categorising the insights (desk-study and personal communications) gathered into the three pillars of adaptation, mitigation and development, in order to determine the respective benefits/ challenges derived from mangrove restoration. The findings were then synthesized into a matrix, as presented in Table 2.

4.0 CHAPTER 4: RESEARCH FINDINGS

Table 2: Assessment of the Potential Contribution of Mangrove Restoration/ Protection in Delivering a Triple-Win for Guyana

Losses/ Trade-offs/ Barriers			Intervention	Gains/ Synergies		
Development	**Mitigation**	**Adaptation**	**Project**	**Adaptation**	**Mitigation**	**Development**
High opportunity costs- Priortorising developmental gains over conservation Interest groups opposed to change (mangrove bark harvesters and burnt-earth producers) Weak institutional framework for mangrove management	Reduced carbon sink capacity with land conversion (increased emissions)	Existing coastal defense structures e.g. seawalls, prevent inland migration of mangroves in response to projected sea level rise	Mangrove restoration and protection along the coastal zone of Guyana	Shoreline protection against coastal erosion and sea level rise	Reduced emissions from deforestation/ degradation (protection of existing mangrove swaths) Carbon Sequestration (expanded carbon sink through mangrove replanting)	Enhanced ecosystem services i.e. fisheries (increased food productivity) Improved livelihood options for local communities linked to mangroves e.g. beekeeping and ecotourism REDD+ financial benefits (payment for ecosystem services)

Table 2 was compiled following a desk-based review of locally available literature and supplementary personal communications conducted with various key informants. The most pertinent documents through which the above inferences were drawn from included: The *GMRP Progress Report Performance Criterion 1 and 2* (GoG, 2012b), *National Mangrove Management Action Plan 2010-2012* (GoG, 2010), *The Socio-Economic Context of the Harvesting and Utilisation of Mangrove Vegetation* (Adrian et al., 2002), *GMRP- Results Oriented Monitoring (ROM) 2012 Report* (Bedasse et al., 2012), *An Assessment of the Economic Impact of Climate Change on the Coastal and Human Settlements Sector in Guyana* (Mason, 2011), *Institutional and Legal Review of Mangrove and Shoreline Management in Guyana* (Fraser, 2013), and *Guyana's Low Carbon Development Strategy 2013 Update* (Office of the President, 2013).

The findings presented suggest that, ongoing mangrove restoration/ protection efforts in Guyana have the potential to generate synergies and multiple benefits for climate change adaptation (shoreline protection), mitigation (carbon sequestration), and development (REDD+ financial incentives, enhanced ecosystem services and improved livelihoods). In effect, although Guyana's Sea Defense Policy and more specifically, the Guyana Mangrove Restoration Project were not designed with the intention of articulating Climate Compatible Development, the results imply that individual project-based interventions are capable of delivering an opportunity for triple-wins. However, as evident in Table 2, these merits are balanced by several interconnected challenges (regrets/ tradeoffs), which can create the fertile conditions for undermining the achievement of the triple-win goals in Guyana. An in-depth analysis of these issues is presented in the following section.

5.0 CHAPTER 5: ANALYSIS AND DISCUSSION

Can mangrove restoration/ protection deliver a triple-win opportunity for climate change adaptation, mitigation and development in Guyana?

5.1 Mangrove Management in Guyana: The Synergies between Adaptation, Mitigation and Development

I. Adaptation Benefits: (Shoreline Protection)

From the standpoint of climate change adaptation in Guyana, various authors and key informants opine that mangroves can deliver shoreline protection benefits against coastal erosion and sea level rise. This notion is largely informed by the physical properties of mangroves. In particular, Othman (1991:2) noted that mangroves are able to attenuate waves i.e. they reduce wave energy; facilitated by their elaborate root systems which obstruct incoming wave energy. While dissipating wave energy, mangroves, especially *Avicennia* species, also trap suspended sediments with their roots, thus enabling the consolidation of soil, and subsequent build-up of the foreshore (GoG, 2002; Anthony and Gatriot, 2012:268). It is this particular characteristic of mangroves that has fueled its global recognition as a resourceful adaptation option in the face of climate change induced sea level rise.

It is important to note that the protection benefits afforded by mangrove ecosystems are highly species dependent. For example, while *Avicennia* species are more favourable for silt-trapping and wave attenuation, *Rhizophora* species are better suited for retarding coastal erosion. As pointed out by Othman (1991), the mud-flats upon which mangroves colonise are highly dynamic, and undergo a thirty year natural cycle of accretion and erosion. During the erosion cycle, the mud-flats become lowered, and *Avicennia* species often topple due to under scouring. However, in the inner zones where *Rhizophora* species dominate, the combination of stronger soils and deeper root systems help to arrest the erosion process significantly. When the following accretion cycle occurs, *Avicennia* can once again naturally colonise the mud-flats. The above description implies that no single species of mangrove acting alone could deliver coastal protection. Instead, a combination of the right zonation with specific species is an important determinant of the ability of mangrove ecosystems to deliver shoreline protection services.

In Guyana, the composition of the current mangrove forest (22,632 ha) found along the coastline reflects the desired pattern of *Avicennia* dominating the outermost, seaward fringe, followed by *Laguncularia* and *Rhizophora* respectively (GoG, 2010:12). Added to which, sediments (silt and clay) emanating from the Amazon river also result in the formation of migrating mud-flats and sub-tidal mud-banks, which in turn facilitate natural mangrove regeneration (Gratiot, 2010:24; Bird, 2010:245). As such, Guyana's coastline thus appears to represent the right mixture of elements and conditions which create the enabling environment for mangroves to deliver coastal protection. In light of Guyana's unique mangrove distribution, coupled with the projections of sea level rise and storm surges, efforts geared towards protection and restoration of mangroves are therefore critical to ensure long term resilience of this ecosystem, and its subsequent contribution to coastal protection.

The Government of Guyana has already demonstrated its commitment in protecting the mangrove forests through the implementation of the GMRP. Over the period 2010-2012, an estimated 336,000 *Avicennia* seedlings were planted at selected sites along the coastal zone, ranging from 50-90 m seaward, following a comprehensive site suitability assessment (GoG, 2012b:29). To date, the planting program has enabled the restoration of 5.59 km of mangroves, which equate to an area of approximately 35 hectares. At the same time, the GMRP has also monitored and protected a 24.2 km existing swath of mature, mangrove forests along the coast from anthropogenic disturbances. According to Bedasse et al. (2012:7), accumulated anecdotal evidence in Guyana suggests that, replanting efforts and protection of existing swaths of mangroves at some of these sites have minimized the cost of maintenance for hard structures, which currently cost US $2200 per linear meter (Bovell, 2011:1). Similarly, Mason (2011:22) also posits that mangroves in Guyana presently offer protection to the hard sea defense structures, and thus reduce the impact of wave action on the sea wall. As a result, there has been a reduction in the occurrence of breaches and inundation associated with wave action following mangrove restoration and protection efforts in Guyana. Telephone interviews conducted during the present study with Mangrove Rangers further indicated that restoration activities have already seeded tangible benefits of shoreline protection at each of the GMRP's intervention sites. In comparing the baseline conditions of wave activity at the various sites to their present day state, each of the Rangers articulated that discernible reductions in wave-overtopping and site

flooding have been observed following intervention efforts. At each of these locations, the baseline conditions varied from lone seawalls to combinations of rip-rap structures, earthen embankments and patches of existent mangroves. Under such prior conditions, the Rangers noted that these sites were regularly prone to flooding during high tides, before mangrove restoration efforts had commenced. In particular, one of the Rangers emphasized that while the prevalence of wave-overtopping has drastically reduced to date, '*the water level would only rise in the mangrove stand during high tides, but no overtopping of the seawall is accompanied*'. Other Rangers also elaborated on observations of the calm flow of water through the mangrove stands at present, as oppose to high energy wave-breaking at the face of the seawall which previously characterized these areas. According to a key informant from the GMRP's Secretariat, the Wellington Park (Region #6) site represents one of the more successful restoration efforts and demonstration of mangroves at delivering coastal protection to date. The informant noted that:

> *'When the mangroves planted had reached about six feet, it was the first time that the high tide did not flood the community. Normally, at every high tide, the residents of Wellington Park would raise their home appliances above the ground, but with the mangroves planted, they do not have to do that anymore'.*

Such observations and insights, though based upon individual perceptions, may thus imply that the land-building and wave-attenuating mechanisms of mangroves are perhaps already at work in many parts along Guyana's coastal zone. Additionally, site observations reported by GoG (2012b:27) further emphasized that seedlings planted at Chateau Margot/ Success (Region 4) and Village #6-10 (Region 5) in 2012, have resulted in rapid recovery of the coastal protective belt. In particular, evaluations of field results reported by (GoG, 2012b) indicated that seedlings at the above-mentioned sites were able to attain canopy closure in one year, following a mean growth rate of 2 m per year. Added to which, evidence of natural secondary succession by *Laguncularia* species was also observed alongside the replanted seedlings.

While the confidence in mangroves as a coastal defense option in Guyana is solely premised on observations and anecdotal accounts, due to the lack of locally robust, scientific evidence; empirical measurements conducted elsewhere have nevertheless justified these local observations. In particular, Hashim et al. (2013:4484) highlighted that in Vietnam, where

mangroves are sufficiently tall, the rate of wave reduction per 100 m is as large as 20 %. This study further predicted that for 6 year-old mangroves, wave heights can be reduced from 1.0 m to 0.05 m across a 1.5 km wide mangrove swath, while reductions of only 0.75 m are expected in areas without mangroves. Similarly, McIvor et al. (2012) indicated that mangroves can reduce the height of wind and swell waves from 13-66 % over a 100 m width of mangroves, and between 50-100 % where the width exceeds 500 m. This study further added that the best use of mangroves usually involve a combined approach with a dike or seawall. Such sentiments have been overly stated in Guyana wherein, mangroves are not regarded as a substitute to seawalls, but rather, an option for augmenting the country's existing hard sea defense structures in a complementary setting (GoG, 2002; GoG, 2010, Ackroyd, 2010). In particular, Mason (2011:26) noted that in 2009, mangroves provided shoreline protection estimated at US $3.3 billion, and in combination with existing hard structures, have since reduced Guyana's annual average vulnerability by US $15.54 billion.

Evidently, the above discussion has thus far demonstrated that efforts to restore and protect mangroves in Guyana are already delivering coastal protection benefits in response to current variability in wave activity. As such, continued efforts to strengthen the resilience of this ecosystem may therefore support Guyana's adaptation to the projected impacts of climate change-induced sea level rise and accompanying wave activity.

II. Mitigation Benefits: (Carbon Sequestration)

In addition to providing adaptation benefits, mangroves also provide the co-benefit of cycling carbon dioxide. As noted by Mitchell et al. (2010:8), mangroves can accumulate around 0.038 gigatonnes of carbon (GtC) per year globally. Added to which, these wetlands sequester carbon faster (50 times greater) per unit area than tropical terrestrial forests (Suratman, 2008). Moreover, Fujimoto (2000) indicated that mangroves are also capable of accumulating and storing carbon in the soil in substantial quantities. In particular, this study highlighted that a 20-year old plantation of *Rhizophora* mangroves can store 11.6 kg m^{-2} of carbon with a burial rate of 580 g $m^{-2}yr^{-1}$; hence, mangrove restoration/ protection can provide a unique opportunity for controlling global climate change, by sequestering atmospheric carbon.

In Guyana, although adaptation is a critical priority, reducing emissions across all sectors is equally important as part of the country's commitments under the UNFCCC. As noted by GoG (2012a), Guyana is considered a carbon sink given its high terrestrial forest coverage (18.39 million ha), however, emissions within the forestry sector itself, range between 2,575 Gg (1999) to 4,499 Gg (1990-1998 and 2002-2004). According to GoG (2010) and Ackroyd (2010), mangrove forests in Guyana sequester on average 17 metric tonnes of carbon per hectare annually. To date, restoration efforts have enabled the expansion of the mangrove carbon sink by as much as 35 hectares, while protection of existing matured swaths (24.2 km) have contributed to avoided emissions from deforestation and degradation (GoG, 2012b). In light of the strong mitigation potential of mangroves, Bedasse et al. (2012) suggests that, continued efforts to restore and protect existing swaths can provide a unique opportunity for Guyana to offset emissions within the forestry sector, and thus support the country's UNFCCC's commitments. Similar views were also articulated by a key informant from the GMRP's Secretariat who noted that:

> *'Any increases in mangrove area can be used to offset losses from terrestrial forest logging and mining activities in Guyana'.*

III. Development Benefits: Enhanced Ecosystem Services, Improved Livelihood Options, REDD+ Financial Benefits)

- **Enhanced Ecosystem Services**

Besides its adaptation and mitigation benefits, ongoing efforts to protect and restore mangroves in Guyana also play an important role in the provision of ecosystem services. According to GoG (2002), mangrove areas in Guyana provide a habitat for juvenile off-shore fisheries, particularly fish and shrimp which support commercial and subsistence purposes. As noted by Kalamandeen (2013) and GoG (2002), coastal residents are known to harvest fish on a daily basis from nearby mangrove wetlands, which provide an important source of protein, as alternative sources of this essential nutrient is expensive at the local level. Additionally, crab harvesting in mangrove areas represent an important livelihood for many rural communities (e.g. Imbotero) in Guyana; an activity widely practiced by rural women (Adrian et al., 2002). Crab harvesting is most common

between July and September, and individual collectors maintain a livelihood by selling crabs sourced from mangrove areas at a price of $200-$250 Guyana dollars per basket (about 15-20 crabs), in Regions #1 and #6, respectively (Adrian et al, 2002). Evidently, continued efforts at restoring and protecting existing swaths of mangroves are likely to generate increased benefits for food productivity (possible health benefits) and livelihood security at the local level.

- **Improved Livelihood Options**

Apart from the ecosystem services (fisheries) afforded by mangroves in Guyana, ongoing restoration/ protection activities have also contributed more broadly to development, through the provision of livelihood opportunities linked to mangroves. As noted by Guyana Times (2013), restoration activities have to date generated employment for more than 370 individuals (mainly as mangrove seedling contractors and planting labourers). While these opportunities are short term, key informants indicated that sustained alternative livelihood opportunities were subsequently introduced into each of the intervention sites following replanting activities. Beekeeping (honey production) in the mangrove area was the main alternative livelihood promoted by the GMRP, and persons interested in this activity were provided access to bee hives. As noted by Adrian et al., (2002), mangroves, especially *Avicennia* species, have flowers which produce a high quality honey. To date, individuals are now earning in excess of $9000 Guyana dollars per gallon of honey, sourced from mangrove areas (GMRP Staff, personal communication, 2013). Added to which, some coastal communities are also benefitting from ecotourism opportunities provided by intact mangrove ecosystems. In particular, Bovell (2011), highlighted that mangroves provide a habitat for the scarlet ibis and many other bird species, and their nesting at Region #1 have complemented the tourism product in that area through the provision of bird-watching opportunities. Likewise, Bedasse et al. (2012) has reported that mangrove restoration/ protection efforts in Guyana have contributed to poverty alleviation, since previously unemployed individuals are now engaged in tour-guiding operations (bird watching), and are earning a steady income from facilitating mangrove tours e.g. residents of Victoria, East Coast Demerara.

- **REDD+ Financial Benefits**

In light of Guyana's substantial forest coverage and historically low deforestation rate, the country is presently seeking compensation for maintaining its standing forests for the global benefit (Cambray et al., 2013:5). To this end, Guyana has developed a model for REDD+, in which the country presently uses to finance the realization of various projects enshrined in its LCDS. Based upon an independent assessment by McKinsey and Company in 2009, the value of Guyana's forests (inclusive of mangroves), known as the Economic Value to the Nation (EVN), was estimated to be US$5.8 billion, or the equivalent of an annual annuity payment of US$580 million (Office of the President, 2013). Added to which, conservative valuations of the Economic Value to the World (EVW) provided by Guyana's forests suggested that, left standing, they can contribute US$40 billion to the global economy each year, as well as avoided emissions of 1.5 gigatonnes of CO_2e by 2020, which would otherwise be emitted should Guyana pursue rational economic development (Office of the President, 2013). Through a partnership with the Government of Norway, Guyana has since secured US$115 million for maintaining a deforestation rate below 0.056 per annum, and additional disbursements totaling US$250 million are expected by 2015. The funds obtained have since supported Guyana's transition towards a low carbon economy through investments in renewable energy (e.g. Amaila Falls Hydropower Project) and the creation of various low-carbon economic opportunities. Evidently, Guyana's mangrove forests, though limited in its current coverage (but strong in its mitigation potential), have been accounted for in the country's REDD+ programme, and has thus supported the provision of financial incentives for the country. Hence, the continued protection of Guyana's mangrove forests both existing and replanted have a role to play in securing future payments for ecosystem services.

The above discussion has demonstrated that ongoing efforts at the project-level to restore and protect mangroves in Guyana can and to some extent have already delivered multiple benefits for adaptation, mitigation and development to date. By extension, this may imply that mangrove restoration can provide a unique opportunity for Guyana to achieve Climate Compatible Development. Moreover, the above findings also justify the work of Tompkins et al. (2013) and Bood (2012), who suggested that soft, coastal protection measures such a mangrove restoration are capable of producing triple-wins.

Bearing in mind the temporal differences between adaptation and mitigation; it is worth noting that, while the adaptation and developmental benefits afforded by mangrove restoration are more evident in the short term, the mitigation benefits will not be realized until decades to come. This is largely due to the long residence time of GHGs in the atmosphere (Dessai et al., 2005). In effect, although synergies are created using this approach, for Guyana to secure and harvest the triple-win benefits afforded by this option, and thus achieve CCD, sustained protection of the replanted and existing mangroves found along the coastal zone is critical. However, the present study finds that the long-term achievement of the triple-wins present a formidable challenge in Guyana. This is due to the fact that mangrove restoration/ protection as a CCD option comes packaged with a spate of regrets (tradeoffs) and challenges, and as demonstrated in the following section, the governance context and other local conditions largely determine the extent to which the triple-wins can be harvested successfully and sustainably.

5.2 Barriers that Hinder the Achievement of the Triple-Win Goals

I. High Opportunity Costs

According to Cambray et al. (2013:5), the most significant constraint to achieving Climate Compatible Development is the high opportunity costs associated with change. In the context of mangrove management, a loss of land for alternative development is therefore the principal tradeoff which needs to be made in order to sustain the benefits afforded by this ecosystem (Tompkins et al., 2013). In fact, Guyana's Low Carbon Development Strategy (2013:101) explicitly acknowledges this regret, noting that, by protecting the country's forests (inclusive of mangroves), Guyana foregoes economically rational opportunities from the use of land in more intensive ways, which may have otherwise provided the equivalent of $430 million to $2.3 billion in additional value per year. However, the present study finds that such statements may not accurately reflect the true realities where the individual forest type; mangrove is of concern. To this end, this study argues that the tradeoff of a loss of land for alternative development does not appear to resonate well in the local context. This notion is adequately supported by concrete evidence which highlights that, while simultaneously implementing mangrove restoration/ protection efforts at selected sites along the coastal zone of Guyana, destruction of mangroves to pursue economic development was evident at the wider national scale.

As noted by Anthony and Gratiot (2012:271), over the past 20-30 years large-scale removal of mangroves to facilitate agricultural and aquaculture activities have resulted in a significant reduction in the country's protective mangrove belt. In fact, Da Silva and Kalamandeen (2011:26) have reported that from 1980-2011, the coverage of mangroves in Guyana sharply declined from 91,000 to 22,632 hectares; representing a 75 percent reduction over a three decade period. While various government reports in the local setting attribute this decline to natural forces (erosion cycle), recent studies now suggest that economic development in Guyana has been the underlying driver of mangrove loss through land conversion.

To demonstrate the above argument more clearly, the present study has relied heavily on the works of Fraser (2013) and Adrian et al. (2002) who have documented concrete evidence of large-scale removal of mangroves on public lands in Guyana by various Government departments. Fraser (2013) in particular, underscored the ad hoc and fragmented manner in which mangrove removal has occurred in recent years, noting that little consideration was given to the negative externalities of specific developmental-facing projects on mangrove ecosystems being executed by various sector agencies. In assessing the impacts of infrastructural works across five sectors (housing, utilities, public works, agriculture and the private sector) in Guyana, Fraser (2013) cogently pointed out that political expediency played a crucial role in propelling the process of mangrove degradation, and the relevant agencies with supporting mandates for mangrove management waived approvals and exempted these initiatives from procedural Environmental Impact Assessments, given the strong political influence. Although the extent of mangrove removal varied among each of the examined cases, the largest estimate was related to the utilities sector (Guyana Power and Light- GPL), wherein, the installation of overhead transmission lines and the construction of sub-stations and electricity generation plants led to the removal of a 2.5 km^2 swath of mangrove forests, in Region 3, West Bank Demerara, in 2011. This initiative which was considered a national priority, not only resulted in fragmentation of the mangrove stand and increased carbon emissions, but it also exposed the shoreline to erosion and increased site flooding. Consequently, the latter impacts resulted in the need for extensive revetment works and pumps to protect the site from flooding during the spring and high tides; protection services which may have otherwise been provided by the mangrove forests.

In other cases, large scale removal of mangrove forests to develop housing schemes have been reported by Adrian et al. (2002:21), as well as the construction of agricultural drainage channels and critical infrastructure e.g. roads and bridges (Fraser, 2013). While government departments have played a role in shaping mangrove loss in Guyana, a spate of unauthorized land conversions by private developers from 2011-2013, was also articulated by various key informants during the present study, as a growing contributor to mangrove degradation. Large-scale land conversions to facilitate the construction of aquaculture farms, provision farms, and cattle ranches were among the activities highlighted by key informants from the GMRP Secretariat.

Based upon the anecdotal evidence reported by various studies in Guyana, it is clear that while political actors continue to lead the agenda for mangrove restoration/ protection in the country; these individuals also facilitate mangrove degradation, by prioritizing the short-term gains from economic development, over the conservation of mangroves. In fact, Dahl et al. (2009:232) supports this view, noting that it is a 'strain' on Guyana's economy that often motivates the prioritization of economic interests over environmental and conservation interests. As such, the present study is therefore in agreement with Cambray et al. (2013) who noted that many governments tend to prioritize the achievement of high growth in the short term, over CCD which may be more socially beneficial in the long term. Evidently, despite the fact that mangroves provide an overall economic value to Guyana worth US $4.462 billion (Mason, 2011:27), they remain a neglected forest type in the country. Moreover, Fraser (2013) has further emphasized that mangroves continue to be perceived as a hindrance to development at the policy level; while GoG (2010:18) similarly suggested that mangroves are still regarded as a common property to be exploited without control, rather than a critical element in the country's sea defense network.

In the context of climate compatible development, this study strongly argues that the long-term sustainability of the triple-wins afforded by mangrove restoration/ protection may not be possible in Guyana, given the high opportunity costs linked to this approach, and the fact that this tradeoff does not currently resonate well in the local context. Additionally, the findings presented above also corroborate the work of Tompkins et al. (2013) who indicated that the governance context will largely determine the extent to which a triple-win option can be delivered without regrets.

II. Interest Groups Opposed to Change

As noted by Cambray et al. (2013), CCD processes can create both winners and losers, especially when the option capable of delivering a triple-win also represents a livelihood for individuals. This particular challenge has materialized in Guyana, wherein, individuals whose livelihoods are dependent upon commercial harvesting of mangroves presently conflict with restoration/ protection efforts, and by extension, can hinder the achievement of the triple-wins. The stakeholders in question include individuals involved in mangrove bark harvesting, and the production of 'burnt-earth'; activities, both of which require the complete removal of the mangrove tree.

According to Adrian et al. (2002), mangroves, especially *Avicennia* species are frequently used as a fuel source in the production of fired clay (burnt earth or burnt brick); a common ingredient for road construction in Guyana. This particular species of mangrove, which as noted previously is the most dominant found along Guyana's coastal zone, is favoured in the burnt earth production process, as it is claimed to produce a higher quality brick (larger-sized and stronger), in comparison to other wood species. Moreover, Bovell (2011) has reported that this activity is unsustainably practiced by various individuals along the coast of Regions 4, 5 and 6 respectively, and the mangroves harvested, are directly sourced from a matured swath which borders the coastal zone. Additionally, both Adrian et al. (2002) and Bovell (2011) also indicated that mangroves, particularly *Rhizophora* species, are harvested to support the domestic and regional leather tannin industry. Both studies noted that the bark of the *Rhizophora* species is known to produce is high quality tannin which is used to tan a variety of leathers. This activity is concentrated in Region 1, and estimates suggest that from 1996-1999, the quantity of mangrove bark extracted increased from 10,800 kg to 90,956 kg (Bovell, 2011).

Although the Government of Guyana has developed a Code of Practice which encourages the sustainable harvesting of mangroves following specific cutting requirements, as well as the identification of substitute leather dyes e.g. *Mimosa*; compliance and adoption remain weak (GoG, 2002; Adrian et al., 2002; Ackroyd, 2010). This is particularly due to the fact that mangroves are readily available and less costly, compared to the substitute (*Mimosa*), which needs to be imported from Brazil (Bovell, 2011:10), coupled with the lack of monitoring and

enforcement of the Code by the relevant institutions. Added to which, political actors, although aware of the above circumstances, also incentivize mangrove degradation by purchasing bricks provided by the same unauthorized burnt-earth producers to facilitate Government-funded road projects (Kaieteur News, 2010). In light of such realities, the present study suggests that both political and local actors do not appear to have in their vested interests the protection of mangroves for its delivery of the triple-win benefits.

Moreover, it is worth noting that while Adrian et al. (2002:16) reported that the commercial harvesting of mangroves has declined at a steady rate from 1999-2001, interviews with key informants suggested that unsustainable harvesting remains prevalent along the coastal zone; particularly in the Administrative Regions #5 and #6. As noted by Cambray et al. (2013), a potential solution to compensate persons who may negatively affect CCD processes is the introduction of alternative livelihoods. However, in Guyana, the alternative livelihood presently promoted (beekeeping) was not designed with the intention of appealing to individuals involved in the extractive uses of mangroves. In fact, one of the key informants from the GMRP's Secretariat explicitly highlighted that:

> '*Where there is massive exploitation and abuse of mangroves, we do not have a specific alternative livelihood programme in place. We have a finite amount of resources and infinite number of areas that need to be addressed.*'

Evidently, while mangrove restoration/ protection efforts in Guyana have generated improved livelihood opportunities across the GMRP's intervention sites, these target areas do not reflect the locations where mangrove degradation is presumably concentrated. Furthermore, as suggested by Roche (2007), alternative livelihoods must offer a comparable level of remuneration in order to dissuade persons from returning to exploitative practices which may threaten conservation goals. However, when questioned directly regarding the economic viability of the current alternative livelihoods in relation to the exploitative, commercial activities, all key informants opined that the extractive-based livelihoods, undoubtedly offer greater financial incentives. In this regard, it is clear that while land conversion to pursue economic development is the major driver of mangrove loss in Guyana, the extractive-based livelihoods linked to

mangroves, coupled with its political incentive, also represent an impediment towards the long term achievement of the triple-wins.

III. Institutional Constraints

As suggested by Dougill et al. (2011:11) and Cambray et al. (2013), the success of CCD initiatives may be hindered by the limited institutional capacities of responsible government bodies, which can manifest into weak implementation and enforcement. Additionally, where unclear differentiation and even conflict of responsibilities across different ministries arise, the effective implementation of CCD processes may be further weakened. In Guyana, the above factors adequately describe the state in which mangrove management presently operates.

Coastal zone management has long been regarded as a challenge in Guyana; a system characterized as largely fragmented and sector-based. Added to which, poor information sharing and communication across agencies, interagency conflicts arising from overlapping jurisdictions and resource scarcity have further perpetuated the degree of fragmentation (EPA, 2000; Dahl et al., 2009). Where mangrove management is of concern, this piecemeal approach is no different. According to Bedasse et al. (2012) and GoG (2010), although the country has in place various pieces of regulations with relevance to mangrove protection, there remains an absence of a clear institutional framework to complement the legislative arm. As such, efforts to enforce existing regulations where infringements have been reported have relied upon several agencies in executing their mandates, but whose approach to date, is largely disjointed, reluctant and futile (Ackroyd, 2010). As a result, mangrove degradation in Guyana has gone unmonitored and unregulated (GoG, 2002), thus threatening the long term achievement of the triple-wins. In light of such realities, the present study therefore supports the views of Dessai et al. (2005) and Fegenhauer (2009) who noted that the implementation of synergetic measures may encounter greater institutional complexity, which could limit the efficacy of the measure itself.

IV. Sea Level Rise and Mangroves

While mangrove restoration is touted as a CCD option, mangroves themselves are highly vulnerable to sea level rise (McLeod and Salm, 2006; Elison and Lovelock, 2007; Alongi, 2008; Duke et al., 2008). As such, the continuous provision of the triple-win benefits hinge on the

ability of mangroves to adapt to sea level rise; either through an increase in soil surface elevation or by colonising more landward areas (McIvor et al., 2013:5). However, most mangrove sediment surface elevations are not presently keeping pace with sea-level rise globally (Duke et al., 2008). Additionally, the ability of mangroves to migrate landward is also determined by local conditions, such as infrastructure (e.g. seawalls) and topography (McLeod and Salm, 2006). Where physical obstructions prevent landward migration, mangroves may revert to narrow fringes or perish altogether (Gilman, 2004).

While sea levels have risen at an average rate of 1.8 mm/yr globally (McGuire, 2013:34), in Guyana, mean sea level has increased by 10.2 mm/yr since 1951 (Leung, 2010:21). Added to which, although sediments are currently available, Anthony and Gratiot (2012) indicate that the rate of sediment trapping by mangroves along Guyana's coast does not appear to be keeping pace with sea level rise, wherein, the quantity of sediment trapped is negligible (less than 1%), in comparison to the overall volume of a typical mud bank (up to 6000 million m^3). Furthermore, the possibility for landward migration of mangroves also presents a formidable challenge in Guyana. As highlighted by various studies (Dalrymple and Pulwarty, 2006; Hollowell, 2009; GoG, 2010), the ability of mangroves to shift their boundaries in response to sea level rise in Guyana is physically impossible due to the coastal zone's high population density (coastal squeeze), and the presence of hard sea defense structures (e.g. seawalls) which currently border the coastline (See Figure 3).

During the present study, field visits conducted to each of the GMRP's intervention sites in Region 4 (7 sites) on July 02, 2013, confirmed the above descriptions. Each of the sites visited were heavily armored by masonry seawalls, and evidence of natural mangrove regeneration occurring immediately in front of the seawall was observed at several locations (See Figure 3). Whether such observations are an indication of mangroves' response to current sea level is unclear, but what is for certain, is that mangroves in Guyana are not capable of shifting their boundaries further in response to projected sea level rise. It is for this reason that the present study opines that the long-term achievement of the triple-wins may not be possible for Guyana, given the likelihood that mangroves may become incompatible under the conditions of a changing climate. Furthermore, the possibility of a dieback of mangroves in Guyana may also trigger a cascade of impacts: increased emissions and vulnerability, and reduced developmental

opportunities. In effect, mangrove restoration, though touted as a cost-effective solution, may in fact lead to overall cost-ineffectiveness in the long term for Guyana. In light of the decreasing likelihood that mangroves would be resilient under projected sea level rise, Dalrymple and Pulwarty (2006:8) suggest that it is perhaps more plausible for Guyana to adopt coastal protection measures which can be adapted to changing sea level conditions e.g. increasing the height of the seawall; an option which may not generate a triple-win, but may be in the better interest of the country. In this regard, the present study is therefore in agreement with both Dessai et al. (2005) and Grist and Jones (2012:12) who noted that synergetic opportunities may not necessarily represent a wise investment in the long term, or the most effective solution, since the net benefit of investing in such pathways (triple-wins), may well be smaller than when funds are otherwise invested in more efficient adaptation or mitigation-specific options in the first place. Added to which, the present study also corroborates the findings of Tompkins et al. (2013) who suggested that the local conditions under which mangrove restoration is applied will largely determine the extent to which the triple-win benefits can be successfully harvested.

Figure 3: Natural mangrove regeneration observed in front of the sea wall at La Bonne Intention (LBI), East Coast Demerara (Region 4)– landward migration is physically impossible due to the presence of the seawall (Photo taken: July, 02, 2013)

Based upon the preceding discussion, it is clear that while ongoing mangrove restoration/ protection efforts in Guyana present a unique opportunity for bridging the country's adaptation, mitigation and development priorities, the long term achievement of the triple-win does not appear possible. By extension, Guyana may not be able to promote Climate Compatible Development using this particular approach. Such a pessimistic outlook is premised on the fact that, although mangrove restoration/ protection is capable of producing a triple-win, such an option also comes packaged with a spate of regrets (tradeoffs) and challenges; which do not appear to resonate well in the local context, but rather, create the fertile conditions for undermining the achievement of the triple wins.

Furthermore, although the conceptual model of CCD (Figure 2) emphasizes that adaptation, mitigation and development goals can mutually coexist and reinforce each other, this study has shown that such a unifying landscape is more or less a fallacy, as striking a balance between these three dissimilar approaches in reality can evidently generate significant regrets (tradeoffs) and challenges at the same time of producing triple-wins. Moreover, while the donor-community remain fixated on advocating for the adoption of triple-win initiatives (e.g. mangrove restoration), in an attempt to improve cost-effectiveness, the country-level analysis presented in this paper has adequately demonstrated that, a heavy focus on supporting synergetic opportunities (e.g. mangrove restoration) does not necessarily guarantee the most effective solution (in the recipient country), and may in fact, overshadow the underlying priority needs (coastal protection) of poor developing countries like Guyana. Furthermore, mangrove restoration as a CCD option should not be regarded as a one size fits all approach, especially since it is the governance context and local conditions under which the policy or project is implemented that will determine whether a triple-win can be successfully harvested without regrets and challenges; conditions which are likely to vary from country to country. It is by this very nature that this study concludes that, while the notion of a triple-win using mangrove restoration is appealing and optimistic, as a panacea for addressing coastal protection under a changing climate, it remains highly contentious and context specific.

6.0 CHAPTER 6: CONCLUSION

There is growing recognition that Climate Compatible Development (CCD) is essential if developing countries are to address the impacts of climate change, while continuing to develop. However, there is inadequate, robust empirical evidence which demonstrate what CCD may look like in practice across diverse contexts and scales, and more importantly, whether such a pathway may generate concurrent, negative impacts and tradeoffs at the same time of producing triple-wins. This study has attempted to address this research gap by examining CCD through the lens of mangrove restoration in Guyana.

Following an in-depth analysis of an existing mangrove restoration initiative in Guyana, this study has shown that this particular approach of coastal protection is capable of generating synergies and multiple benefits for climate change adaptation (shoreline protection), mitigation (carbon sequestration), and development (REDD+ financial incentives, enhanced ecosystem services and improved livelihoods). However, the long term achievement of these triple-wins and subsequent promotion of CCD in Guyana may not be possible. This is due to the fact that, mangrove restoration comes packaged with a spate of regrets (tradeoffs) and challenges which do not appear to resonate well in Guyana, but rather, serve to undermine the achievement of the triple-wins. As such, this study therefore cautions that the successful adoption of mangrove restoration as a CCD initiative elsewhere will largely depend upon the governance context and local conditions under which this option is applied. In effect, a triple-win induced through mangrove restoration is highly context specific.

While this study has unpacked and exemplified the synergies and tradeoffs associated with mangrove restoration in Guyana, it has not determined whether the benefits/ regrets derived from such synergetic opportunities are larger or smaller in relation to other coastal protection strategies e.g. ‘hard’ sea defense structures, or when adaptation, mitigation and development actions are pursued separately. This limitation represents a significant research gap that warrants further assessment. Given the vague and contentious nature of CCD, additional research is critical in order to strengthen the theoretical guidance to the development community, regarding the implications of supporting triple-win strategies. In the absence of a strong evidence base, there is a risk that the development community may continue to prioritize investments in

policies/ projects which create triple-wins with regrets at the expense of more effective policies that might only deliver co-benefits, but with low or no-regrets.

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APPENDIX 1

Interview Schedule

GMRP Secretariat Staff (Personal Communications)

1. How does mangrove restoration/protection contribute to addressing climate change mitigation, and adaptation in Guyana?
2. What empirical evidence currently exists to justify the role of mangroves in shoreline protection in Guyana?
3. What are the development benefits of mangrove restoration/protection in Guyana?
4. To what extent is legislation enforced to protect mangroves in Guyana?
5. Describe the effectiveness of the current institutional framework for mangrove management, and how has this impacted on protection efforts to date.
6. Which extractive uses of mangroves still require alternative sources/ substitutes to be identified?
7. Which areas currently represent the largest exploitation of mangroves in Guyana?
8. Does the alternative livelihood programme target the areas noted in question 7?
9. To what extent do you consider the current alternative livelihood opportunities to be economically viable compared to the commercial uses of mangroves?
10. Do you think that the current activities promoted in the alternative livelihood programme would appeal to those persons engaged in commercial activities?

Mangrove Rangers (Personal Communications)

1. Which intervention site do you currently provide monitoring services for?
2. Prior to the GMRP's intervention efforts, what type of sea defences previously existed in your monitoring area?
3. Describe the baseline condition of the sea defences in your monitoring area. In particular, did the area previously experience wave-overtopping, breaches, inundation under the baseline conditions?
4. What differences have you observed in (wave-overtopping, breaches, inundation) your monitoring area following mangrove restoration/ protection efforts?

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