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# Ecotourism and Water Quality: Linking Management, Activities and Sustainability Indicators in the Caribbean

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Ecotourism and Water Quality: Linking Management, Activities and Sustainability Indicators in the Caribbean

by

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## Dedication

To Dora, Darrion, Kristen and Jayden

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If I were to list everyone that has aided in bringing me to this point, then this will be the biggest section of this work. Since only a single page is allowed, the persons of most recent memory are highlighted below but by no means or measure represents everyone that deserves thanks. To those persons, too numerous to mention, a heart felt thank you for your efforts in bringing me through the preparation of this work.

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## TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

ECOTOURISM AND WATER QUALITY: LINKING MANAGEMENT, ACTIVITIES AND SUSTAINABILITY INDICATORS IN THE CARIBBEAN.

Ken Darrie Thomas

ABSTRACT

Ecotourism from its genesis and founding theories has been set out to conserve and preserve the environment through sustainable operation that includes surrounding communities in efforts to reduce their poverty levels. Over the years ecotourism has been hypothesized to have departed from this ideal with several researchers, through social, qualitative analyses, have said that these non-sustainable ecotourism operations are simply due to poor management. This work sought to test this central hypothesis as a first approach to quantitatively linking ecotourism activities to management with surface water quality as the key indicator of sustainable ecotourism as a complex system through systems thinking. This pilot work was done by the use of two study sites in the Caribbean: Iwokrama, Guyana and Greencastle, Jamaica.

From General Systems Theory, before systems dynamics can be applied there is a need to first observe components of the system in a reductionist view. This approach had to be taken also since the required data inputs for the systems approach were not available, as is the norm throughout the Caribbean. Thus by creating simple, easy-to-use and transferrable sustainability indicator based reductionist-type assessment tools relevant data on ecotourism activities, management and water quality can be obtained in

the future and acts as a start to understanding the true systems dynamics among these three entities. The creation of these quantitative reductionist tools utilized social surveying onsite, target plots, sustainability indicators and Social Network Analysis. Tools created were tested through what-if scenarios, with sensitivity analyses, and determined to be able to respond to societal, environmental and economic changes.

The basic findings of these reductionist tools were used to establish and initial pathway for quantification inclusive of a framework in STELLA® for the numerical linking of ecotourism management, water quality and sustainability indicators in the Caribbean. This work also established water quality baselines for both study sites through in situ water sampling and testing and further ex situ analysis. As an indirect systems approach to linking sustainable development and the Caribbean, an audit of the Caribbean's primary and secondary school's system was conducted and recommendations suggested for the infusion of sustainability into formal education both during and after the United Nations Decade for Education for Sustainable Development (2005-2014).

# CHAPTER 1: INTRODUCTION

## 1.1 Motivation

Ecotourism was originally driven by the need to sustain biodiversity, reduce poverty and generate income for communities and has emerged in very rural and remote areas throughout the world (Manson, 2008). Ecotourism, in theory, was conceptualized as a resolution of tourism and environmentalism with sustainability being at its very core. Several countries promote ecotourism to attain Goal 7 (i.e. Ensure Environmental Sustainability) of the United Nations Millennium Development Goals (UNMDGs). However, the movement of people, capital, goods and services into many rural and remote areas of the world has caused different types of ecosystem changes amid the growing global climate of ecotourism. The World Tourism Organization (WTO) emphasizes the need to study and quantify the impacts of the ecotourism industry as they have found that ecotourism's extensive and intense human activity has altered the balance of ecosystems to the detriment of the natural environment in several global destinations. The management and planning aspects of ecotourism have now come under scrutiny by the WTO.

The Caribbean Tourism Organization (CTO) believes that most of the interest in ecotourism throughout the Caribbean by stakeholders stems from several lucrative governmental incentives (inclusive of tax holidays, interest free government loans and no import duty on industry related goods) rather than true care about environmental protection and sustainability (CTO, 2006a). Coupled with the fact that the global ecotourism industry is growing at a rate of approximately 20% per year (TIES, 2009) more rigorous monitoring of the industry is needed.

This need for ecotourism industry impact monitoring was the key catalyst the WTO utilized in rationalizing its need to hold the 2002 World Ecotourism Summit in Quebec, Canada and have the United Nations declare 2002 the International Year of Ecotourism; which played well into the United Nations' declaration of the Decade of Education for Sustainability Development (2005-2014). According to the Caribbean Tourism Organization (CTO), ecotourism in the Caribbean, even till now, has focused on marketing and enhancing global appeal without major concern for the non-financial impacts of the industry (Denman, 2008). There is need for the Caribbean to study the impact that ecotourism has with a reductionist-type framework first; however the use of the sustainability umbrella for assessment of the ecotourism components of interest makes the conventional reductionist approach less myopic and more systematic in its thinking (Stewart, 2006). Once this can be implemented, data generated can be used for the development of systems approaches to ecotourism.

## 1.2 Problem Definition

There is a lack of quantification in the tourism and ecotourism industries. Most of the literature involved with this industry are social and offer qualitative measures in the realm of social sciences. The lack of current environmental and social data collection and historical data in the Caribbean necessitate reductionist approaches to assessing the various aspects of the ecotourism industry and in the meanwhile collecting relevant information to do systems dynamics studies.

The management of tourism impacts on water resources has received comparatively little attention from the scientific community, other than from a public health stand point (Ceballos-Lascurain, 1996; Holden, 2000). However, land-use planning in relation to water quality and point and non-point source pollutants, and to methods of managing eutrophic recreational waters, is frequently mentioned in literature concerning tourism and ecotourism (Holden, 2000; Manson, 2008). Protection of surface waters is of extreme importance since most Caribbean territories are totally dependant on them as a source for treatment to drinking water standards.

As in most spheres of development the Caribbean region lags much of the world according to the United Nations Development Programme's 2009 Human Development Index Spectrum. Despite the lack of much needed tourism and ecotourism data, this work provides tools that are applicable even now in the Caribbean to assess the sustainability of ecotourism. It considers the impact of ecotourism on surface water quality of ongoing and planned ecotourism activities and management structure.

### 1.3 Research Objectives

The overall goal of this dissertation was to increase the state of sustainability in Caribbean ecotourism directly by the use of sustainability indicators and indirectly through inculcation of sustainability principles into the Caribbean's formal education structure. With respect to the assessment tools, it was of paramount importance to create quantitative tools for application throughout the Caribbean's ecotourism sector that are easy to use and transferrable throughout the region. This study will subliminally test the ecotourism management structure for improved environmental protection and preservation through the use of 2 Caribbean study sites (Iwokrama, Guyana and Greencastle, Jamaica) with differing management structures (i.e. non-governmental and self-autonomous government related). Some of the more specific objectives to attempt to meet this goal are identified below.

### 1.3.1 Ecotourism Activities

- Identify sustainability indicators of ecotourism activities in the Caribbean.
- Develop an integrated assessment tool for measuring the sustainability of ecotourism activities in the Caribbean.
- Test the tool created by use of scenarios then utilize sensitivity analysis for analysis.
- Use the Monteverde, Costa Rica ecotourism example as a model to make recommendations on how to improve the sustainability of ecotourism activities in the Caribbean.

### 1.3.2 Management of Ecotourism

- Identify appropriate methods to quantify the site-specific strength of ecotourism management structure by using 2 Caribbean study sites.
- Identify sustainability indicators, for the development of an assessment tool, and for the management of ecotourism in the Caribbean at the national and/or county level.
- Use Social Network Analysis (SNA) to devise a method to quantify the strength of an ecosite's management.

### 1.3.3 Measuring Surface Water Quality

- Develop baseline water quality data at both Caribbean study sites.
- Use field sampling and testing as a teaching tool to train ecotourism staff at both sites on water quality testing.
- Create a conceptual model of watershed water quality management for the ecotourism industry in the Caribbean.

#### 1.3.4 Pathway to Understanding the Dynamics of Ecotourism Activities, Onsite Management and Water Quality

- Develop a region specific pathway to obtaining the information to map the dynamics of ecotourism activities, management, sustainability indicators and water quality.
- Explain the construction of a STELLA® framework that links ecotourism activities, inclusive of visitor impacts, and management with water quality.
- Provide a first approach model that can expand depending on a site's water quality indicators.

#### 1.3.5 Sustainability in Caribbean Education

- Identify what is currently being done to teach sustainability at primary and secondary school levels.
- Develop a framework to incorporate concepts of sustainability into select subject curriculum.
- Recommend the path that needs to be taken to get recommendations implemented.

### 1.4 Scope of Work and Approaches

Both the preliminary and theoretical nature of this study, as well as the infancy of relevant data collection in the Caribbean, led to the consultation of developed recommendations for tourism sustainability indicators by the World Tourism Organization (WTO); environmental sustainability indicators by the UNMDG Committee and the United Nations Department of Economic and Social Affairs (UNDESA), among others. The general indicators provided by these institutions were scrutinized for applicability to the Caribbean's ecotourism setting before choice.

This work represents a first approach to the application of sustainability to ecotourism in the Caribbean as a function of its management; quantification of ecotourism impacts with regards to management and ecotourism activities; development of a water quality model for ecotourism that considers management as well as the incorporation of sustainability issues into formal education (i.e. primary and secondary) in the Caribbean. Sustainability by definition implies treating any entity under consideration like a business. As such the conventional business tool Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis was incorporated to assess the link between ecotourism activities, its management and surface water quality for overall sustainability of ecotourism. Given that this is the Decade of Education in Sustainable Development, a relevant approach to achieve the UNMDG of Ensuring Environmental Sustainability, includes the education of Caribbean students at levels that most of the population typically attain (i.e. primary and secondary education). This bottom-up approach will train future ecotourism employees, and as many citizens as possible, in core sustainability concepts that can benefit them for life. The diffusion of this knowledge will help to ensure that all of the engineering innovations enhance sustainability and have a higher potential for adoption.

### 1.5 Expected Contributions

The work contained herein can have the following contributions:

- Development of reductionist assessment tools for ecotourism activities and management that each incorporates social, environmental and economic impacts. Results can be used by ecohotels, ecotourism certification bodies and legislative agencies as a guide for planning and decision making.
- Creation of a pathway for development of a water quality model framework which assesses the sustainability of ecotourism operations in the Caribbean as a function of management.

- Provision of ideas to introduce the principles of sustainability to Caribbean primary and secondary school students through curriculum development.

## 1.6 Dissertation Structure

Inclusive of this chapter, this dissertation has 9 chapters. Chapter 2 gives the background and scope of the work done through use of a literature review. Materials and Methods are described in Chapter 3 inclusive of laboratory, field and social techniques utilized and/or developed. Chapter 4 assesses Ecotourism Activities to develop a framework for quantitative analysis of the sustainability of ecotourism in the Caribbean. Similarly, Chapter 5 highlights the Management of Ecotourism through the use of a modified network framework for analysis of strengths and weaknesses. In Chapter 6, Measuring Surface Water Quality as an Ecotourism Sustainability Indicator, background monitoring data is presented along with a conceptual model to improve water quality management for the Caribbean's ecotourism industry. The pathway for the development of modeling framework to link ecotourism activities in the Caribbean to management structure and water quality, by the use of the systems thinking software STELLA®, is explored in Chapter 7. Sustainability in Caribbean education is the focus of Chapter 8 and provides the framework for inculcating sustainability into primary and secondary school curriculum. Chapter 9 gives an overview and summary of the dissertation along with avenues for future propagation of this work. This work combines the disciplines and sub-disciplines of environmental engineering, social studies and education.

# CHAPTER 2: BACKGROUND

## 2.1 Introduction

### 2.1.1 Ecotourism: Definition and Associated Issues

The ecotourism concept dates back to the 1960's when ecologists and environmentalists became concerned over the inappropriate use of natural resources (Fennell, 2003). The preservation of biodiversity was threatened in favor of economic interest and the exploitation of natural resources. The ecologist Hetzer introduced the term 'ecotourism' and identified four normative principles in 1965. According to Hetzer ecotourism should have minimum environmental impact, minimum impact on – and maximum respect for – host cultures, maximum economic benefits to the host country's grassroots, and maximum recreational satisfaction to participating tourists (Higham, 2007).

The International Ecotourism Society, TIES (2001) offers a succinct and widely accepted definition:

*Ecotourism is responsible travel to natural areas that conserves the environment and sustains the well-being of local people.*

The World Conservation Union (IUCN) also provides a slightly expanded description of ecotourism's key characteristics:

*[Ecotourism is] environmentally responsible travel and visitation to relatively undisturbed natural areas, in order to enjoy and appreciate nature (and any accompanying cultural features – both past and present) that promotes conservation, has low visitor impact,*

*and provides for beneficially active socio-economic involvement of local populations (cited in Brandon, 1996).*

The above definition and expanded description have been used in forming this study. There are several different definitions and descriptions of the term ecotourism, but they all are hinged on the underpinnings of Hetzer. These definitions and descriptions have been studied by several scholars and some key findings are presented below in Table 2.1.

**Table 2.1** Recurring ecotourism dimensions, themes and components (adapted from Higham, 2007).

| Fennell (2003) | Diamantis (1999) | Sirakaya et al. (1999) |
|---|---|---|
| Interest in nature | Nature-based component (protected and non-protected natural areas) | Environmentally friendly tourism |
| Contribution to conservation | Sustainable management component (nature-centered approach) | Educational travel |
| Reliance on forested areas inclusive of protected ones | Educational/interpretation component (educational programs) | Low-impact travel |
| Benefits local people/long term benefits | | Recreational and romantic trips to natural sites |
| Education development and creation of programs and ecotourism research | | Contributions to local welfare |
| Low impact/non-consumptive, ethical and responsible management | | Ecocultural travel; sustainable/non-consumptive tourism |
| Sustainable operations | | Responsible business approach to travel |
| Appreciation/enjoyment and respect for culture | | Community involvement |
| Outdoor/nature adventure | | Tourist involvement in preservation |
| Small scale | | Contribution to conservation |

In 2002, after the international conference for the United Nation's International Year of Ecotourism, the Quebec Declaration on Ecotourism was presented (World Ecotourism Summit, 2002) and stated that ecotourism:

*'embraces the principles of sustainable tourism, concerning the economic, social and environmental impacts of tourism. It also embraces the following specific principles that distinguish it from the wider concept of sustainable tourism:*

- *contributes actively to the conservation of natural and cultural heritage;*
- *includes local and indigenous communities in its planning, development, and operation and contributing to their well-being;*
- *interprets the natural and cultural heritage of this destination to visitors;*
- *lends itself better to independent travelers, as well as to organized tours for small size groups.'*

What ecotourism should be, according to ideas of sustainability and best practice in development (both of which are contested terrain), does not always coincide with how ecotourism actually operates in reality. The resulting gap between theory and practice is a major source of dissatisfaction with ecotourism-both within the academic world (Cater, 2004; Duffy, 2002; Ross and Wall, 1999; Cater, 1994; Whelan, 1991) and within communities and non-governmental organizations (World Ecotourism Summit, 2002). Despite the issues that persist with sustaining ecotourism globally the industry continues to thrive with few checks and balances in place to ascertain negative impacts on ecosystems, etc..

## 2.2 Global Ecotourism

Since the 1990s, according to TIES, ecotourism has been growing annually at a rate of 20%-34% on the global scale (TIES, 2001). In 2004 TIES published that ecotourism/nature tourism was expanding 3 times quicker than the entire tourism industry globally. Sun-and-sand tourism is considered to have “matured as a market” and its trajectory is projected to remain a plateau. The converse is true when considering experimental tourism. This form of tourism includes ecotourism, nature, heritage, cultural and soft adventure tourism, as well as sub-sectors such as rural and community tourism. Experimental tourism, inclusive of ecotourism, is among the industries projected to grow exponentially over the next 20 years. The United Nations Environment Programme (UNEP) and Conservation International (CI) have indicated that most of tourism’s expansion is occurring in and around the world’s remaining natural areas. Sustainable ecotourism could grow to 25% of the world’s travel market within 6 years, taking the value of the sector to US$473.6 billion a year. Tourism market analysts have predicted an upsurge in eco-resorts and hotels, and a spike in nature tourism. The nature tourism sector is already growing at 20% a year. The predictions of the analysts suggest that early converts to sustainable tourism, inclusive of ecotourism, will secure market gains.

The ecotourism sector, though considered in its youth, has proven to be very economically lucrative in many parts of the world. Some key statistics from the International Ecotourism Society (TIES, 2001) alluding to this are:

- “In Dominica, “stay over” tourists using small, nature-based lodges spent 18 times more than cruise ship passengers spend while visiting the island.
- At Indonesia’s Komodo National Park independent travelers spend nearly US$100 locally per visit; package holidaymakers spend only half this. In contrast, cruise-ship arrivals on average spend US$0.03 in the local economy.
- 80% of the money for all-inclusive package tours goes to airlines, hotels and other international companies. Eco-lodges typically hire and purchase locally and sometimes put as much as 95% of money into the local economy.”

The overall steering of global ecotourism is encompassed under the basic mandate of the United Nations' World Tourism Organization (WTO). This organization was established in 1925 promotes the development of responsible, sustainable and universally accessible tourism, paying particular attention to the interests of developing countries. Since its inception, the WTO has encouraged countries to first become members then to establish governmental management structures for internal management of tourism management and marketing, inclusive of ecotourism. The WTO encourages the implementation of the Global Code of Ethics for Tourism, with a view to ensuring that member countries, tourist destinations and businesses maximize the positive economic, social and cultural effects of tourism and fully reap its benefits, while minimizing its negative social and environmental impacts. Interesting to note is that Jamaica is a member of the WTO, but Guyana is not. This may be attributed to the sizeable annual membership fees and its nascent tourism industry.

### 2.2.1 Ecotourism in the Caribbean

The Caribbean region has traditionally been associated with 'sun, sand and sea' tourism since it is the largest revenue earner for over 10 Caribbean countries and a major foreign exchange earner for most. As such, all Caribbean countries have some governmental Ministry devoted to tourism, inclusive of ecotourism, for the management, marketing and sustainability of the industry on a country basis. Though the WTO has international level support for every member country, the Caribbean Community (CARICOM) created a Caribbean Tourism Organization (CTO) which provides intellectual support for individual Caribbean member countries on strengthening their tourism products.

Environmental preservation of biodiverse and unique ecosystems has many challenges in the 21st century and ecotourism is one tool that attempts to sustainably preserve natural habitats (TIES, 2001). The multibillion dollar worldwide ecotourism industry is growing at a rate of 20% per year and models on how ecotourism activities are best administered and managed to achieve environmental preservation are limited and quantifiable measures of the impact on water quality do not exist. The upsurge of global environmental awareness has pushed most Caribbean and Latin American territories to advertise ecotourism (CTO, 2006), however, only a few have a national technical framework that protects the pristine/unique ecosystems. The Caribbean Tourism Organization (CTO) believes that most of the interest in ecotourism by stakeholders has come from several lucrative governmental incentives (inclusive of tax holidays, interest free government loans and no import duty on industry related goods) rather than true care about environmental protection and sustainability (CTO, 2006).

Similar to the structure of Ecotourism Societies in the United States, several organizations exist to attempt to sell a sustainable tourism product. Most of these organizations focus on conventional type coastal/resort tourism (eg. Blue Flag, Caribbean Tourism Development Company) and only dabble in the sphere of ecotourism. As such, not much data is collected on ecotourism visitation in the Caribbean and it is typically lumped under ‘tourism statistics’. Nevertheless, according to TIES, Dominica leads the Caribbean in the development of a saleable, sustainable ecotourism product. To ensure the continuation of a sustainable product there is need for increased awareness of the complex system that affects the longevity of indigenous flora and fauna, upon which successful ecotourism depends (Tremblay, 2008).

## 2.3 Study Sites

The 2 sites chosen for this study were similar, besides both being located in the Caribbean Community (CARICOM); in that they are both young in the ecotourism business and both have desires of implementing water quality monitoring programs. The sites represent the differences that are expected to be found among any Caribbean ecotourism sites. The Guyana site is land-locked, expansive with vast rivers, densely forested, remote and is considered pristine according to Conservation International. The Jamaica site, on the other hand, is much smaller, coastal, rural (but not remote), onsite rivers are very small in length and breadth and the site has a history of non-sustainable onsite farming practices. The sites are also in the 2 geographical extremes within the Caribbean; that is Jamaica is a small island developing state while Guyana, an underdeveloped country, is on the continent of South America. The Jamaica site's ecotourism product is managed by a non-profit non-governmental organization (NGO) while the Guyana site's ecotourism activities are run by a government affiliated autonomous non-profit body. The intrinsic differences between these 2 sites – physical terrain and geography coupled with management structure, historical and present land usage and ecotourism product offerings - encapsulate the myriad of differences that are known to be found at typical ecotourism sites throughout the Caribbean region. See Appendix C for photos from both sites.

### 2.3.1 Greencastle Estate, Jamaica

Greencastle estate is a 1600 acre (6.47 $km^2$) property on Jamaica's northeast coast between the Blue Mountains and the sea (see Figure 2.1) located in the parish of St. Mary. Greencastle Estate offers ridge to coast tourism, making it attractive to the typical ecotourist, the coastal ecotourist, as well as the sun-sea-and-sand tourist.


**Figure 2.1** General location of Jamaica in the Caribbean region (red circle in insert) and Greencastle Estate in Jamaica (red star) (CIA, 2008).

The estate is currently owned by a single non-Jamaican and the ecotourism activities are managed by the non-profit NGO called Greencastle Tropical Study Center (GTSC). GTSC was created in 2005 to develop a dynamic model for Jamaican economic viability through agricultural sustainability, ecotourism, research and education. A saleable ecotourism product has been marketed at Greencastle since 2005.

GTSC's envisions becoming a leading resource for information and education that brings significant and lasting improvements to Jamaica's economy, the quality of life of its people and the preservation of its ecosystems. Its mission is to provide education and practical solutions to Jamaica's rural communities by researching, developing and demonstrating economically viable and environmentally sustainable agricultural practices, and empowering stewardship and preservation of Jamaica's diverse ecosystems. GTSC has formed several partnerships with the communities surrounding Greencastle Estate (i.e. Robin's Bay and Rosend), lessees, governmental and non-governmental organizations and national and international academic institutions. GTSC has partnered with the University of the West Indies's Mona, Jamaica campus to be used as a study site for courses offered through the Center for Marine Sciences as well as the Departments of Biology and Ecology. The University of Minnesota offers study abroad experiences for undergraduate and graduate students registered for certain classes offered through the Department of Fisheries, Wildlife and Conservation Biology as well as the Department of Sustainable Agriculture. It is through these academic partnerships that GTSC has begun collecting small amounts of water quality data at limited and variable sample sites at least once annually.

Population of Robin's Bay and Rosend are not well defined under Jamaica's census categorization but the St. Mary population reported in the 2008 population census results was 114, 317 which represented 4.246% of the Jamaican population at that time (Statistical Institute of Jamaica, 2009).  St. Mary is Jamaica's fifth smallest parish covering an area of 634 $km^2$. The parish has a variety of agricultural resources with principal products being bananas, sugar, citrus, pimento, cocoa, coconuts and coffee. The agricultural industry operates on a large scale necessitating major roads and highways throughout the parish. As a result the parish is zoned by the government as a rural agricultural, residential and industrial area. The principal rivers from east to west are the Dry River, the Wag Water, the Rio Nuevo and the White River (CIA, 2008).

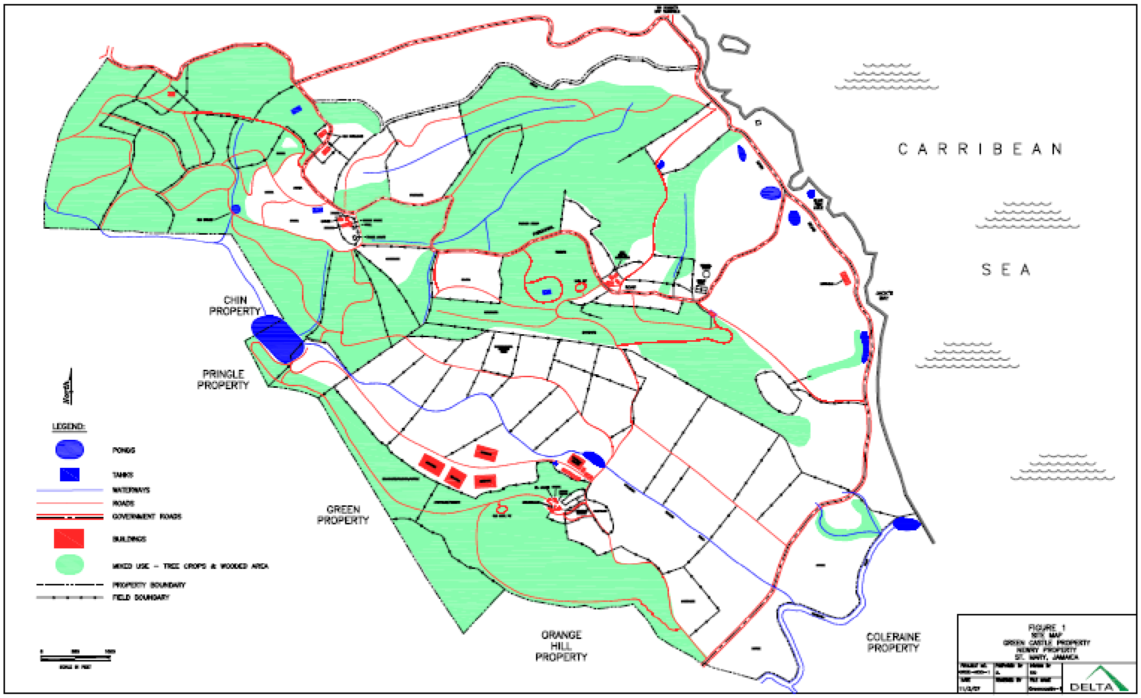



**Figure 2.2** Plan view of the Greencastle Estate. (Source: Mrs. A. Dickson of GTSC)

Figure 2.2 shows the fresh water features of the Greencastle property. The features are comprised of ponds, rivers and a swamp. However the features are all very small in comparison to the Guyana site (see site photos in Appendix C). The rivers onsite are on average 0.5 to 2 m wide except where they empty into the sea. Depths are estimated to range from 0.2 to 2.5 m.

### 2.3.2 Iwokrama, Guyana

This interior region of Guyana, located in Region 8 (see Figure 2.2), is 3710 $km^2$ of forest (1.6% of Guyana's landmass and 2% of Guyana forests) and it is managed by the Iwokrama International Center for Rainforest Conservation and Development (IIC). IIC is a self-autonomous non-profit organization governed by an international Board of Trustees. IIC was established in 1996 under a joint mandate from the Government of Guyana and the Commonwealth Secretariat to manage the Iwokrama forest. The entire forest area is split into a Sustainable Utilization Area (SUA) and a Wilderness Preserve (WP) as demarcated in Figure 2.4.


**Figure 2.3** General location of Guyana in the Caribbean region (red landmass in insert) and Iwokrama in Guyana (red star) (CIA, 2008).

IIC intends to become the leading international authority on development of models for commercially sustainable, practical and community-inclusive conservation businesses based on tropical forests and their natural assets. IIC's mission is to promote conservation and the sustainable and equitable use of tropical rainforests in a manner that will lead to lasting ecological, economic and social benefits to the people of Guyana and to the world in general by undertaking research, training and the development and dissemination of technologies.

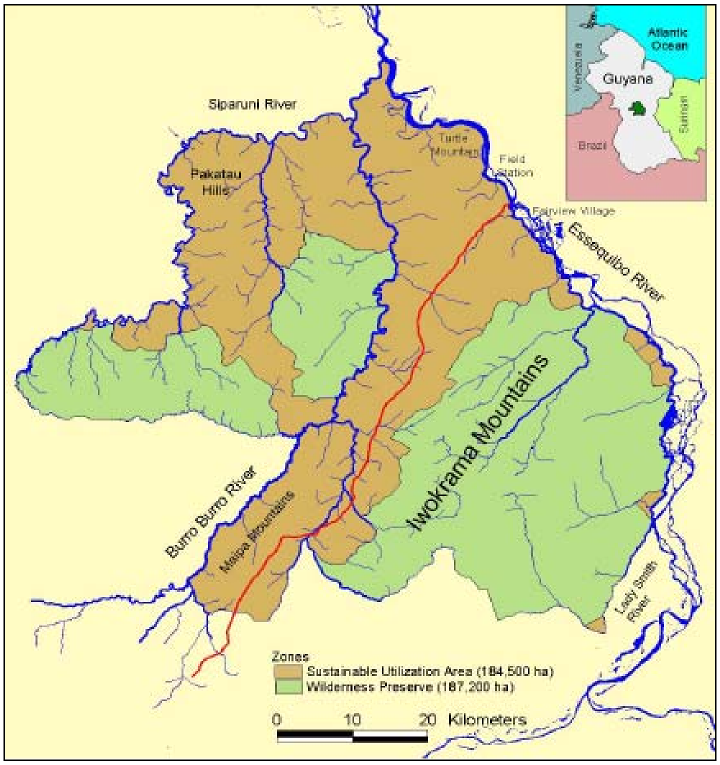



**Figure 2.4** Location of some of the surface water features of the Iwokrama Forest (IIC, 2004).

Besides its ecotourism venture, Iwokrama has an ongoing timber business that involves a number of the surrounding communities inclusive of Fairview Village which actually lies entirely within the Iwokrama forest boundary. Fairview Village owns 22,000 hectares of Iwokrama forest. The timber business and ecotourism only operate in areas designated as SUAs. Note that IIC is involved in the timber business with 16 other surrounding communities, most of which lie in Region 9 and is zoned as remote and a rural forested area. From the results of the most recent population and census done by the Guyanese Bureau of Statistics in 2002, it was found that Regions 8 and 9 had the second highest poverty marginality index zoning of 1.98 to 2.05 with the richest region having areas with an index value of -0.14 (Bureau of Statistics of Guyana, 2004). The 16 villages surrounding Iwokrama are comprised completely of indigenous people in low population density. The population structures of these villages are given in Table 2.2.

**Table 2.2** Population structure of communities surrounding Iwokrama by age. (Source: Dr. R. Thomas of IIC)

| Village | Age (years) | | | | | | | | | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|
| | <1 year | 1-4 | 5-14 | 15-19 | 20-25 | 26-29 | 30-44 | 45-64 | 64+ | |
| Apoteri | *16* | *40* | *142* | *18* | *16* | *13* | *26* | *25* | *22* | **328** |
| Rewa | *6* | *31* | *56* | *20* | *17* | *10* | *29* | *17* | *0* | **194** |
| Crashwater | *5* | *23* | *46* | *39* | *24* | *21* | *23* | *19* | *3* | **204** |
| *Annai District:* | | | | | | | | | | |
| Rupertee | *8* | *35* | *81* | *36* | *37* | *8* | *30* | *26* | *7* | **275** |
| Kwatamang | *18* | *46* | *82* | *36* | *32* | *22* | *38* | *48* | *10* | **330** |
| Wowetta | *5* | *39* | *88* | *25* | *37* | *20* | *30* | *28* | *9* | **281** |
| Surama | *11* | *41* | *61* | *26* | *27* | *12* | *42* | *15* | *6* | **242** |
| Annai Central | *17* | *47* | *132* | *49* | *49* | *36* | *61* | *61* | *18* | **472** |
| Massara | *17* | *46* | *103* | *43* | *42* | *24* | *42* | *37* | *9* | **381** |
| Toka | *8* | *26* | *60* | *33* | *14* | *13* | *29* | *14* | *10* | **210** |
| Yakarinta | *17* | *63* | *138* | *61* | *43* | *23* | *66* | *66* | *17* | **495** |
| Yupukari Central | *14* | *85* | *96* | *58* | *41* | *61* | *48* | *44* | *22* | **469** |
| Kwaimatta | *4* | *21* | *40* | *10* | *8* | *7* | *10* | *3* | *2* | **131** |
| Fairview | - | - | - | - | - | - | - | - | - | **186** |
| Katoka | *24* | *97* | *150* | *45* | *45* | *30* | *72* | *42* | *10* | **515** |
| Aranaputa | - | - | - | - | - | - | - | - | - | **491** |
| **Total** | **170** | **640** | **1275** | **499** | **432** | **300** | **546** | **445** | **145** | **5204** |

The Iwokrama forest is drained by the Essequibo River and 2 smaller rivers, the Burro-Burro and Siparuni, which are briefly confluent before joining the Essequibo. It is bordered to the east by the Essequibo River and to the north and west by the Siparuni River. The Burro-Burro River runs through the central part of the Iwokrama forest. Approximately, 1500 $km^2$ of the Iwokrama forest drain directly to the Essequibo River, 1500 $km^2$ to the Burro-Burro and 900 $km^2$ to the Siparuni River (Hawkes and Wall, 1993).

According to Watkins et al. (2005), in the vicinity of the Iwokrama forest the Essequibo River has main channels 250–500 meters wide and is at most approximately 1 km wide. It is characterized north of Kurupukari Falls by extensive sand bars that are visible during low water. In several places throughout the Iwokrama forest, it is crossed by volcanic dykes that form rapids. The Essequibo has a probable maximum depth of 40 m (Hawkes and Wall, 1993), and its banks are not high except where scouring has occurred (Hawkes and Wall, 1993).

### 2.4 Ecotourism and Sustainable Development

According to Mihelcic et al. (2003), sustainable development is the design and use of human and industrial systems to ensure that humankind's use of natural resources and cycles do not lead to diminished quality of life due either to losses in future economic opportunities or to adverse impacts on social conditions, human health and the environment. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), sustainable development 'is a vision of development that encompasses populations, animal and plant species, ecosystems, natural resources and that integrates concerns such as the fight against poverty, gender equality, human rights, education for all, health, human security, intercultural dialogue, etc.' Theoretically, the success of ecotourism (i.e. its sustainable development as a business enterprise that preserves the environment as it seeks to reduce poverty in surrounding communities) relies on the adherence of the industry to the founding principles of sustainability since it directly utilizes ecosystems services in its day to day operations.

#### 2.4.1 Sustainability

There are many definitions of sustainability but one of the most widely accepted definitions is that from the Brundtland Commission's report (1987) which says that sustainability refers to “meeting the needs of the present generation without compromising the ability of future generations to meet their needs." This report further states that sustainability can only be attained through sustainable development that considers both equity between generations and equity within generations (Dresner, 2002). From its genesis sustainability had 3 core pillars: environment, society and economy (McConville and Mihelcic, 2007). Ongoing research and development in the field of sustainability science has expanded those 3 core pillars to 5 pillars of sustainability: environment, socio-culture, community participation, politics and economy (McConville and Mihelcic, 2007).

## 2.5 Sustainability Assessment Methods

Sustainability concepts can be applied to virtually any field of study or development project and to date there have been thousands of sustainability assessment tools/methods created. Many of the tools, however, tend to focus on solutions in one sphere of sustainability (Muga, 2008). These methods are either qualitative, quantitative or a mix of the both and can be categorized as:

- Sustainability audit;
- Life cycle assessment;
- Sustainability potential analysis; or
- Sustainability indicators for development.

The methods utilized in this work best fit into the last category and include all 5 spheres of sustainability in the ecotourism assessment.

In this work indicators of sustainability are chosen and represented visually in the form of a material selection target plot (MSTP). Target plots map various independent variables on a radial scale, making it easy to visually compare combined effects and have been successfully applied to various sustainability spheres. These MSTPs also offer a novel way of transferring perception from being qualitative to quantitative. Table 2.3 shows previous applications of MSTPs.

**Table 2.3** Former applications of target plots in the form of a material selection target plot.

| Application | Reference |
|---|---|
| Environmental product design | Brezet and van Hemel, 1997 |
| Streamlined life-cycle assessment (Assessing generic automobiles of yesterday and tomorrow) | Graedel, 1998 |
| Life cycle assessment (General product assessment tool) | Graedel and Allenby, 1998 |
| Life cycle thinking assessment (Sustainability factors for rainwater projects) | McConville and Mihelcic, 2007 |
| Sustainability (Wastewater treatment technology assessment) | Muga and Mihelcic, 2008 |

## 2.6 Sustainability Assessment of Tourism

Ever since the WTO declared 2002 as the International Year of Ecotourism, there has been great publicity about the industry both in terms of propagation of ecotourism ventures throughout the word as well as research into the sustainability of ecotourism across the three pillars – societal, economic and environmental sustainability (Parker and Khare, 2005). Circa 2002 there was a misconception that followed ecotourism operations. Since most of these operations are small and ecotourism was founded on the principle of environmental preservation it was usually assumed that all ecotourism operations contributed to sustainable development and hence minimal environmental impact (Roberts and Tribe, 2008). This realization has necessitated appropriate tools to improve the environmental, and overall, sustainability of ecotourism operations. Though environmental sustainability of ecotourism is still growing as a research niche, most of the tools developed are qualitative (Schianetz and Kavanagh, 2008).

### 2.6.1 Sustainability Indicators in Tourism

Quantifying the impacts of the tourism industry on the environment, society or economy requires vital data. This data includes the conditions of the environment, society and economy with respect to any managerial changes that resulted. This type of information is both difficult to collect and monitor over time thus amplifying the need for sustainability indicators. The tourism literature calls these indicators the building blocks of all contemporary planning, management and monitoring initiatives. The contemporary approach to such initiatives is to identify and then measure the impacts that tourism can have on the society, environment and economy. It should be noted that there are many scepticisms towards the use of sustainable development indicators (Rey-Valette, Laloë and Le Fur, 2007).

### 2.6.2 Tourism Sustainability Indicators

In the context of sustainable tourism development, indicators are information sets which are formally selected to measure changes in assets and issues that are key for the tourism development and management of a given destination (Yunis, 2004). Indicators are measures expressed in single numbers, percentage or ratios, qualitative descriptions or existence/non-existence of certain elements concerning environmental, social and economic issues (OECD, 1993). They are signals of current issues, emerging situations or problems, need for action and results of actions.

Sustainability indicators should be easy to comprehend, as well as be economically and technically feasible to measure for them to be classified as good (OECD, 2003; Yunis, 2004). Benefits from good indicators include (adapted from Yunis, 2004 and OECD, 2003):

- Better decision making in order to lower risks or costs;

- Recognition of emerging risks and or conflictive issues, thus allowing prevention;
- Detection of impacts to allow for timely remedial action when needed;
- Performance measurement of the implementation of development plans and management actions;
- Reduced risk of planning mistakes;
- Reduced public liability; and
- Regular monitoring which can lead to rolling improvement.

According to Yunis (2004), there are different kinds of indicators, each with different purposes for decision makers:

- Early warning indicators (e.g., decline in numbers of tourists who intend to return);
- Indicators of stresses on the system (e.g., water shortages, or crime indices);
- Measures of the current state of the industry (e.g., occupancy rate, level of tourists' satisfaction);
- Measures of the impact of tourism development on the biophysical and socio-economic environments (e.g. indices of the level of deforestation, changes of consumption patterns and income levels in local communities);
- Measures of management efforts (e.g., cleanup cost of coastal contamination); and
- Measures of management effect, results or performance (e.g., changed pollution levels, greater number of returning tourists).

### 2.6.3 Indicator Development

The 2 sites considered for this study – Greencastle, Jamaica and Iwokrama, Guyana - clearly exhibit that different destinations have very differing levels of tourism planning and regulation processes. Literature suggests that where a tourism strategy is already established (such as at Iwokrama), having a focus on sustainability indicators can help by improving data input sources, analysis of the collected data as well as reporting methods. For places such as Greencastle, where there is currently no formal tourism plan, they can benefit immensely from indicator development. Indicator development according to the WTO's recommended procedure contains some core fundamentals of tourism planning to allow for the selection of the most relevant and feasible indicators for a given site. The main elements of this procedure are shown below in Figure 2.5.

*Research and Organization*

A. Definition/delineation of the destination
B. Use of participatory processes
C. Identification of tourism assets and risks; situation analysis
D. Long-term vision for a destination

*Indicators Development*

E. Selection of priority issues and policy questions
F. Identification of Desired Indicators
G. Inventory of data sources
H. Indicators selection

*Implementation of indicators*

I. Evaluation of feasibility/implementation procedures
J. Data collection and analysis
K. Accountability and Communication
L. Monitoring and Evaluation of Results

**Figure 2.5** Recommended scheme for indicator development (adapted from Yunis, 2004).

According to the WTO (2004) the main criteria for selecting sustainability indicators in tourism are classified as:

- Relevance of the indicator to the selected issue;
- Feasibility of obtaining and analysing the needed information;
- Credibility of the information and reliability for users of the data;

- Clarity and understandability to users; and
- Comparability over time and across jurisdictions or regions.

Historical data is required to go through this indicator selection route suggested by Yunis (2004). This work attempts to find indicators that are applicable throughout the Caribbean as a first approach by which data collection can commence and allow for the tailoring of indicators based on collected data.

## 2.7 Management of Ecotourism in the Caribbean

Measuring sustainable development, across any industry, requires regulation as a form of management (Stewart, 2005). For tourism, inclusive of ecotourism, in the Caribbean this comes in the form of national level management of the industry by some governmental agency or ministry within each territory. According to Stewart (2005) and Finnetty (2000), the management of tourism, in its various forms, by Caribbean governments has not usually been met with positive acclaim. Thus to ensure the sustainability of the industry a lot of onus is placed on the ecosite's owners to have corporate responsibility with regard to sustainability (Tisdell, 2001; Miller, 2001).

For the latter reason there has been an upsurge in the number of ecohotels throughout the Caribbean that are being managed by Non-governmental organizations (NGOs), whether for-profit or non-profit, that have some type of environmental conservation and/or preservation mandate (Finnetty, 2000). Typically the other key type of management of ecotourism in the Caribbean involves some type of government partnership. Regardless of the type of ecotourism management employed at a site, assessment of the site's management is done only if the ecohotel is attempting to gain certification and this is done through qualitative measures (Holden, 2000; Finnetty, 2000;

Stewart, 2005). This work used Social Network Analysis (SNA) to simply compute the strength of ecotourism's management strength.

### 2.7.1 Social Network Analysis (SNA)

SNA is used widely in the social and behavioral sciences, as well as in economics, marketing, and somewhat for project management in industrial engineering (Taagepera, 2008). The social network perspective focuses on relationships among social entities and is an important addition to standard social and behavioral research, which is primarily concerned with attributes of the social units (Wasserman and Faust, 1994). Management, of any kind, refers to the use of people (i.e. social units), in some level of seniority to others, to control some commodity. According to some measuring indices of SNA, characteristics of each actor's interaction or management activities will affect the holistic management of assets in terms of sustainability and structure (Li and Chen, 2006).

Social network theory and methods of SNA are being increasingly used to study real-world networks in order to support knowledge management and decision making in organizations (Hu, 2009). As was alluded to earlier, SNA has been used since the early 1970's as the theoretical basis for the examination of general social and behavioral science communities (Wasserman and Faust, 1994). The importance of SNA is highlighted by the demonstration that an individual's behavior can often times be categorized by their relations with others. According to Cairns (1979) and Rogers (1962), social network research can range from small-scale studies (micro level) of a persons' intimate social network to system studies (macro level) focusing on larger societal and community organizational structure. SNA is inherently based on the underlying premise that "the structure of relations among actors and the location of individual actors in the network have important behavioral, perceptual, and attitudinal consequences both for the individual units and for the system as a whole" (Knoke and Kuklinski, 1982).

Researchers in the field concur that one's social network is not consistent and varies depending on context and situation. As such one accepted classification of social networks is as either formal or informal. Formal social networks describe personal contacts that act as organized circuits of information where interaction usually occurs in a planned or structured setting (such as in management). On the other hand, informal social networks are usually those personal contacts that comprise casual or spontaneous sources of information and interaction usually occurring in an unplanned or unstructured setting (Agadjanian, 2002). Another common categorization is based on the strength of the ties between actors and is based on the Strength of Weak Ties (SWT) Theory. This theory identifies strong ties as those that include relations with family or friends and weak ties as those that consist of acquaintances or distant contacts. In SWT weak ties are utilized to obtain new information and strong ties are used to apply or act on the new information. Hence, having these ties so classified in an ecotourism management network can be advantageous for more effective creation and dissemination of information.

Regardless of the type of network that is created (i.e. formal or informal; and strong or weak ties), SNA can be carried out on a whole or partial network basis. Simply put, a network can be analyzed with all possible relations (links) among the actors or only select relations. Studies that only examine certain relations and actors are called egocentric. These egocentric networks are the most practical to collect data for and study (Carrasco et al., 2006). This is the type of network utilized in this work to analyze the strength of just managerial relations at each ecosite.

## 2.8 Water Quality as an Indicator of Sustainability

Ecotourism facilities throughout the world, inclusive of the Caribbean, are often located in rural and remote areas with limited potable water supply (Eagles, McCool and Haynes, 2002) and heavy reliance on harvested rainwater and surface water withdrawals (Manson, 2008). This is in addition to the ecosystem services that fresh waterways provide for aquatic flora and fauna and as such there needs to be concern from both the human health and species propagation angles (Meybeck, Chapman and Helmer, 1989; Chapman, 1996).

Anthropogenic river pollution can be categorized as emanating from municipal, industrial or agricultural sources (Gleick, 1993). The effluents from municipal and most industrial effluents are point sources as they disseminate into waterways from known points unlike non-point sources (Chapman, 1996). Agricultural pollution and runoff are the most common form of non-point sources of surface water and ground water pollution (Gleick, 1993). Typically agricultural pollution contains, in excess, nitrogen (mainly in the forms of ammonium, nitrate and nitrite) and phosphorus which are the key proponents of eutrophication (Biswas et al., 2006). From both point and non-point sources typical pollutants include toxics such as heavy metals, synthetic and industrial organics, chlorides and salts (Kotti et al., 2005). Not to be omitted are the microbiological contamination that can enter surface waters. This type of contamination is of extreme importance whether the water ways are being used for drinking water sources, recreation (e.g. swimming or boating), and irrigation of crops or as a source of fish for human consumption (Meybeck, Chapman and Helmer, 1989; Chapman, 1996).

Ecotourism activities at any ecotourism site include some measure of anthropogenic activity. The extent of both on-site and off-site anthropogenic activity is expected to increase as the ecotourism industry continues to grow. Hence, a tool to assess surface water quality in correlation with increasing ecotourism activity (inclusive of tourist visitation) is needed. Traditionally, river water quality parameters of environmental concern have included $NO_3^-$-N, $NO_2^-$-N, $PO_4^{3-}$-P, Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). These parameters have been given priority since the classification of river water quality into 4 categories by both Petts and Eduljee (1994) and Dunette and O'Brien (1992). These authors have called Class I 'good quality', Class II 'fair quality', Class III 'poor quality' and Class IV 'bad quality'. The major parameter in determining a Class I water according to their scheme is BOD, where such water must have a BOD <3 mg/L so that it is suitable to be used as a potable water supply as well as support aquatic life while having a high amenity value (Kotti el al., 2005).

Petts and Eduljee (1994) defined a Class II water as one that needed improvements and known to receive turbid discharges while they described a Class III water as having a dissolved oxygen saturation (DO%sat) below 50% and urgently needing improvement of quality to support aquatic flora and fauna. Class IV water was summarized by both Petts and Eduljee (1994) and Dunette and O'Brien (1992) as water that is heavily polluted and possibly anoxic having BOD values in excess of 12 mg/L and consequently unable to support life. It is in consultation with this classification scheme as well as the selection criteria developed by Chapman (1996) that parameters were decided upon for this study. An adaptation of the selection criteria developed by Chapman (1996) is given in Table 2.4 where only the uses of surface water at the 2 sites are extrapolated upon.

**Table 2.4** Summary of selection criteria of variables for water monitoring program (adapted from Chapman, 1996).

| | Background monitoring | Aquatic life and fisheries | Drinking water source | Recreation and health | Agriculture | |
|---|---|---|---|---|---|---|
| | | | | | Irrigation | Livestock watering |
| *General variables* | | | | | | |
| Temperature | xxx | xxx | | x | | |
| Color | xx | | xx | xx | | |
| Odor | | | xx | xx | | |
| Suspended solids | xxx | xxx | xxx | xxx | | |
| Turbidity | x | xx | xx | xx | | |
| Conductivity | xx | x | x | | x | |
| Total dissolved solids | | x | x | | xxx | x |
| pH | xxx | xx | x | x | xxx | |
| Dissolved oxygen | | | x | | x | |
| Hardness | | | xx | | | |
| Chlorophyll a | | | xx | xx | | |
| *Nutrients* | | | | | | |
| Ammonia | x | xxx | x | | | |
| Nitrate/nitrite | xx | x | xxx | | | xx |
| Phosphorus or phosphate | xx | | | | | |
| *Organic matter* | | | | | | |
| Total organic carbon | xx | | x | x | | |
| Chemical oxygen demand | xx | xx | | | | |
| Biochemical oxygen demand | xx | xxx | xx | | | |
| *Major ions* | | | | | | |
| Sodium | x | | x | | xxx | |
| Potassium | x | | | | | |
| Calcium | x | | | | x | x |
| Magnesium | xx | | x | | | |
| Chloride | xx | | x | | xxx | |
| Sulfate | x | | x | | | x |
| *Trace metals* | | | | | | |
| Heavy metals | xx | xxx | | | x | x |
| Arsenic & selenium | xx | xx | | | x | x |
| *Microbial indicators* | | | | | | |
| Fecal coliforms | | | xxx | xxx | xxx | |
| Total coliforms | | | xxx | xxx | x | |
| Pathogens | | | xxx | xxx | x | xx |

x – xxx Low to high likelihood that the concentration of the variable will be affected and the more important to include the variable in a monitoring program.

At both sites surface water was used for all of the purposes highlighted. Hence, the information in Table 2.4 was intersected with United Nations' Environmental Programme (UNEP) basic monitoring variable for streams as exists in its GEMS/WATER programme (UNEP, 2009). The basic stream monitoring variables according to the GEMS/WATER programme are: water discharge/head; total suspended solids; transparency; temperature; pH; conductivity; dissolved oxygen; calcium; magnesium; sodium; potassium; chloride; sulphate; alkalinity; nitrate plus nitrite; total phosphorus (unfiltered); total phosphorus (dissolved); reactive silica; and chlorophyll A (Turner II et al., 1995; UNEP, 2009). The final bias of selection of monitoring variables came down to cost of equipment and analyses.

River water quality varies both spatially and temporally (Gleick, 1993). These variations depend on geography, morphology and pollutant loadings and so water quality is specific to location and its surrounding land use/land cover (LULC) applications (Kotti et al., 2005; Maillard and Pinheiro Santos, 2008). According to Maillard and Pinheiro Santos (2008), in any given watershed, and across any time scale, almost everything within the watershed will be deposited in the streams that drain it. Stormwater runoff is the main source of non-point pollution carrying nutrients and chemicals into receiving water bodies and is the root of the relationship between LULC and water quality (Waite, 1984; Kotti et al., 2005; Maillard and Pinheiro Santos, 2008). Therefore the LULC within a watershed affects the degree of water pollution and surface water quality in any given watershed and so it is important to assess the entire catchment when attempting to monitor and/or manage water quality (Maillard and Pinheiro Santos, 2008).

It is well documented in the literature that statistical modeling has traditionally been used to create water quality models based on a limited number of water samples. This has become increasingly popular and applicable due to the high cost in water sampling and consequent analyses. For instance, the Maillard and Pinheiro Santos (2008) study utilized 15 sample points to compute a statistical model. Similarly, the studies of Fisher et al. (2000) and Basnyat et al. (1999) utilized 10 and 8 water sampling sites throughout their respective watersheds in computing multivariate statistical water quality models. Though these models were based on data collected over both the dry and wet seasons, this approach is only acceptable since there is an underlying assumption that the LULC at each watershed is predictable in the future. This underlying assumption is what inherently dismisses the idea for application to ecotourism as land usage in the watershed introduces new water quality interchanges to the natural hydrological cycle (Biswas et al., 2006). The normative principles behind tourism, and ecotourism alike, often concur that with expansion for the industry will come LULC issues. This is especially true in the years of infancy, applicable to both sites chosen for this study in terms of a saleable ecotourism product. Therefore, to accurately model water quality in these watersheds there must be a sustained water quality monitoring program to transcend seasons (i.e. wet and dry), watershed population increases, development of ecotourism activities (inclusive of increased visitation) as well as natural fluctuations in stream flow in times of flooding and natural disasters.

The modeling of water quality in a watershed in light of ecotourism activities and an ecosite’s management takes on a complex system framework. As is typical of dealing with complex systems, they must first be dissected for study (i.e. a reductionist approach) before individual results can be combined through systems thinking (i.e. systems approach) according to General Systems Theory (von Bertalanffy, 1968; Checkland, 1993; Greenwood, 2006).

## 2.9 Reductionist Approaches Versus Systems Approaches

According to General Systems Theory, reductionist approaches are best applied in the study of sub-systems whereas the systems approach looks at whole systems (Checkland, 1993). Therefore the reductionist approach is used to attempt to solve problems within a system while the complex systems approach is used thereafter to frame and define the issues (Checkland, 1993; Greenwood, 2006; Muga, 2008). Reductionist approaches attempt to solve sub-system interactions (e.g. ecotourism activities and indicators studied devoid of water quality). The dynamics of such sub-system interactions are then linked in trying to understand the complex system in question. The application of reductionist and systems approaches within the scope of this work is highlighted in Figure 2.6.

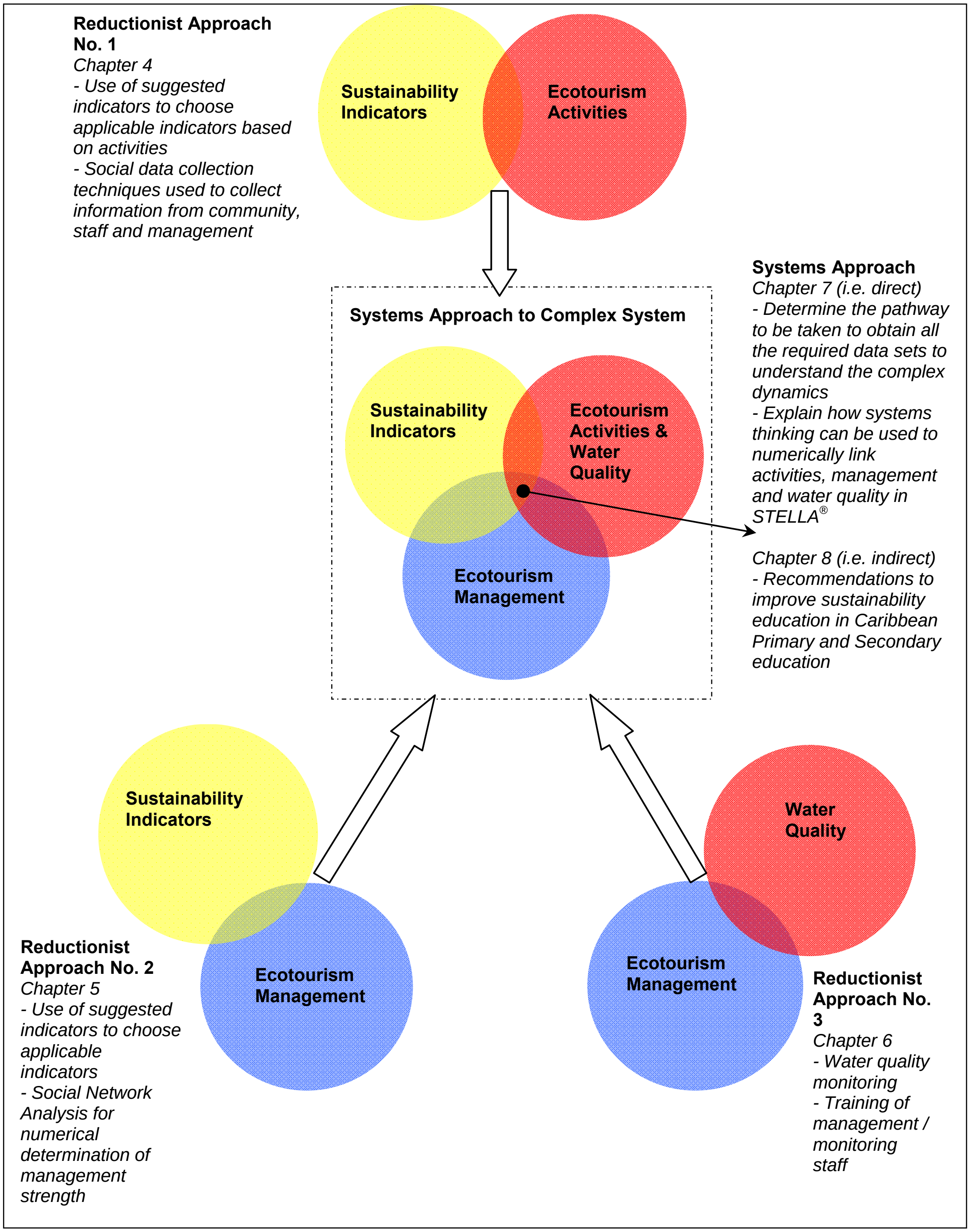



**Figure 2.6** Reductionist and systems approaches utilized in this work.

### 2.9.1 Systems Approach

Any collection of components that work together to produce a unique quality is called a system (Fisher, 2005). Systems theory is based on the assumption that all types of systems have common characteristics regardless of their unique internal structures (Skyttner, 2005). That is, areas characterized globally by ecotourism activities have similar sets of interdependent controlling processes even if the behavior of individuals and the physical structures of the specific locality are different. Systems approach consists of systems thinking and systems dynamics. Systems thinking is a methodology used to identify and solve phenomena operating in and arising out of a larger environment (Shiflet and Shiflet, 2006). Systems dynamics is the use of computer simulations to model the global dynamics of the systems components to understand rather than predict the behavior of the system over time (Ford, 1999; Shiflet and Shiflet, 2006).

#### 2.9.1.1 STELLA®

The STELLA® software is specifically designed for modeling the dynamics of highly complex or interdependent systems (Hannon and Ruth, 2001). One of the main advantages of STELLA® is its ability to make small modifications to a model and then run simulations to observe the effects provoked on the overall model dynamics (Forster and Hamlyn, 2001; Diaz-Ibarra, 2004). The software allows one to represent complex systems conceptually through a series of simple building blocks that represent the controlling processes operating to produce an emergent behavior (Ford, 1999). An icon – based graphical interface in the form of “Stock and Flow” diagrams is used to represent the concepts of systems thinking. The model equations are automatically generated and made accessible beneath the model layer.

#### 2.9.1.2 Sustainability Education

Regardless of the success of engineering fixes, models, etc. in order to try to sustain sustainability in the future there is need to educate the adults of tomorrow of their role in responsible sustainable development (Hougham, 2008; McLean, 2009). Thus a systems approach is required to educate children of today to help them to acquire the skills to make informed decisions that will both benefit themselves and generations to come. In order to achieve several reductionist approaches are needed that would then hopefully culminate in a successful education system. One of UNESCO's famous quotes on education for sustainable development reads:

*'Sustainable development is seeking to meet the needs of the present without compromising those of future generations. Therefore we have to learn our way out of current social and environmental problems and learn to live sustainably.'*

This work focuses on a bottom-up approach to educating Caribbean children in sustainability and sustainable development. The top-down approach to sustainability education has been widely studied, though not in the Caribbean, and can be easily transferrable (Crede, 2009; Hougham, 2008). This is of particular importance since this is currently the United Nations Decade of Education for Sustainable Development (2005-2014), for which United Nations Educational Scientific and Cultural Organization (UNESCO) is the lead agency. During this decade UNESCO's goal is to integrate the principles, values, and practices of sustainable development into all aspects of education and learning, in order to address the social, economic, cultural and environmental problems we face in the 21st century. Should the Caribbean remain on its current track, it will not be able to achieve this decade's goals. This work recommends actions that can set the Caribbean on its path to achieving the goal through inclusion of sustainability into formal primary and secondary school education.

# CHAPTER 3: MATERIALS AND METHODS

## 3.1 Introduction

Greencastle, Jamaica was visited in August 2008 and Iwokrama, Guyana was visited in March 2009. During these visits, fresh surface water quality was monitored by use of a Quanta Hydrolab$^{TM}$ and simultaneously grab surface water samples were taken. Each water sample was then acidified after alkalinity measurements were completed in the field. Further analyses were conducted *ex situ*. While in the field at each site, surveys, screening and scoping exercises as well as environmental checklists were utilized to attempt to understand the dynamics of the population, society and ecotourism in the respective areas. The underlying principles for the choice of the structure of these instruments are detailed herein. This work attempts to create assessment frameworks from the reductionist and systems approaches and the steps in creating these are also delved into here.

## 3.2 Reductionist Approaches

### 3.2.1 Water Quality Monitoring and Sampling Techniques

*IN SITU*

Quanta Hydrolab$^{TM}$ calibration requires the following materials and equipment:

- ~18.1 MΩ-cm Deionized (DI) water
- Electrode storage solution (11% KCl on mg/kg basis) (Thermo Electron Corporation)
- pH 4, 7 & 10 buffer solutions (Fisher Scientific)

- 500 μΩ/cm, 445 μΩ/cm and 200 μΩ/cm Conductivity/TDS standards (Ricca Chemical Co.)
- 40 NTU (Ricca Chemical Co.) and 10 NTU (Hach Chemical Co.) turbidity standards
- Etrex GPS handheld (Garmin)
- Quanta Hydrolab™ multimeter

The calibration procedure followed was that suggested by the manufacturer in the multimeter's manual. This procedure can be found on the World Wide Web at: http://www.ecoenvironmental.com.au/eco/water/hydrolab_quanta.htm (Hydrolab Corporation, 2002).

The GPS was used to determine elevation when the meter was being calibrated. This information was then utilized to mathematically determine the atmospheric pressure at that elevation. This value was input during calibration for %DO sat.

Grab Surface Water Sampling requires the following materials and equipment:

- Liquid-nox solution
- Sodium hydroxide (NaOH), extra pure pellets (Acros Organics)
- ACS grade concentrated nitric acid ($HNO_3$) (Fisher Scientific)
- High density polyethylene (HDPE) bottles
- ~18.1 MΩ-cm Deionized (DI) water

The method utilized for water sampling was as described in Standard Method 1060 B (APHA, AWWA and WEF, 1998). In accordance with this method, samples were taken with 250 mL HDPE bottles (Nalgene). These bottles, inclusive of respective caps, were all first pre-washed with 1% liquid-nox solution then rinsed 3 times with tap water. The pre-washed bottles were then soaked in a 1 N NaOH bath for at least 1 hour. After base soaking, the bottles were rinsed with DI water 3 times before being soaked in a 10% $HNO_3$ bath. The bottles were soaked in the acid bath for at least 1 hour before being rinsed 3 times with DI water. All bottles were left to drip dry at room temperature. Note that all glassware and plastic materials utilized for *ex situ* methods were cleaned in this manner.

After samples were taken in the field, the samples were placed in doubly sealed Ziploc™ bags. Once the *in situ* analyses were complete the bottles were sealed with Para film™ and acidified to 5 % $HNO_3$ before being shipped. Once the samples were received at the lab they were kept in the refrigerator.

Alkalinity measurement requires the following materials and equipment:

- ~36 N Sulfuric acid ($H_2SO_4$), A.S.C. Plus (Fisher Scientific)
- ~18.1 MΩ-cm Deionized (DI) water
- Phenolphthalein, Certified A.S.C. (Fisher Scientific)
- Methyl Orange, indicator (Acros Organics)
- Ethyl alcohol, 190 proof spectrophotometric grade ethanol (Acros Organics)
- Burette

Alkalinity measurements were made within 24 hours by titrating 50 mL of samples with 0.02 N $H_2SO_4$ to a phenolphthalein end point then to a methyl orange end point. Each associated volume was noted so as to determine the caustic/$OH^-$ alkalinity and the carbonate alkalinity respectively. Note that this analysis was carried out before the water samples were acidified with ultra pure nitric acid to give a 0.1% acid solution. Some samples were also filtered using a 0.2 µm PES filter (Nalgene) and acidified with nitric acid. All acidified samples were stored for elemental analysis.

Microbial analysis and enumeration requires the following materials and equipment

- Thermotote™ Portable incubator
- Membrane filtration apparatus (0.45µm membrane filter, filter cup, hand pump)
- Fisherbrand™ disposable Petri dishes (Fisher Scientific)
- m-FC agar media
- Bifocal magnifying glass
- Para film™
- ~18.1 MΩ-cm Deionized (DI) water

125 mL of each collected grab sample was kept for enumeration of coliform bacteria. 100 mL of sample was filtered through a 0.45 µm membrane filter, which is capable of trapping all bacteria (Agard, 2002). The membrane filter was then placed within a Petri dish containing m-FC agar media. This m-FC media selects for *E. coli*, which is the chief indicator of fecal coliform (Edberg, 2000). Each Petri dish was then sealed with Para film™ then placed in an incubator at 44.5°C for 24 ± 2 hours. During this time period, individual bacterial cells grew on the filter into visible colonies. Following the allotted time period, the samples were removed from the incubator and colonies of coliform bacteria were counted using a bifocal magnifying glass with a 10 x magnification, fecal coliform colonies appeared dark blue. This color arises from the interaction of a metabolite of lactose that reacts with the dye that is in the culture medium. The colonies were counted and reported as # CFU/100 mL.

*EX SITU – samples filtered with 0.45 µm (Nalgene) bottle top filters*

The reference methods followed for the *ex-situ* analyses are shown in Table 3.1. Also highlighted in Table 3.1 are the preservation techniques and holding time limitations that had to be adhered to preserve the integrity of the samples. Once the samples were preserved and brought to the lab, they were all kept below 4°C by refrigeration.

**Table 3.1** Summary of *ex-situ* methods utilized for water analyses.

| Parameter | Units | Methodology | Reference | Maximum Holding Time | Preservation Technique |
|---|---|---|---|---|---|
| Phosphorous | mg/L | Spectrophotometry | STM | 4 Weeks | Acidified with $H_2SO_4$ or $HNO_3$; pH≤ 2 |
| $NO_3^-$-N | mg/L | Spectrophotometry | STM | 2 Days | Refrigerate at 4°C |
| COD | mg/L | Block digestion | STM | 2 Days | Refrigerate at 4°C |
| Total Hardness | mg/L $CaCO_3$ | Titrimetric, EDTA | STM | 6 Months | Acidified with $H_2SO_4$ or $HNO_3$; pH≤ 2 |
| Ca, Mg | mg/L | Titrimetric, EDTA | STM | 6 Months | Acidified with $H_2SO_4$ or $HNO_3$; pH≤ 2 |
| Dissolved Metals (Cd, Pb, As, Al, Se) | µg/L | Atomic Absorption | USEPA | 6 Months | Acidified with $H_2SO_4$ or $HNO_3$; pH≤ 2 |
| Fecal coliform/ *E. coli* | CFU/100 mL | Incubation | STM | 6 hours | Refrigerate at 4°C |

STM – Standard Methods (APHA, AWWA and WEF, 1998); USEPA – United States Environmental Protection Agency (USEPA, 1979).

Chemical Oxygen Demand (COD) testing requires the following materials and equipment:

- Hach® DR/4000U spectrophotometer
- Hach® COD reactor (Model H0492805390)
- Hach® COD high range (0 – 1500 mg/L) test kit (tubes contain 5 mL mercuric sulfate [$HgSO_4^{2-}$] solution)
- ACS grade concentrated nitric acid ($HNO_3$) (Fisher Scientific)
- ~18.1 MΩ-cm Deionized (DI) water

A pre-prepared test tube was prepared per sample by addition of 1 mL of sample. A blank was also created by addition of concentrated $HNO_3$ to 5 % $HNO_3$, the concentration to which samples were acidified for preservation. While the test tubes were being prepared, the COD reactor was warmed to 150°C. Once warmed, the sampled were placed into the reactor for digestion for 1 hr at 150°C. At the end of the hour the samples were allowed to air cool to room temperature. The Hach® DR/4000U spectrophotometer was then programmed to method 2720 and wavelength of 620 nm before the blank was used to set the COD concentration to 0 mg/L. All the other tubes were placed into the spectrophotometer and the COD readings determined. Note that before being placed into the spectrophotometer the test tube surface was cleaned with lint free wipes.

Nitrate testing requires the following materials and equipment:

- Hach® DR/4000U spectrophotometer
- Hach® N high range (0 – 30 mg/L $NO_3^-$-N) test kit with NitraVer X Reagent B powder packets
- ACS grade concentrated nitric acid ($HNO_3$) (Fisher Scientific)
- ~18.1 MΩ-cm Deionized (DI) water

Similar to the COD test described above, the Hach® DR/4000U spectrophotometer was programmed to method 2511 and wavelength of 410 nm. A pre-prepared test tube was prepared per sample by addition of 1 mL of sample and a blank was created by addition of concentrated $HNO_3$ to 5%. All these prepared test tubes were then inverted for proper mixing. To the mixed tubes was added a single packet of NitraVer X Reagent B powder per tube before being mixed again. The tubes were then allowed to react for 5 minutes before the outside of the tubes were cleaned with lint free wipes and the readings taken on the spectrophotometer.

Phosphorous analysis requires the following materials and equipment:

- Ammonium molybdate-vanadate soln. ASTM D-15 – for P in Water (Ricca Chemical Co.)
- Potassium Phosphate, Monobasic (Potassium Dihydrogen Phosphate Anhydrous) (EMD Chemicals, Inc.)
- ~36 N Sulfuric acid ($H_2SO_4$), A.S.C. Plus (Fisher Scientific)
- ~12.1 N Hydrochloric acid (HCl), Certified A.S.C. Plus (Fisher Scientific)
- Fisherbrand 1cm path length disposable plastic cuvette (Fisher Scientific)
- ~18.1 MΩ-cm Deionized (DI) water
- Genesys 20 Spectrophotometer (Thermo Scientific)
- Hot block (Environmental Express, Model SC150)

The analysis for P in surface waters was done in accordance with Standard Method 4500-P C (i.e. Vanadomolybdophosphoric Acid Colorimetric Method) (APHA, AWWA and WEF, 1998). In order to determine total P present an acid mixture was made such that 60 mL concentrated HCl was mixed with 8 mL concentrated $H_2SO_4$ and diluted to 200 mL with DI water. 25 mL of each unfiltered sample was then poured out into HDPE digestion vessels and 0.8 mL of the acid mixture added to each vessel. The prepared samples were then placed in the hot block and kept at around 90$^oC$ for 1 hour. After this hour the samples were allowed to air cool to room temperature. Once cooled, the samples were then raised to the 25 mL mark with DI water and stirred for homogeneity. These samples will be referred to hereunder as the treated samples.

For both the treated and untreated sample sets 1.2 mL of each was placed into a clean disposable 1 cm path length cuvette. To each cuvette was then added 0.4 mL Ammonium molybdate-vanadate solution and 0.4 mL DI water. The samples were then allowed to sit for 10 minutes for proper color development. During this time the spectrophotometer was warmed and then the absorbances found at 400 nm.

From a stock of 100.0 mg/L $PO_4^{3-}$-P, made from stock monobasic potassium phosphate, treated and untreated standards of known concentration (i.e. 0, 0.5, 1, 3, 5 and 10 mg/L) so as to develop a calibration curve. Fresh stocks of 100.0 mg/L $PO_4^{3-}$-P and calibration standards were prepared on analysis days. Clearly note that in the case of treated standards these were heated along with the actual samples to ensure similar conditions were experienced. The treated samples will give the total P and the respective untreated sample gives the P as orthophosphates. Thus the difference of these 2 values will give, for any given sample, the acid hydrolysable P.

Total Hardness, Ca and Mg concentration analyses require the following materials and equipment:

- Water hardness buffer APHA/ASTM/EPA – for Water hardness (Ricca Chemical Co.)
- EDTA, 0.01 M (M/100) Volumetric Solution (APHA)
- Ethyl alcohol, 190 proof spectrophotometric grade ethanol (Acros Organics)
- Hydroxylamine hydrochloride, reagent A.C.S. (Acros Organics)
- Eriochrome Black T, pure, indicator grade (Acros Organics)
- Murexide indicator, Ammonium purpurate-sodium chloride mixture APHA/EPA – for Ca (Ricca Chemical Co.) or Hydroxynaphthol Blue (MP Biomedicals, Inc.)
- Sodium hydroxide, extra pure pellets (Acros Organics)

- ~18.1 MΩ-cm Deionized (DI) water
- Burette

The computation of these 3 entities are based on the assumption that total hardness is due to the presence of $Mg^{2+}$ and $Ca^{2+}$ only. That is:

$$\text{Total Hardness} = \text{Hardness due to } Mg^{2+} + \text{Hardness due to } Ca^{2+} \tag{3.1}$$

The analytical technique followed is as described in Standard Method 3500 (EDTA Titrimetric Method: Ca, Mg, Total hardness) (APHA, AWWA and WEF, 1998). Samples were filtered through 0.45 μm PES filters (Nalgene).
For all the analyses done standard 0.01 M EDTA was placed in a burette and 50 mL of each sample in a clean acid rinsed beaker. For the determination of total hardness 2 mL hardness buffer was placed into each sample along with 4 drops EBT indicator. The samples were then titrated to a blue color. For the determination of the Ca concentration 2 mL of 1 M NaOH was added to each sample and along with either 0.1-0.2 g murexide or hydroxynaphthol blue crystals, ensuring the pH was above 12 before commencement of the titration. Once above pH 12, each sample was titrated to a royal blue color. Mg concentration was then computed by use of Equation 3.1.

Eriochrome black T indicator was prepared by dissolving 0.5 g eriochrome black T and 4.5 g hydroxylamine hydrochloride in 100 ml 95% ethyl alcohol.

Elemental Metal Analysis - Graphite Furnace Atomic Adsorption (GFAA) Methods
Only dissolved metal analysis was done by use of the Varian Spectra AA640. The system utilized was fitted with an automated sample injection arm (GTA 100). The auto

sampler was programmed to recalibrate after each 6 samples and a total of 3 replicates were run for all standards in calibration curve generation. Manual pre-mixing of standards was done at each elemental run. This system was used to analyze for the following metals: Pb, As, Al, Se, Cd, Ni, Cu. Table 3.2 gives the details of the settings used for each of the listed metal's analysis. These settings were taken from the Varian operating manuals (Varian Australia, 1989; Rothery, 1988).

**Table 3.2** Operating GFAA conditions used for metal analysis (adapted from Varian Australia, 1989; Rothery, 1988).

| Element | Operating conditions | | | | |
|---|---|---|---|---|---|
| | Wavelength (nm) | Lamp current (mA) | Matrix and makeup | Modifier | Injection volume (µL) |
| Pb | 283.3 | 5 | 0.1% $HNO_3$ | Pd solution (500-2000 µg/mL) + reducing agent ascorbic acid (4% w/v used) | 20 total; 15 sample + 5 modifier |
| As | 193.7 | 10 | 0.1% $HNO_3$ | Pd solution (500-2000 µg/mL) + reducing agent ascorbic acid (4% w/v used) | 20 total; 15 sample + 5 modifier |
| Al | 396.2 | 10 | 0.1% $HNO_3$ | None | 20 sample |
| Se | 196.0 | 10 | 0.1% $HNO_3$ | Pd solution (10 µL of 500 µg/L) | 20 total; 15 sample + 5 modifier |
| Cd | 228.8 | 4 | 0.1% $HNO_3$ | Pd solution (500-2000 µg/mL) + reducing agent ascorbic acid (4% w/v used) | 20 total; 15 sample + 5 modifier |

For all the analyses done ultra pure argon gas (Airgas) was used as the carrier gas. The makeup solution was made from ACS grade concentrated nitric acid ($HNO_3$) (Fisher Scientific). The standards utilized for obtaining calibration curves were 0, 5, 10, 20 and 40 µg/L which were all diluted from 1000 µg/L standard stocks (all stocks were in a $HNO_3$ matrix;  Cd, Se and Pb were from Acros Organics; As and Se were from Fisher Scientific; while As and Al were from Ricca Chemical Co.).

### 3.2.2 Evaluation of Ecotourism Activities

Conventional environmental auditing principles were used to develop 2 environmental audit tools: Environmental checklist; and Screening and Scoping Exercise (see Appendix A). Both tools were fundamentally designed and constructed so that conclusions on the significance of impacts of onsite activities (past and future) are clear and supported by well rationalized and documented impact descriptions and analyses. The Checklist was developed as a tool to be filled by each site manger and probes into the past and planned onsite activities. Physical environment, ecology, human environment and regulatory framework were all incorporated into the questioning, which was spread across the core pillars of sustainability. The Screening and Scoping Exercise was designed as a researcher tool to assess current and future impacts of, in consideration of observations, onsite discussions with staff as well as historical land use/land change (LULC) information attained from governmental agencies.

A survey instrument (see Appendix A) was designed to gauge the surrounding communities' acceptance of, and impact on, the ecotourism ventures studied in this work. The main sections of the survey were demographics, tourism and ecotourism involvement of household members, water and sanitation household practices as well as respondent outlook on ecotourism and tourism potential for their communities (Oppenheim, 1992). The integrity of this type of research is based on the systematic collection and analysis of information. More specifically, it assumes, first of all, that the researcher has maintained an atmosphere of scepticism and objectivity as part of the process of collecting information (Burns and Bush, 1995). According to Boxill et al. (1997) and Babbie (1992), the dilemma which the social researcher faces is that of collecting valid and reliable information from human subjects without infringing on their personal rights and freedoms. As such to ensure this study did not violate any intrinsic codes of ethics, the survey was put before that University of South Florida's Internal Review Board and passed with exemption status (see Appendix A for exemption letter).

The survey was person-administered such that the interviewer read the questions to the respondent and recorded his or her answers. Despite person-administered surveys being the primary administration method, its popularity has fallen off as communications systems have developed and technology has advanced (Burns and Bush, 1995). However, this method was deemed most appropriate for the Caribbean's rural areas that were being utilized since technology at the Guyanese communities utilized was very meagre. The subjects utilized in the survey were chosen via a non-probability sampling technique (Fink, 2003a; 2003b) as known managers and senior level staff, and members of their households, at the ecotourism businesses at the 2 study sites were purposefully omitted from the survey. This type of judgemental (or purposive) sampling, according to Schensul, Schensul and LeCompte (1999), is acceptable in social research when the judgement is thought to, or known to, protect the integrity of the study.

The results of the checklist, screening and scoping exercise as well as the community survey were analyzed in consideration of observations and historical LULC for the regions of concern to determine indicators across the 3 core pillars of sustainability – environmental, societal and economic sustainability. More detail on the choice of indicators is given in Chapter 4. Nevertheless, the chosen indicators were represented in a target plot that was generated with Microsoft Excel$^{TM}$ after each indicator was assigned an impact factor on a scale of 0 (no impact) to 3 (high impact) in increments of 0.5. In order to assess impacts and assign impact factors a non-exhaustive list of questions were developed for each chosen indicator. For both sites 5 scenarios were developed to test that this tool created is able to respond to changes in demographics and society.

### 3.2.3 Management of Ecotourism

Informal semi-structured interviews were conducted with the ecotourism managers at each site to gauge management style, structure and effectiveness. The semi-structured interview is shown in Appendix A. This interview session was used to understand the organizational structure for each study site so that their management network could be mapped. Social Network Analysis (SNA) theory was then applied to the management network created to ultimately determine the strength of the network as well as to provide recommendations that will improve the effectiveness of management. In order to create this management network, a modified SNA had to be done such that only the interaction amongst players of interest was institutionalized into the formal management structure. Once the network was created for each site, it was analyzed according to the sociocentric SNA approach (Chung, Hossain and Davis, 2005).

The network's strength was determined through the use of matrix algebra in Microsoft Excel$^{TM}$. In this analysis each player was analyzed for their management influence on all the persons that are connected. Where a player has a relationship with another, that link is given a score of 1 and where there is no relationship a score of 0 was assigned.

Sustainability indicators for ecotourism management in the Caribbean were assessed through consideration of management performance indicators as well as tourism performance indicators provided by the World Tourism Organization (WTO), Inter-American Development Bank (IDB), and Asian Development Bank (ADB) as well as the Global Sustainable Tourism Criteria developed in partnership with the Rainforest

Alliance, WTO, the United Nations Environment Programme (UNEP) and the United Nations Foundation. As was alluded to in Chapter 2, these suggested indicators were considered due to the lack of relevant information required for analysis for the Caribbean's ecotourism industry inclusive of at the 2 study sites. Nevertheless, these suggested indicators were intersected with the results of the interviews with the site management as well as literature on the Caribbean to develop 2 ecotourism management frameworks. The first framework to assess sustainability of ecotourism in the Caribbean was done in consideration of management at the countrywide level (i.e. a top down approach). The second framework was designed to assess at the site level the sustainability of the ecotourism management regardless of type of management. Both frameworks were represented through the use of target plots and were developed in the same manner as mentioned above. Similarly, to assess impacts a non-exhaustive list of questions was also developed for each chosen indicator. Note that the target plots developed for management were done across the 5 pillars of sustainability – environment, society, economics, cultural respect and political structure.

### 3.3 Systems Approach

STELLA® was used to construct the framework by which management of ecotourism activities, inclusive of visitor impacts, can be linked to water quality such that the output of the model will be water quality parameter values at a single point in the surface water. The point of interest is defined as one that is utilized by the tourists (e.g. for bathing) or by the ecohotel as a water withdrawal point. Before the STELLA® representations can be built, systems thinking theory had to be utilized to find a logical path of linking the entities in the aforementioned relationship in consideration of the limited data available. Once a numerical model was developed based on a single water quality parameter, the systems thinking behind it was tested by putting it into STELLA® to determine if it can be run i.e.

to determine whether the thinking behind the model is correct from a systems perspective. To double check that the numerical model was represented correctly in STELLA®, the automatically generated equations generated by STELLA® was algebraically manipulated to determine if the starting numerical model can be arrived at. To observe if this model can be applied to multiple water quality parameters a bi-indicator scenario was constructed in STELLA® after a modified numerical model was arrived at. As was done for the uni-indicator model, the automatically generated equations were algebraically manipulated to determine if the starting numerical model was indeed what was run in STELLA®.

The model developed utilizes staff and tourist dynamics as well as management's effect on water quality. This represents a first quantitative attempt to model ecotourism activities and surface water quality as a function of the ecosite's management, which according to the World Tourism Organization (WTO) is needed to assess the sustainability of the industry (Manson, 2008). Also of concern to the WTO is the impact that tourist themselves have on the often sensitive areas where ecotourism exists. This concern comes from the standpoint that when ecotourists visit these areas they often utilize sunscreens, gels, creams, etc. before utilizing waterways for ecotourism activities. As such the numerical and STELLA® model frameworks were created to easily include pharmaceuticals and personal care products (i.e. known endocrine disrupting compounds) that may be released into waterways by ecotourists as possible water quality indicators into the model. Recommendations of the data requirements for construction of a more stringent model have been determined and highlighted.

### 3.4 Incorporation of Sustainability into Caribbean Education

The idea and concepts of sustainability is current and spreading throughout the developed world, however the Caribbean has not yet begun to formalize sustainability education. As a first approach to attempt to suggest how this can be done there was an audit of Caribbean Examinations Council's (CXC) approved syllabi for high school and post high school subject offerings; literature review of published work on Caribbean education; and an audit of CXC approved pre-elementary and elementary school text books for highlighted and common themes. This assessment led to recommendations for where and how sustainability can be infused into curriculum and school activities (e.g. through clubs such as 4H club and Girl Guides as well as national and regional academic project-based competitions), both with the aims of increasing the awareness of sustainability in the Caribbean as well as the gathering of much needed data.

# CHAPTER 4: ECOTOURISM ACTIVITIES

## 4.1 Introduction

For the purposes of this work ecotourism activities encompassed all onsite activity that is needed to support the propagation of the ecotourism business. This includes other businesses operated onsite to offset or augment ecotourism profits and/or longevity. In order to gauge the magnitude and breadth of the impacts of ecotourism activities at each site typical environmental audit tools (see Appendix A) were created and used for assessment inclusive of a community survey, environmental checklist, screening and scoping exercise and a semi-structured interview. The results obtained were factored into observations made to create a tool for assessment that can transcend geographical boundaries within the Caribbean for the analysis of ecotourism activities.

### 4.1.1 Objective and Subtasks

The main aim of the work in this chapter is to study ecotourism activities at each site and develop a rigid and widely applicable sustainability reductionist tool that can be applied to ecotourism sites in the Caribbean so as to quantify impact. The specific subtasks were to:

- Create environmental audit instruments and use them onsite to collect information,
- Select indicators that can be representative across the Caribbean's ecotourism sites for assessing sustainability of ecotourism activities,
- Create an assessment tool that can be used across the Caribbean region at ecotourism facilities that is dynamic with demographic and social changes, and

- Provide site specific recommendations for improvement of the sustainability of ecotourism activities.

## 4.2 Comparison of Ecotourism at Greencastle and Iwokrama

### 4.2.1 Survey Results

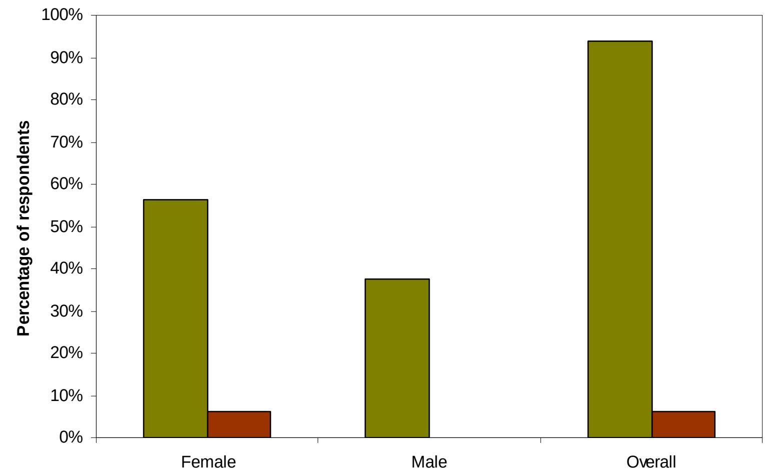
In order to assess and gauge community acceptance and perception of ecotourism activities in both study areas a person administered questionnaire was used as a survey instrument for persons found in and around the communities of concern. The survey instrument is shown in Appendix A and the compiled data collected at both sites are given in Appendix B. It should be noted that non-probability judgmental (purposive) sampling was carried out. This means that there was indeed bias in the study so as to eliminate persons that are known to be involved in the management activities at the study sites of interest.

At the Greencastle site it was found that all respondents (n=8; $n_{female}$=5; $n_{male}$=3) said that they will support the development of tourism/ecotourism activities in their communities but at the Iwokrama site only 94% of the total respondents (n=16; $n_{female}$=10; $n_{male}$=6) were of that supportive view. A myriad of responses were obtained from the tourism development supporters when questioned as to why they were of this view. All responses fell under 5 general themes as shown in Table 4.1.

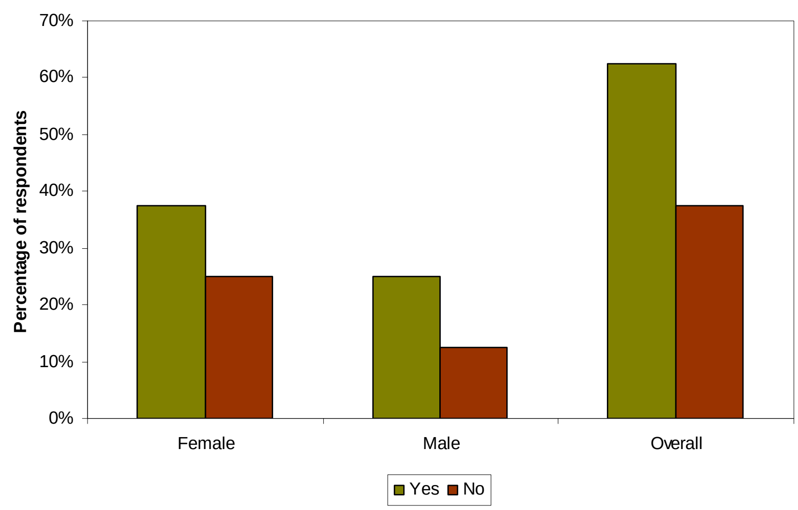
**Table 4.1** Respondents' rationale for supporting tourism development in Greencastle and Iwokrama.

| Theme | % of respondents | |
|---|---|---|
| | Greencastle | Iwokrama |
| Development of area | 25 | 19 |
| Job creation | 63 | 38 |
| Business diversity in the area | 13 | 0 |
| Revenue generation | 0 | 19 |
| Increased recognition of communities | 0 | 19 |

From Table 4.1 it can be seen that the majority of locals in and around Greencastle and Iwokrama believe that development of tourism in their communities will assist with job creation. In consideration of Figure 4.1, one can auger that locals are of this view since for most of the respondents the tourism industry provides gainful employment for fellow household members.




(a)

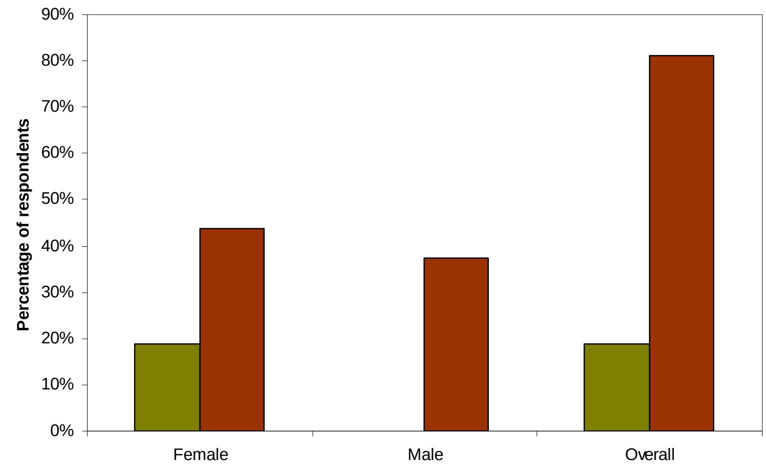



(b)

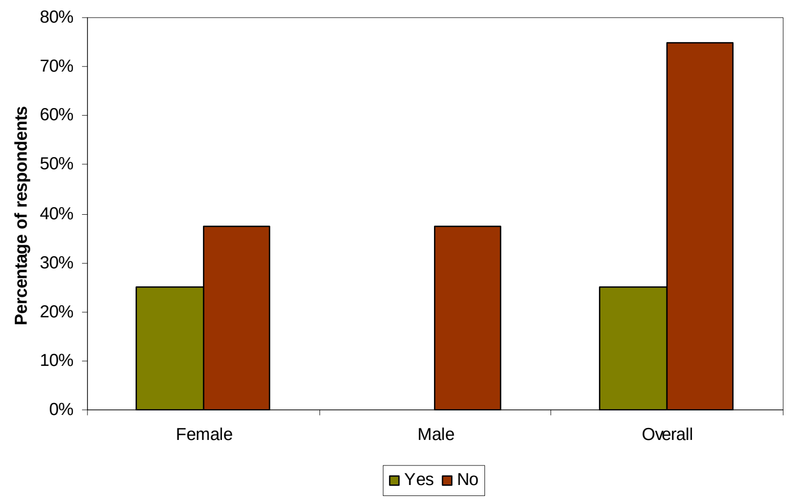
**Fig 4.1** Survey results for number of household members working in tourism industry. (a) Iwokrama and (b) Greencastle.

The modal number of household members working in tourism as determined at the Iwokrama site was 1 according to 88% of the respondents. However, a single respondent had 2 household members employed within tourism. Interesting to note is that of the 15 respondents that said their household contained tourism industry workers, the highest level of education of the tourism worker in the majority of those households (i.e. 10 of the 15) was reported as that of elementary or primary education. Of these 10 persons, their employment category can be classified as maids/kitchen staff.  Four other responses reported the highest education level to be attainment of a Caribbean Examination Council (CXC) certificate, the Caribbean's equivalent of a US High School Diploma while 1 other response stated the highest educational level to be a CXC graduate with vocational studies. The 4 CXC graduates are generally employed in the capacity of tour guides while the CXC graduate with vocational studies is employed as a mechanic in the industry.

A similar analysis for Greencastle showed that the modal number of household members working in tourism as also 1 with 63% frequency. All other responses claimed that none of their household members worked in the tourism industry. Of the 5 households with a member working in the tourism industry 3 of those had elementary or primary education as their highest formal level attained and they work as an office assistant/tour guide, maid and handyman. The 2 other households with tourism industry employees both have as their highest education level CXC attainment but at 2 different levels. The employee with the regular CXC high school graduation works as a maid but the other employee that has CXC with A levels is employed as a driver/mechanic. Note that A levels represents the equivalent of the first year of college in the Caribbean's system of education and can only be attempted after regular CXC high school graduation.




(a)




(b)

**Figure 4.2** Survey results for household utilization of tourism or ecotourism products and services. (a) Iwokrama and (b) Greencastle.

Despite several respondents at both sites having household members employed within the tourism industry, Figure 4.2 shows that the households in question, generally, do not utilize tourism or ecotourism products and services. Of the Iwokrama respondents 82% of the respondents' households do not use tourism products and services while at Greencastle 75% of the total respondents were of the same position. Table 4.2 summarized the common themes highlighted as reasons for the non-use of tourism or ecotourism products and services.

**Table 4.2** Respondents' rationale for non use of tourism products and services in Greencastle and Iwokrama.

| Theme | % of respondents | |
|---|---|---|
| | Greencastle | Iwokrama |
| Expensive | 0 | 44 |
| Busy | 63 | 13 |
| Not interested | 0 | 19 |
| Uncertain | 0 | 7 |
| Too old | 13 | 0 |

From Table 4.2 it is clear that the major deterrent from using the product and services of tourism is cost or expense in the case of Iwokrama respondents while the Greencastle respondents attributed the same to their lack of time. The survey respondents' average annual household income for the Greencastle respondents is approximately US$1068 while that for the Iwokrama respondents is approximately US$567.

Regardless of their views on supporting the development of tourism in their communities or the reasons for not using tourism amenities, all respondents agreed that their communities had all the necessary amenities and/or infrastructure to allow for further development of the industry. The respondents were able to give an array of ideas as to how they wish to see the development of the industry in their communities. Their responses are given below in Table 4.3.

**Table 4.3** Suggested activities given by Greencastle and Iwokrama respondents for the enhancement of the tourism / ecotourism product in their communities.

| Area | Suggested activity |
|---|---|
| Lethem (Guyana) | Bird watching<br>Training persons to be bird watching guides<br>Development of nature trails for bird watching |
| Georgetown (Guyana) | Sailing or kiting |
| Rupununi (Guyana) | Development of a butterfly farm like in Fairview<br>Organic farming to support Iwokrama International Center's growing food needs<br>Craft with natural materials for sale<br>Outdoor camping |
| Fairview (Guyana) | Annual heritage festival<br>Rafting in rapids<br>Boat trips<br>Fishing experience - especially using traditional Indian methods<br>Craft store to give more opportunities to young women |
| Greencastle area (Jamaica) | Water sports for the sea<br>Kayaking<br>Anything that utilizes the sea around Robin's Bay<br>Yearly community festival<br>Opening a craft store with handicrafts made by the local community<br>Night time beach bar<br>Coastal water sports |

### 4.2.2 Onsite Ecotourism Activities

#### 4.2.2.1 Greencastle, Jamaica

Ecotourism in the Caribbean is highly seasonal with annual interruptions due to hurricane seasons as well as prolonged rainy seasons. The management of Greencastle Estate together with the Board Members of Greencastle Tropical Study Center (GTSC), the not-for-profit Non Governmental Organization (NGO) that manages the ecotourism activities, has embarked upon leasing various parts of the property for several different onsite operations that lend to the income generation to promote ecotourism. Some of the more noteworthy operations include Greencastle Orchids, JamOrganiX and the Jack's Bay beach facility.

According to GTSC, Greencastle Orchids is Jamaica's largest producer and supplier of cut orchids as well as potted orchid plants. At Greencastle Estate their operations are in 3 one-acre shade houses and a one-half acre main house. The primary product is cut flowers. In addition to cut flowers, the operation includes approximately 30,000 potted orchids which are sold on the local market. The greenhouses are part of the Estate tour for ecotourists.

JamOrganiX prides itself in organic farming, unlike the Greencastle Orchids operation. JamOrganiX uses, at an agreed price to GTSC, the onsite coconuts to produce at Greencastle Estate coconut oil by traditional methods. This company also uses the arable land on the Estate to grow hot peppers and pimento. These crops when harvested are taken offsite for further processing. It should be noted that during the Estate tour tourists are allowed to see the oil production process.

At Jack's Bay beach facility, GTSC has leased a narrow strip of property to the operators to run a day beach facility. Here persons that wish to partake are asked to pay a modest daily fee of US$3 per adult and US$1.50 per child. The facility allows for seclusion in a clean, partitioned surrounding where daily lunch is prepared for sale. Ecotourists at Greencastle are taken to Jack's Bay through arrangement with GTSC at no extra charge. The operators are trying to obtain a bar license which they believe will further attract clientele.

GTSC has a none-cost arrangement with Jamaica's Eastern Livestock Development Association Limited. Part of this arrangement uses about 3 acres of Greencastle's pasture for rearing of cattle in dwindling numbers in Jamaica. Currently there are 4 different breeds that are kept on site. This herd consists of pedigreed animals of the Jamaican Red Poll, Jamaican Black Poll and Jamaican Brahman breeds.

Greencastle Estate offers ridge to coast tourism. The rare location of Greencastle allows it to attract the typical ecotourist, the coastal ecotourist, as well as the sun-sea-and-sand tourist. With ocean views from the Estate House, the sole current ecotourist accommodation onsite, there are views of the surrounding ocean below. Both Jack's Bay and Fisherman's Beach are in walking distance and are frequently utilized by guests. Also well received is the Blue Hole, an inlet bay at the coast where an old sunken boat and its turquoise blue waters makes it an ideal candidate for snorkeling. All of these coastal features are included in the Estate tour along with a tour of the craft shop, Taino ruins as well as an 18$^{th}$ century historic windmill and waterfall. Besides these tourist activities, guests are often entertained at nearby bars and eating places in the surrounding communities (Robin's Bay and Rosend). The road that is called the North Coast Highway in Figure 4.3 actually passes through the Greencastle Estate's mangrove ecosystem closer to the coast. Though zoned as rural Jamaica this area cannot be considered remote very much unlike the Iwokrama site that is well removed from major infrastructurally developed settlements as well as the coast.

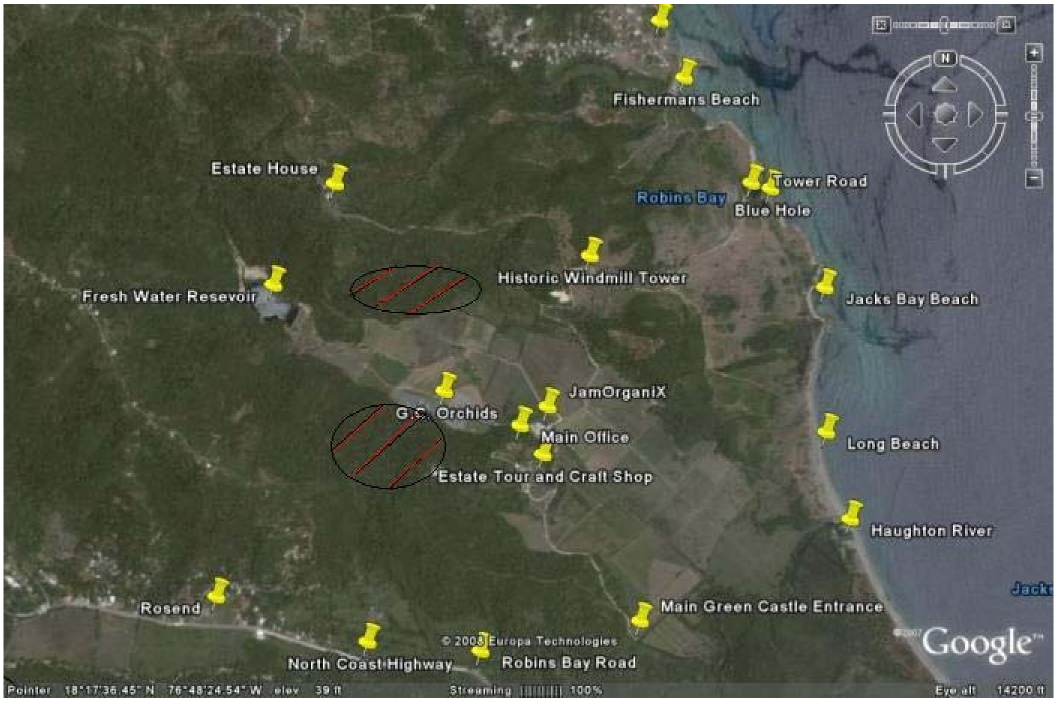



**Figure 4.3** Google Earth image of Greencastle with circled areas showing future boutique hotel suites.

Though plans for the ecotourism expansion project have not been made clear for purposes of this study, it is known that the Greencastle management is embarking on the construction of 5 to 10 boutique suites to add to the ecotourism accommodations. The suites are intended to be in the circled areas of Figure 4.3. The suites will be constructed between 2010 and 2014. The planned construction phase would involve construction on the 2 slopes independently and separately. On each slope there is expected to be small sized communal type swimming pools, a detail which was left out of the checklist (see Appendix B) when it was completed by Greencastle officials but was incorporated into confidential plans that were later shared.

GTSC has embarked upon several educational and training ventures that include collaboration with schools, community and an agriculture based government institution. In an effort to start developing an environmental monitoring program, GTSC has just commenced work on collaboration through academia with the University of Minnesota as well as the University of the West Indies, Mona, Jamaica. There is not yet any rigor in the current monitoring. Since 2007 to date, monitoring is done through classes offered at the aforementioned universities once annually. GTSC has offered non-certified agricultural tour guide training primarily to residents of Robin's Bay and Rosend once since its inception. There has been collaboration with the local St. Mary's Agricultural Extension Office where GTSC has arranged for the office to utilize Greencastle Estate as a hands-on teaching space for its School Education Series. Programs that are currently carded to start include: Robin's Bay Basic and Primary School Environmental Improvement; Eco-Tourism Community Capacity Building; and Education Initiative for GTSC Employees and Their Children.

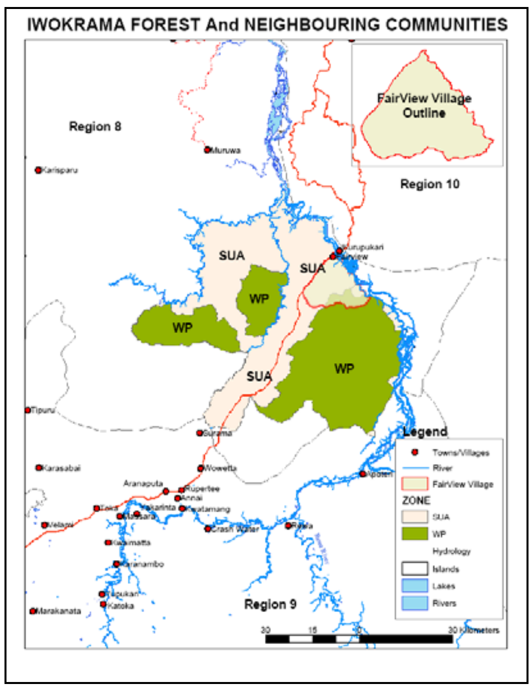
The facilities at Greencastle Estate that allow for all these activities include maid quarters adjoining the Estate House that can house 2 persons; a managers residence; a security dwelling (above the Estate House); an office and business center with training room; researcher residence hall; and temporary worker accommodations. Note that these amenities are in addition to those used for production by JamOrganiX and Greencastle Orchids.

#### 4.2.2.2 Iwokrama, Guyana

Guyana being on the South American continent is safe from the Inter Tropical Convergence Zone and hence is unaffected by hurricanes. Nevertheless, like most of Amazonia, Guyana experiences 2 rainy seasons annually which coincides with Iwokrama's low tourist arrival records. As such, there is a need to get involved in other activities onsite to generate revenue towards the cause of environmental preservation.

The Iwokrama International Center (IIC), the government-affiliated autonomous organization that manages ecotourism activities at Iwokrama, has an ongoing timber business that involves a number of the surrounding communities inclusive of Fairview Village which actually lies entirely within the Iwokrama forest boundary (see Figure 4.4). Fairview Village actually owns 22,000 hectares of Iwokrama forest. The business only operates in areas designated as Sustainable Utilization Areas (SUA).

Note that IIC is involved in the timber business with 16 other surrounding communities, most of which lie in Region 9 as shown in Figure 4.4.




SUA – Sustainable Utilization Area; WP – Wilderness Preserve

**Figure 4.4** Iwokrama forest and its surrounding communities. (Source: Dr. Raquel Thomas of IIC)

Iwokrama is certified for sustainable forest management and good practice timber production by the Forest Stewardship Council (FSC). The FSC has also bestowed upon the IIC the ability to train locals in sustainable forestry and present them with FSC certificates upon completion. With this certification and power of training under the FSC umbrella, IIC is mandated to upkeep strict environmental preservation and conservation methods and have annual audits to evaluate effectiveness. Thus Iwokrama has its own environmental monitoring (inclusive primarily of road, river and forest impact monitoring) unit that attempts to fulfill this mandate while increasing its analytical capabilities.

There is a formalized partnership, in the form of a joint venture company (JVC), for the timber business at Iwokrama that involves IIC, Fairview Village, the 16 collaborating communities as well as a private company (Tigerwood Guyana Inc.). The agreement is extrapolated upon in Figure 4.5.

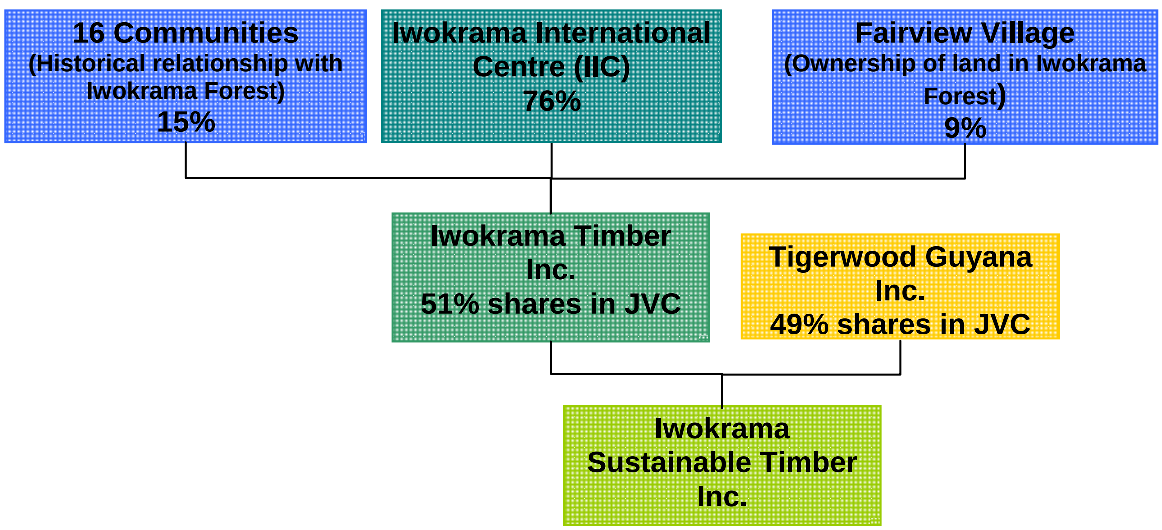



**Figure 4.5** Iwokrama sustainable forestry partnership agreements. (Source: Dr. Raquel Thomas of IIC)

The Iwokrama forest is a dendritic network of rivers throughout its nearly one million acres and so it allows for use of its water courses by ecotourists. For the ecotourist the river networks are not just used for occasional bathing but for guided bird watching boat trips as well as to get to various points of ecological interest within the forest inclusive of Turtle Mountain. From the tourist accommodations there are also many nature trails for exploring the forest. As a part of the Iwokrama ecotourism appeal is the Fairview butterfly farm which is a short walk from guest housing. A reported favorite of ecotourists is the Iwokrama canopy walk which is accessible by road.

IIC has onsite 4 researcher/staff accommodation building each with a capacity of 10 persons. Also at the main site are 5 bungalows for tourists as well as a business center that houses conference and training facilities among other amenities such as a mini grocery/craft store, the kitchen and storage of GIS and monitoring equipment. In the next 1 – 4 years IIC is expected to exactly duplicate (in both design and construction) its researcher/staff accommodation, inclusive of bathroom facilities. At the timber field station there is a large open shed used for housing sawmills, other related tools and equipment as well as cut lumber.

## 4.3 Sustainability of Ecotourism Activities

### 4.3.1 Chosen Ecotourism Indicators

Ecotourism indicators selected are applicable throughout the Caribbean region. Thus assignments of measures of impacts to the indicators were done in keeping with data and information which is currently available in the Caribbean region.

#### 4.3.1.1 Method of Selection

Primarily the WTO's *Indicators of Sustainable Development for Tourism Destinations* guide (2004) was used as a guide for choice of indicators. This guide describes around 50 major sustainability issues and makes recommendations for indicators to measure them. Concrete application examples are provided for each issue and there are around 20 case studies included for complete indicator application frameworks at different destinations. The sustainability issues are grouped as socio-cultural, economic, or environmental in consideration of management and global issues and cover a wide range of topics from the satisfaction of local communities and tourists, through the management of natural resources (e.g. water, energy), land use, seasonality, employment, health and safety, planning process, just to mention a few.

A shortlisted indicator inventory was then put through the Driving force-State-Response (DSR) Framework based upon the modified (i.e. in consideration of ecotourism) Pressure-State-Response (PSR) Framework (shown in Figure 4.6) for selection of the most crucial indicators to ecotourism activities' sustainability in the Caribbean.

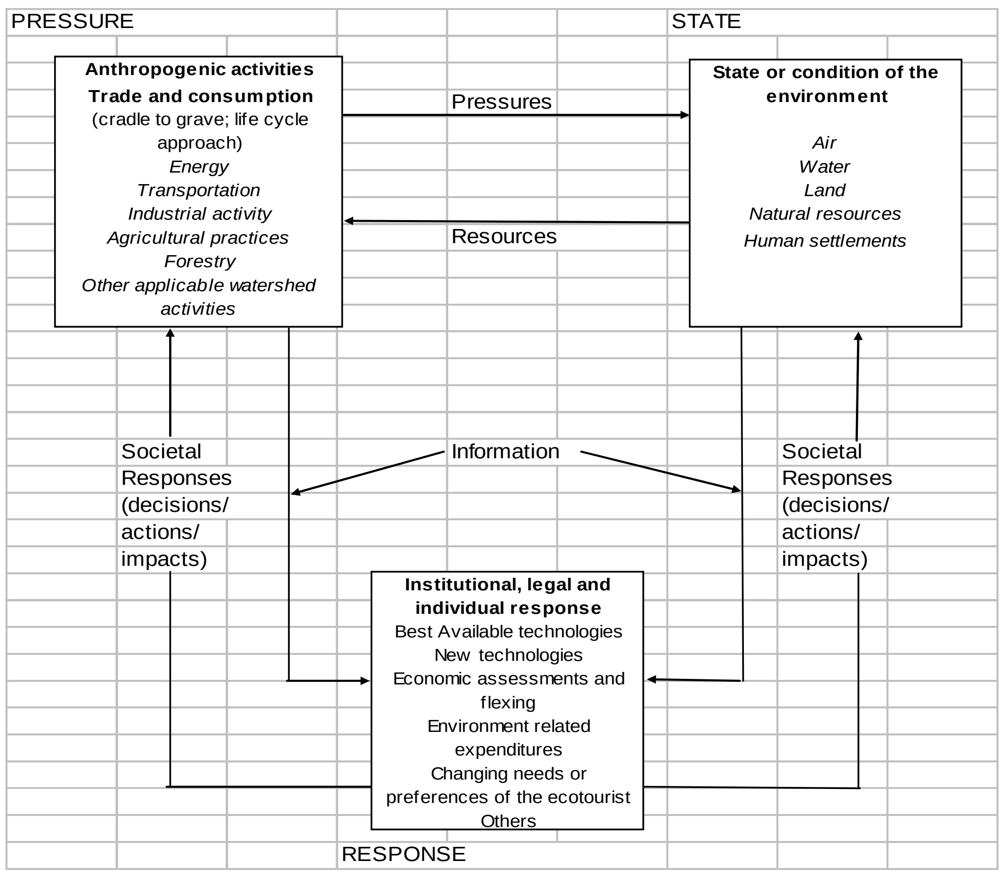



**Figure 4.6** Ecotourism Pressure-State-Response framework (adapted from Griffith, 2007).

It should be noted that in the DSR model the driving force replaces the pressure term in the PSR model as pressure was associated with negative environmental impacts of development (Mortensen, 1997). However, the use of driving force to replace pressure was done to encompass both the positive as well as negative impact of development on the environment and society (Mannis, 2002). Thus the DSR/PSR matrix, as was developed by the Organization of Economic Cooperation and Development (OECD), was utilized to assign priority to societal and environmental indicators as well as to define the indicators as either driving force indicators, state indicators or response indicators. Driving force indicators refer to human activities patterns and processes that have, or can have an impact on any attempt for sustainable development. These indicators typically give an indication of the impacts – positive or negative – on the condition of the desired level of sustainable development. State indicators, as the name suggests, simply give the state or condition of sustainable development at any given instance. Mortensen (1997) and Greenwood (2006) stated that the response indicators refer to options for policy as well as responses to changes in the state indicators.

The final selection of all indicators hinged largely upon the WTO's core categories of indicators for sustainable tourism. These core categories and their suggested units (where applicable) of weighting are shown below in Table 4.4.

**Table 4.4** Core indicators of the WTO for Sustainable Tourism (adapted from WTO, 1996).

| Sphere | Core Indicator | Suggested measure |
|---|---|---|
| Environmental | Waste management | Amount of sewage produced from site and/or receiving treatment (kg/person/month) |
| | | Grey water production/water demand (gallons/person/month) |
| | Critical ecosystems | Quantified rare fauna and flora (number per specie/hectare) |
| | | Endangered species' presence (number per specie/hectare) |
| | Site protection | Level of protection of natural resources (comparative measure) |
| | Stress | Tourists numbers visiting the site (persons/month) |
| | Developmental planning | Existence of environmental assessment protocol and/or controls over development of site and use densities |
| | Use intensity | Stringency of use of destination in peak periods (persons/hectare) |
| Societal | Social impact | Ratio of tourists to locals (person/person/month) |
| | Planning process | Existence of local and/or regional frameworks for tourism destinations |
| | Customer satisfaction | Level of satisfaction by visitors (questionnaire based) |
| | Local satisfaction | Level of satisfaction by locals (questionnaire based) |
| Economic | Contribution of tourism to the local economy | % of total local economic activity generated by tourism ($/tourist/month) |

### 4.3.2 Selected Indicators

After screening, 15 indicators were chosen among the 3 core spheres of sustainability: Environmental, Economic and Societal. The 15 indicators all fell into 1 or more of the core WTO sustainable tourism indicators. These indicator designations along with the type classification in reference to the DSR model are given in Table 4.5. This classification will assist in assigning recommendations in section 4.4.

**Table 4.5** Classifications of selected indicators.

| Sphere | Indicator | Applicable core WTO indicator(s) | Type of Indicator |
|---|---|---|---|
| Environmental | Energy consumption/demand | Waste management | Driving force |
| | Ecological footprint | Use intensity; critical ecosystems | Driving force |
| | Solid waste generated/recycled | Waste management | Driving force |
| | Biocapacity | Stress; developmental planning; use intensity; critical ecosystems | State |
| | Potable water demand | Waste management | State |
| | Grey water disposal | Waste management; site protection | State |
| | Internal environmental monitoring level | Site protection; developmental planning | State |
| Economic | Operational and management cost | Contribution of tourism to the local economy; local satisfaction | State |
| | Cost to users | Customer satisfaction | Response |
| Societal | Community involvement in ecotourism activities | Contribution of tourism to the local economy; local satisfaction | State |
| | Tourism revenue accrued to the community | Contribution of tourism to the local economy; social impact | State |
| | Number of local workers employed in tourism | Contribution of tourism to the local economy; local satisfaction; social impact | Response |
| | Integration of tourism into local/regional framework (i.e. laws) | Planning process | Response |
| | Certification adoption | Planning process; customer satisfaction; development planning | Response |
| | Training of locals for ecotourism jobs | Social impact | Response |

Each indicator selected is described below.

#### 4.3.2.1 Indicator 1 - Energy Consumption/Demand

Energy production, transmission and distribution are neither cheap nor reliable in much of the developing world. The energy needs of the ecotourism facility should first and foremost not be in competition with that of their surrounding communities while there needs to be on-going attempts to reduce its load through conservation efforts, etc. Thus an audit of the consumption patterns of the facility can quantify this indicator and impact assigned when compared to the average per capita consumption.

#### 4.3.2.2 Indicator 2 - Ecological Footprint

Ecological footprint (EF) represents a method that allows for quantification of sustainability. Theoretically, EF can be quantified, and compared, on the level of geographic location, institutions, households and individuals. EF is actually a summation of a few other tools and assessment approaches (Wackernagel et al., 1999) many of which were not quantifiable. EF is typically measured in global hectares (gha) where 1 gha represents the equivalent to a hectare of biologically productive space with world average productivity (Patterson, 2005).

According to the introducers of the concept (Wackernagel and Rees, 1996), an EF is simply a measure of the total area of productive land and water required to continuously produce all resources consumed while assimilating all wastes produced by a defined population in a geographic region. Thus, according to Costanza (2000), EF is of particular importance and usefulness as it agglomerates and transitions complex resource use patterns into a single value.

The template used to assess EF was developed by Wackernagel and Rees (1995). The assessment method is a matrix method hinged upon 5 core consumption categories and 6 major land use categories (Ryu, 2005). The consumption categories are: food, housing, transportation, consumer goods, services and wastes while the land use determinants are: cropland, grazing land, forest, built-up land, fish and carbon assimilating capacity. The actual Wackernagel method to compute the EF value consists of 3 sections (Kumar et al., 2001): consumption analysis (consumption = imports + production – exports); energy balances (traded energy = net imports x embodied energy); and summation (all EF components are added). Note that if the total area required for propagating and supporting the final consumption of a given study population exceeds what is available locally, this would imply that the population being studied is mimicking the carrying capacity of 'similar' localities (Feng, 2001). The actual EF at each site was calculated by using the EF calculator tool as accessed from www.rprogress.org (on April 15$^{th}$, 2009).

In assigning impact factor for this indicator the World Wildlife Fund's (WWF, 2000) *National rankings of ecological footprints by country* publication can be used for comparison.

#### 4.3.2.3 Indicator 3 - Solid Waste Generated/Recycled

In the Caribbean, there are very few legal dumping grounds and most nations are plagued with irregular collection of solid waste by public entities. Thus one of the promoted activities for ecotourism facilities is reuse of wastes through re-purposing of materials, composting and/or recycling. Attempts to do these kinds of programs by ecotourism facilities can greatly reduce the negative impacts of solid waste generation. To quantify the actual amount of waste generated, a mass balance has to be computed over time.

#### 4.3.2.4 Indicator 4 - Biocapacity

The carrying capacity concept has long been utilized in the tourism sector and it is from this line of thinking that the biocapacity concept was born. Biocapacity simply represents the total extension of ecologically productive land in an area. In other words, it is really the potential capacity to supply natural services from local ecosystems (Patterson, 2005).

Note that in the calculation of biocapacity some level of the existing biocapacity must be considered as untouchable for human use. According to Wackernagel (1994), 12% of the existing biocapacity needs to be taken as indispensable to account for the conservation of biodiversity. Similar to the calculation of EF, biocapacity calculations were done by using the spreadsheet that is downloadable from www.rprogress.org (accessed April 15th, 2009).

#### 4.3.2.5 Indicator 5 - Potable Water Demand

Ecotourism does necessitate some potable water source to meet the demands of guests and staff alike. Efforts to reduce this demand on municipal supply, especially through alternative means of water supply, are of particular importance when assessing the sustainability of operations. With over 40% of the Caribbean's potable water distributed being unaccounted-for water, ecotourism facilities are to be conscious that their demand does not interrupt the supply that is demanded to the typical rural areas in which they reside. Comparison of the individual ecotourism facility's per visitor water consumption to that of the respective national average consumption can provide a quantifiable indication of impact.

#### 4.3.2.6 Indicator 6 - Grey Water Disposal

The analysis of this indicator has 2 dimensions: the method of disposal and the quantity to be disposed of per person. Whether the best disposal practices are adhered to or not will affect the impact as well as the quantity to be dealt with. Both territories, Jamaica and Guyana, have guidelines for remote areas that mandate the use of septic systems with leach field for handling grey water. As for the assessment of quantity, the per person per site disposal value needs to be compared to the average per capita Caribbean estimate.

#### 4.3.2.7 Indicator 7 - Internal Environmental Monitoring Level

In order to be serious about a mission of engaging in sustainable tourism activity there is a need to engage in regimented, scheduled environmental monitoring. A simple audit of the extent of site specific monitoring programs can be used to quantify this impact against the typical environmental monitoring needs of tourism facilities as given in the World Bank Technical Paper 140 (*Environmental Assessment Sourcebook, Volume 11: Sectoral Guidelines, 1991*).

#### 4.3.2.8 Indicator 8 - Operational and Management Cost

One of the underpinnings of ecotourism as a business is its potential to allow for environmental preservation while earning essential revenue to allow for enhancing of onsite preservation techniques. One way of better achieving this mandate is by reducing operational and management costs. The operational costs associated with ecotourism include power and water supply, upkeep of infrastructure and landscaping. The average operational and management cost per visitor can be compared to that of the Caribbean Tourism Organization (CTO) for eco hotels when assigning an impact.

#### 4.3.2.9 Indicator 9 - Cost to Users

According to Panda, Mishra and Parida (2004), value is more important than price but fees need to be constantly adjusted to incorporate changes in inflation and demand for the attraction within the local tourism market. This statement implies that there is a need to both price cost to users in consideration of economic factors as well as at a price that allows for the sustainability of the attractiveness of the destination through proper pricing. To get an indication of this impact the number of guests has to be considered with the suggested CTO regional per night pricing suggestions.

#### 4.3.2.10 Indicator 10 - Community Involvement in Ecotourism Activities

The basic premise behind this indicator is that in order for a local activity to be sustainable, the local community members must have interest and become involved. The community has the right to be aware of ongoing activities with regards to tourism, especially if they are considered a stakeholder. Thus the community should have access to analyzed information and be encouraged to participate in the decision making. Without this interest the eco facility may be forced to seek external assistance in light of exacerbated security issues towards the operations and the guests. Thus, community involvement is considered by the WTO to be an almost mandatory commensalistic relationship for the true sustainability of ecotourism activities. To measure this impact, the level of community involvement has to be dissected to determine the role of the community in the functioning of the ecotourism activities onsite.

#### 4.3.2.11 Indicator 11 - Tourism Revenue Accrued to the Community

Since 2002, the International Year of Ecotourism, the WTO has promoted ecotourism as a venture for poverty alleviation in remote areas especially in developing countries. This idea of enhancing ecotourism sustainability in the community has led to several success stories globally which have further promoted the use of this indicator in ecotourism planning. The 2 main routes that allows for tourism revenues are through direct community partnerships and then through indirect community retailing to accommodate the guests of increased tourism activity in the area.

#### 4.3.2.12 Indicator 12 - Number of Local Workers Employed in Tourism

The WTO has listed as a major indicator of the survival of any tourism venture the need for continuous employment of locals to ensure a steady supply of both indirect revenue for the community as well as potential employees for the onsite ecotourism activities.

#### 4.3.2.13 Indicator 13 - Integration of Tourism into Local/Regional Framework

The institutionalization of meaningful measures to at least promote environmental sustainability necessitates some level of reporting of both lessons learnt and future expectations to local and or regional agencies. These agencies can then inform the legislators as to what legal measures need to be put in place to allow for sustainable development of the industry. This necessitates the internal acceptance and development of sustainability indicators that are monitored with trend analysis; incorporation of environmental training into management's talent pool; as well as infusion of stakeholder participation in planning exercises.

#### 4.3.2.14 Indicator 14 - Certification Adoption

In the realm of tourism, and more so ecotourism, obtaining voluntary certification of operations is a definitive statement of dedication towards sustainable operations. To attain and keep certification through any of the numerous certifying bodies, the eco-facility will have to undergo and pass continuous environmental audits, many of which are unannounced. Any step towards achieving or ensuring certification is attained and retained are measures to reduce overall impact of ecotourism activities.

#### 4.3.2.15 Indicator 15 - Training of Locals for Ecotourism Jobs

In order for ecotourism to be truly sustainable, there must be a readily available trained workforce in the area where the activity is underway. Thus the ability to offer training and then the actual offering of training needs to be factored in. The frequency of training, accessibility (in terms of cost and schedule) of training to the community members as well as the certification of the training all can give a measure of the societal importance of the ecotourism activities to the management.

In consideration of the above mentioned indicator descriptions, Table 4.6 summarizes the unit of measure for each indicator in determining impact.

**Table 4.6** Selected indicators and their units of impact measurement.

| | Indicator | Unit of measure |
|---|---|---|
| | *Environmental* | |
| 1 | Energy consumption/demand | kWh/day/visitor |
| 2 | Ecological footprint | Global hectares/visitor |
| 3 | Solid waste generated/recycled | kg/day/visitor |
| 4 | Biocapacity | Global hectares/visitor |
| 5 | Potable water demand | Gallons per day/visitor |
| 6 | Grey water disposal | Gallons per day/visitor |
| 7 | Internal environmental monitoring level | Qualitative measure |
| | *Economic* | |
| 8 | Operational and management cost | $/visitor |
| 9 | Cost to users | $/night/room |
| | *Societal* | |
| 10 | Community involvement in ecotourism activities | Qualitative measure |
| 11 | Tourism revenue accrued to the community | $/visitor |
| 12 | Number of local workers employed in tourism | Population fraction employed/visitor |
| 13 | Integration of tourism into local/regional framework (i.e. laws) | Qualitative measure |
| 14 | Certification adoption | Qualitative measure |
| 15 | Training of locals for ecotourism jobs | Local employee to tourist ratio |

### 4.3.3 Overall Sustainability of Ecotourism Activities

Even in a single region, such as the Caribbean, it is expected that overall sustainability of ecotourism activities will vary due to different level of indicator impacts. The selected indicators were able to assess sustainability of ecotourism activities within the 3 core spheres of sustainability: environmental, economic and societal. To combine the 3 aspects of ecotourism activities' sustainability specific site target plots were used. The genesis of target plots for environmental application was in material selection as applied to life cycle assessments in product design (Graedel, 1998). These plots are found to provide a useful overall assessment and so there applicability to overall sustainability assessment seems in lieu. Target plots thus allow for quick visual comparisons across the 3 spheres of sustainability.

Figure 4.7 shows the sustainability indicators utilized in the analysis of ecotourism activities within the 3 dimensions of sustainability. It also shows the impacts of each indicator on a scale of 0 to 3, where a rating of 0 indicated no impact and that of 3 indicates highest impact. Thus an impact value closer to the center, for any given indicator, is more preferable.

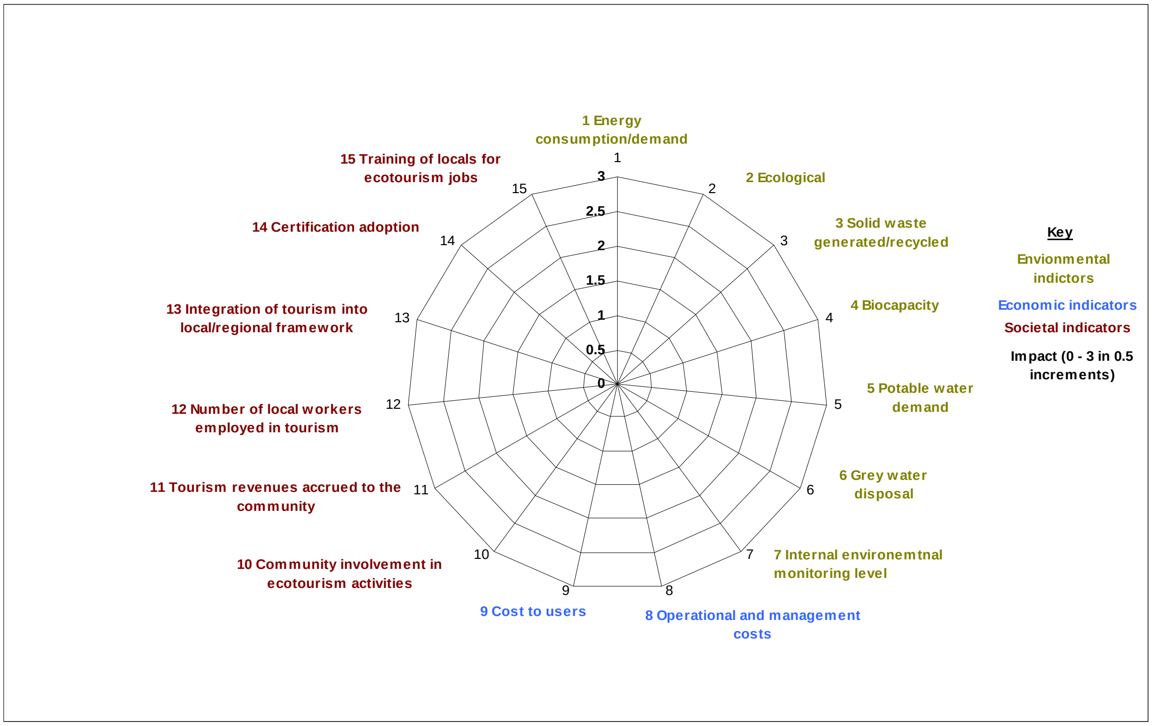



**Figure 4.7** Target plot showing the sustainability dimensions of ecotourism activities and selected indicators.

#### 4.3.3.1 Scenarios to Test Effect on Overall Sustainability of Ecotourism Activities

An assessment of sustainability was done for each site in consideration of 5 scenarios. The scenarios that were tested are:

- Scenario 1:Carrying out the plans to improve infrastructure at each site in the next 5 years;
- Scenario 2: Population increases in the watershed of concern by 50%;
- Scenario 3: Stricter monitoring of environmental laws and regulation by governmental agencies;
- Scenario 4: 50% increase in tourist arrival annually; and
- Scenario 5: 50% reduction in annual tourist arrivals.

Some of the considerations used in assigning impact factors are highlighted below by indicator. These were used in tandem with the results of the survey (summarized above and full details are in Appendix B) as well as the responses of informal interviews conducted and under the assumption that only the planned activities that are reported above will be ongoing or have been completed. Note that the list hereunder is by no means exhaustive but rather should provide an idea of what was considered to make an assessment of potential impact so as to ensure that impacts inculcated aspects that were beyond simply the comparison of measured indicator values (where applicable).

*Indicator 1 - Energy consumption/demand*

- What is the minimum energy requirement for operation?
- Are there any energy saving programs in place on site?
- Are policies in place to encourage guests to minimize electricity use?
- Is hot water available to guests in showers?
- What is the cost of energy consumption?

- Are there technological fixes in place to minimize dependence on non-renewable fuels? What is the typical bill for the facility when running at full guest load?
- Are the energy needs met by more than one source?
- Are there any plans by government or private ventures to increase gridded power supply in the area?
- Is energy demand reduction at the household level a priority?

*Indicator 2 - Ecological footprint*

- Are buildings constructed to greatly reduce the amount of impervious surface?
- Are buildings built on the ground or above ground?
- Are the above ground buildings able to allow easy access for stormwater to percolate? How much green space has (or have) to be lost in order to erect buildings?
- Are driveways and roadways paved?
- Will any increase in the number of buildings at the site, constructed in a similar manner, increase the ecological footprint of the site?
- Are drains and canals present and impervious?
- Does the site produce any emissions during normal operations?
- If there are emissions, can any of them be considered green house gases?
- What is the rate of emissions?
- Are there any obvious discharges to on site water bodies?
- Are there any activities on site that can potentially lead to toxic run off into waterways?

*Indicator 3 - Solid waste generated/recycled*

- How much solid waste is created on site?

- What it the rate of production of this waste?
- Are there any programs that are currently being implemented to reduce solid waste generation/promote recycling?
- Is staff being trained in reuse and recycling?
- Does the country/county/parish promote recycling?
- Is there any financial incentive to become involved in recycling?
- What items are allowed for recycling (i.e. glass only, plastics only, both)?
- Is composting encouraged on site?
- Are items that cannot be necessarily recycled at least re-purposed on site?
- Is recycling the norm at the household level?
- Is there any national drive to promote recycling by businesses and households?
- Is guest waste sorted after room collection?

*Indicator 4 - Biocapacity*

- What is the extent of ecologically productive land available?
- What is the total land area of the eco facility?
- Does the area have the ability to supply all its required local ecological resources?
- Do on site activities allow for preservation of biodiversity?
- Is biodiversity compromised during normal operations of the eco facility?

*Indicator 5 - Potable water demand*

- Is potable water required for the day-to-day operations of the ecotourism activities?
- How much potable water is required for daily operation of the facility?
- On average, how much potable water is required per guest daily?

- Is any of the potable water demand subsidized by other water sources?
- Is rain water harvesting done? Is surface water utilized for non drinking purposes?
- Is the eco-facility connected for direct treatment plant supply?
- Is the water obtained from a public or private utility?
- What is the cost of potable water?
- Did the eco facility have to input its own lines to gain supply or was there an existing distribution grid in the area?
- Is the potable water supply regular?
- Does the potable water demand exceed the supply schedule (thus necessitating intermediate storage)?

*Indicator 6 - Grey water disposal*

- How is grey water disposed of on site?
- What is the average daily production of grey water from the facility in both tourist low and high seasons?
- Is the disposal system monitored and/or maintained?
- How is the disposal system monitored and maintained?
- Is the grey water disposed well away from surface waters?
- Are there any plans in the works to reduce the amount of grey water produced by the facility?
- With an increase in tourist flow, will the current disposal system be able to handle increased loading?
- How is grey water typically disposed of in the area?
- Is there a national standard for the proper disposal of grey water?

*Indicator 7 - Internal environmental monitoring level*

- Is there a formal environmental monitoring program adopted?
- If yes, how long has the program been ongoing?
- What is the frequency of monitoring?
- What parameters are currently monitored?
- Is the monitoring done in-house or contracted?
- Are employees of the eco facility trained to carry out the monitoring?
- Does the facility own equipment to undertake its own monitoring?
- Are the methods utilized standard? Is there an inventory of historical data?
- How is the data analyzed?
- Are the results of the analyses used to make any operational changes?
- Are there any plans to strengthen the program by using more stringent methods or a wider range of parameters?

*Indicator 8 - Operational and management cost*

- Are the operational costs high?
- What are the major drivers of the operational costs?
- What efforts, if any, are currently being undertaken to reduce operational costs?
- What is the current average operational cost per visitor?
- What are the managerial costs associated with daily operations?
- What is the average managerial cost per visitor?
- What is being done to reduce managerial costs?
- Is there any internal auditing team set up to assess these costs?

*Indicator 9 - Cost to users*

- Are any facilities that were used by locals now accessible only by fee due to tourism activities?
- What is the per night cost to visitors?
- Is the per night cost to visitors different in the tourist high and low seasons?
- Are any efforts being tried to lower the cost to users?
- Is there a discounted cost to nationals and/or Caribbean natives?
- What are the factors affecting the calculated cost to users?
- Are tourists satisfied with the value for their money?

*Indicator 10 - Community involvement in ecotourism activities*

- Are there any formal or informal partnerships with surrounding communities?
- How long have relationships with the nearby communities existed?
- Does the eco facility sponsor or donate to community initiatives?
- What is the general perception of the impact of tourism on the communities?
- What is the perception of tourist contribution to local culture?
- Are the communities kept updated on plans for sustainable tourism?
- What is the perception of the community with regards to the quality and quantity of the information that it receives as it pertains to tourism issues and sustainability?
- Does the eco facility consider the surrounding communities key stakeholders in their tourism venture?

*Indicator 11 - Tourism revenue accrued to the community*

- Does the community perceive that it benefits financially from the ecotourism activities in the area?

- Does the eco facility have any percentage profit arrangement with the community?
- If there is a financial profit percentage arrangement how long has this been in place?
- Are the revenues that the communities obtain from tourism only through non-contractual sales?
- Does the management of the eco facility encourage the patronage of the communities by their guests?

*Indicator 12 - Number of local workers employed in tourism*

- Is the business an equal opportunity employer?
- Does the business provide gainful employment for women?
- Are there any plans to increase the number of local employees in the business?
- Are the majority of on site workers from the surrounding communities?
- Is the average salary of the employees above the national per day average?
- Is the required range of skills needed in employees available locally?
- If yes, are these skills readily available within the surrounding communities?

*Indicator 13 - Integration of tourism into local/regional framework (i.e. laws)*

- What is the number and types of new legislation or amendments introduced to preserve eco sites at the local/national level?
- Is there a local government arm that has a mandate for administering tourism in the area?
- Are the applicable laws monitored by governmental agencies?
- Do laws that are currently in place adequately address environmental concerns arising out of tourism operations?

- Does the site have nationally unique flora and/or fauna or environmentally sensitive areas that can influence research and subsequent laws?

*Indicator 14 - Certification adoption*

- Is the area protected by law?
- Is certification of the tourism product important to management?
- Have any efforts been started to try and achieve ecotourism certification?
- Does the business have any other national, regional or international certification?
- Have any past profits been set aside for the attainment of certification?
- Is the business targeting a specific type of certification (e.g. Green Globe, Blue Flag, etc)?

*Indicator 15 - Training of locals for ecotourism jobs*

- Are there any training or scholarship opportunities for locals to become trained?
- In the past has the eco facility entered into training of locals?
- Were any of the locals trained by the eco facility able to find employment with that eco facility?
- Does the eco facility send current staff for external remedial or advancement training? Are there any projections to increase the number of trained locals to take up positions in the ecotourism business?
- In how many different areas does the eco facility offer training?

These questions were used to assign impact values in consideration of the chosen indicators for sustainability of ecotourism activities within a range of 0 (no impact) to 3 (high impact). The values assigned to the present state and the potential values in the event of each scenario are presented in Tables 4.7 and 4.8. Despite most indicators having a quantifiable unit of measure, the assignment of impact values are highly based on perception and must be assigned in consideration of geographic location and scales.

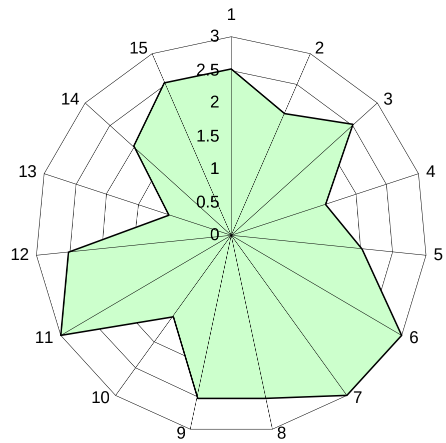
**Table 4.7** Summary of impacts for scenarios compared to present at Greencastle.

| Indicator | Present | Scenario | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 1 | 2.5 | 3 | 2.5 | 2.5 | 3 | 2 |
| 2 | 2 | 3 | 2 | 2 | 3 | 2 |
| 3 | 2.5 | 3 | 2.5 | 2.5 | 3 | 1.5 |
| 4 | 1.5 | 2 | 1.5 | 1.5 | 2 | 1.5 |
| 5 | 2 | 3 | 2 | 2 | 3 | 1 |
| 6 | 3 | 3 | 3 | 3 | 3 | 3 |
| 7 | 3 | 3 | 3 | 2 | 3 | 3 |
| 8 | 2.5 | 2.5 | 3 | 2.5 | 2 | 3 |
| 9 | 2.5 | 3 | 3 | 2.5 | 2 | 3 |
| 10 | 1.5 | 1.5 | 1.5 | 1.5 | 1 | 1.5 |
| 11 | 3 | 3 | 3 | 3 | 3 | 3 |
| 12 | 2.5 | 2 | 2.5 | 2.5 | 1 | 3 |
| 13 | 1 | 1 | 1 | 1 | 1 | 2.5 |
| 14 | 2 | 1.5 | 2 | 2 | 1.5 | 3 |
| 15 | 2.5 | 2 | 2.5 | 2.5 | 2 | 3 |

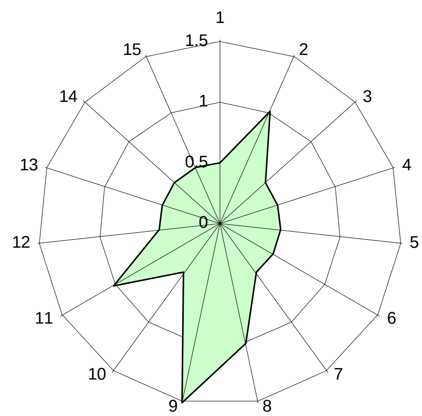
**Table 4.8** Summary of impacts for scenarios compared to present at Iwokrama.

| Indicator | Present | Scenario | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| 2 | 1 | 1.5 | 1 | 1 | 1.5 | 1 |
| 3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| 4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| 5 | 0.5 | 0.5 | 0.5 | 0 | 0.5 | 0.5 |
| 6 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| 7 | 0.5 | 0.5 | 0.5 | 0 | 0.5 | 0.5 |
| 8 | 1 | 0.5 | 1 | 0.5 | 0.5 | 2.5 |
| 9 | 1.5 | 1.5 | 1.5 | 1 | 1 | 2.5 |
| 10 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| 11 | 1 | 1 | 1 | 0.5 | 0.5 | 2 |
| 12 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| 13 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 1 |
| 14 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 1.5 |
| 15 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

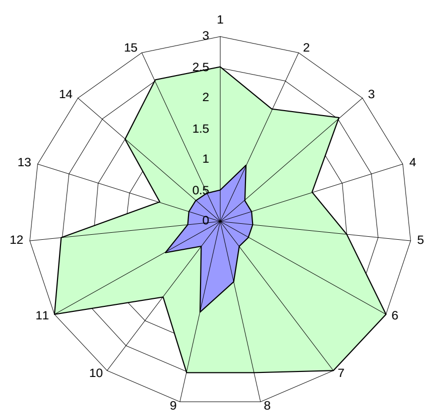
For a more visual comparison, target plots were used to evaluate the present state as well as the possible state in the even that each scenario arises at the both sites.




(a)

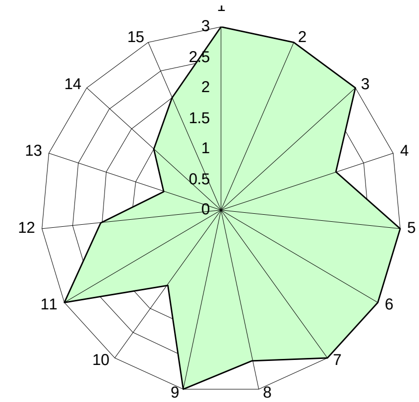



(b)

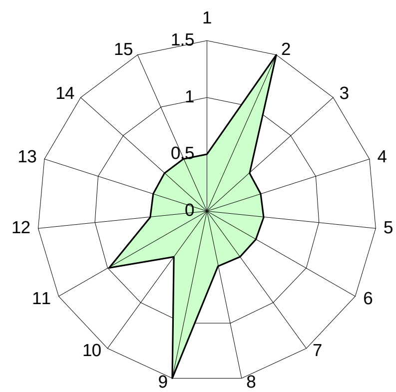



(c)

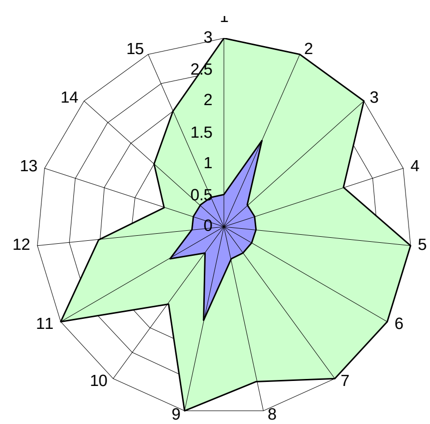
**Figure 4.8** Summary of impacts in the present state at (a) Greencastle and (b) Iwokrama. (c) is the overlay of (a) and (b). Plots indicate that Iwokrama's current ecotourism activities (purple) are more sustainable than that for Greencastle (green) as most of Iwokrama's impacts are closer to the center.




(a)




(b)




(c)

**Figure 4.9** Summary of potential impacts for scenario 1 at (a) Greencastle and (b) Iwokrama. (c) is the overlay of (a) and (b). The plots show that Greencastle's sustainability of its ecotourism activities will be severely threatened if scenario 1 arises. Iwokrama's impact would also intensify but not to the extreme of Greencastle's.

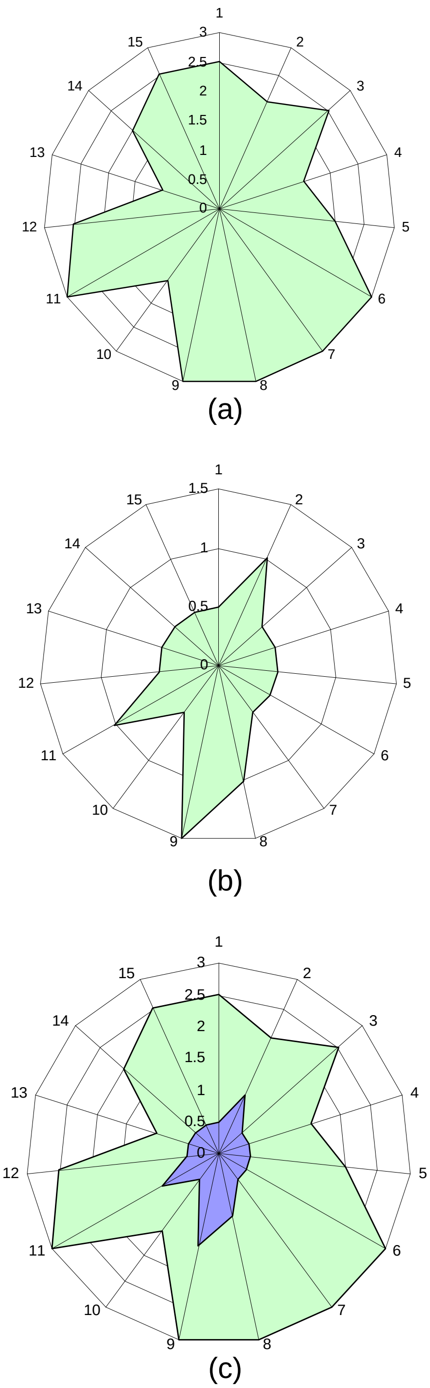
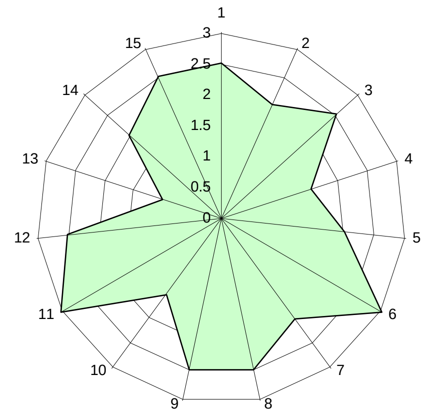
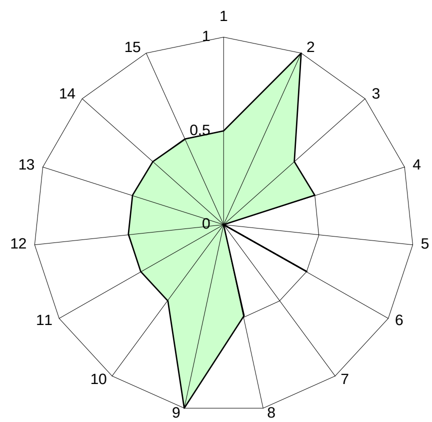


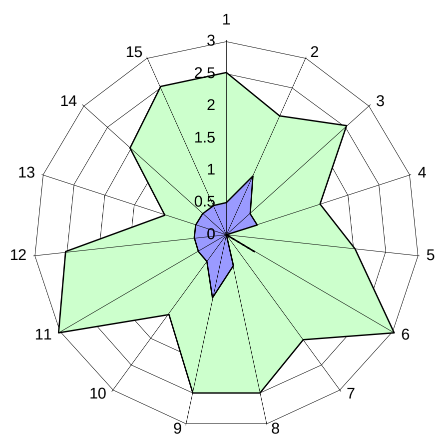

**Figure 4.10** Summary of potential impacts for scenario 2 at (a) Greencastle and (b) Iwokrama. (c) is the overlay of (a) and (b). Iwokrama's impact would remain similar to its present impact if scenario 2 arises however Greencastle's would intensity.




(a)




(b)




(c)

**Figure 4.11** Summary of potential impacts for scenario 3 at (a) Greencastle and (b) Iwokrama. (c) is the overlay of (a) and (b). This scenario gives values similar to the present impact values for both sites.

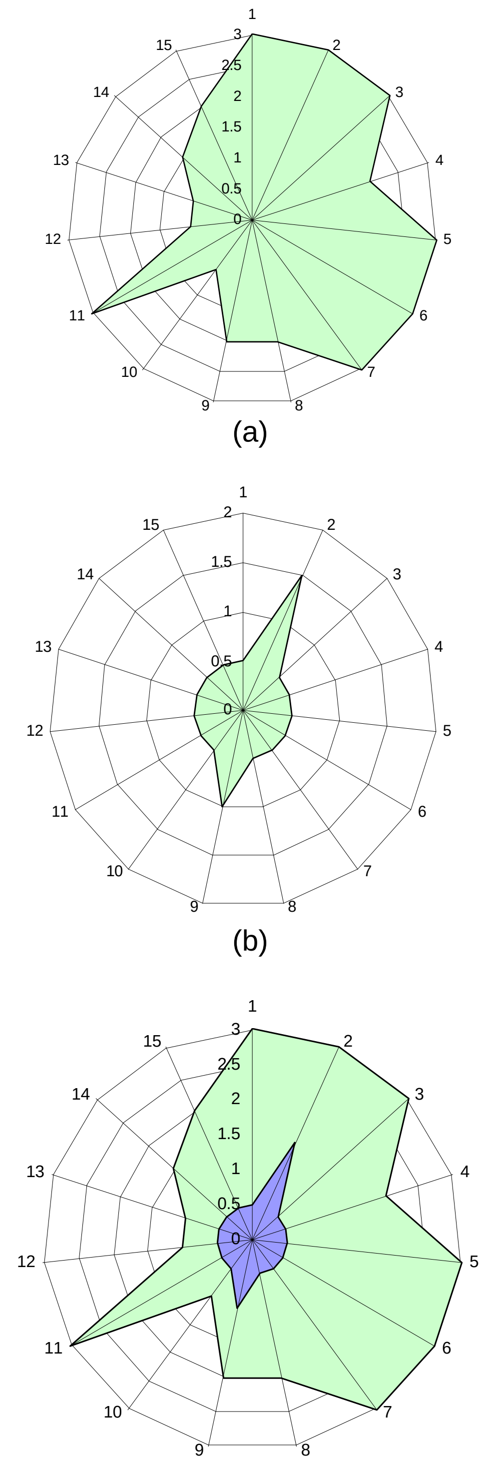
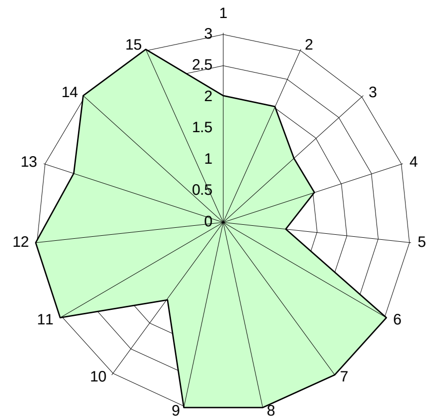
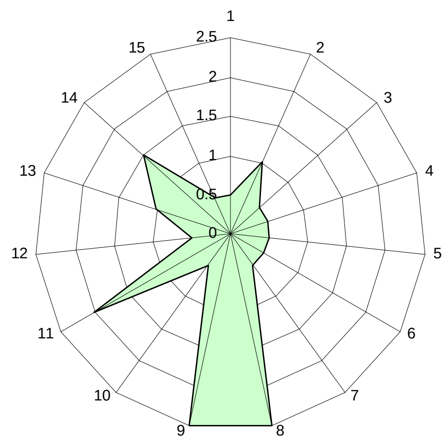


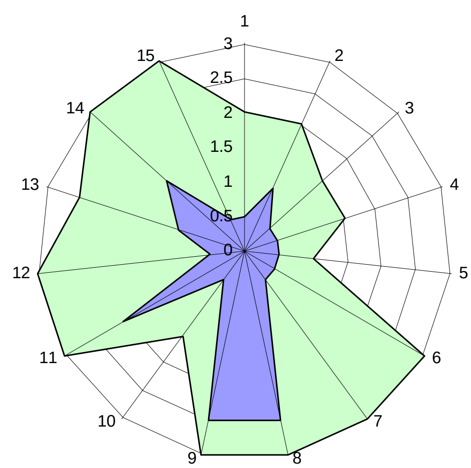

**Figure 4.12** Summary of potential impacts for scenario 4 at (a) Greencastle and (b) Iwokrama. (c) is the overlay of (a) and (b). The majority of the destructive impacts for both Greencastle and Iwokrama fall under the environmental indicators.




(a)




(b)



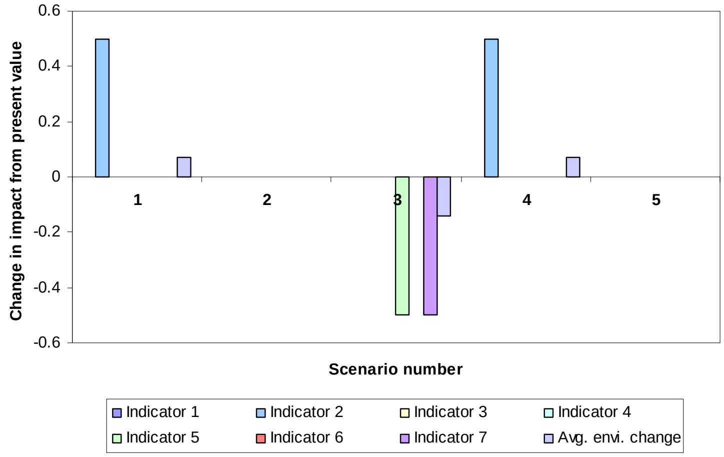

(c)

**Figure 4.13** Summary of potential impacts for scenario 5 at (a) Greencastle and (b) Iwokrama. (c) is the overlay of (a) and (b). This scenario most adversely impacts economic and societal indicators for both Greencastle and Iwokrama. This scenario is Iwokrama's worst departure from present state.

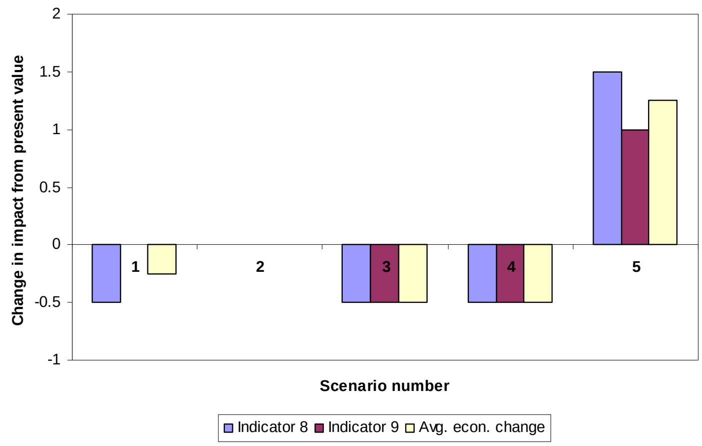
The target plots give a good platform for visual comparison and assessment in consideration of Figures 4.8 – 4.13. However, one must keep in mind that though Iwokrama appears to be the site with the more sustainable ecotourism activities this may simply be because of its more pristine present nature. In order to gauge sustained impact an assessment of the deviations of impact values from the present need to be considered. In such a case, a negative deviation is more desirable than a positive one. Consider Tables 4.9 and 4.10 below which deviations are characterized by sustainability pillar across each scenario for each indicator.

**Table 4.9** Iwokrama's deviations from present impact values for scenarios 1 – 5.

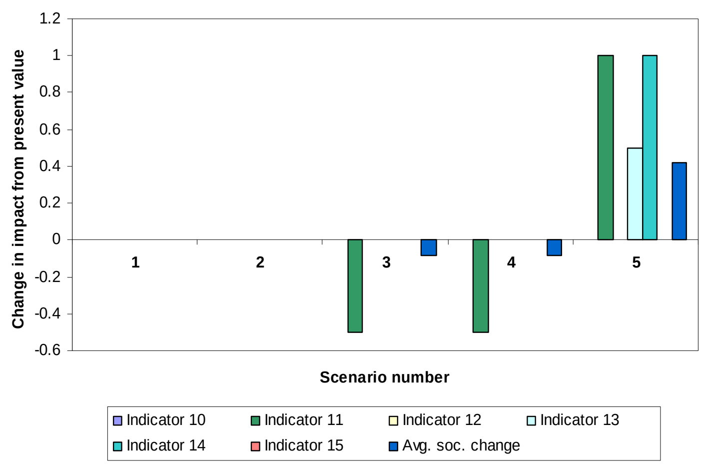
| Indicator | Present | Scenario | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 1 | 0.5 | 0 | 0 | 0 | 0 | 0 |
| 2 | 1 | 0.5 | 0 | 0 | 0.5 | 0 |
| 3 | 0.5 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0.5 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0.5 | 0 | 0 | -0.5 | 0 | 0 |
| 6 | 0.5 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0.5 | 0 | 0 | -0.5 | 0 | 0 |
| *Avg. envi. impact change* | | *0.071* | *0* | *-0.14* | *0.071* | *0* |
| 8 | 1 | -0.5 | 0 | -0.5 | -0.5 | 1.5 |
| 9 | 1.5 | 0 | 0 | -0.5 | -0.5 | 1 |
| *Avg. econ. impact change* | | *-0.25* | *0* | *-0.5* | *-0.5* | *1.25* |
| 10 | 0.5 | 0 | 0 | 0 | 0 | 0 |
| 11 | 1 | 0 | 0 | -0.5 | -0.5 | 1 |
| 12 | 0.5 | 0 | 0 | 0 | 0 | 0 |
| 13 | 0.5 | 0 | 0 | 0 | 0 | 0.5 |
| 14 | 0.5 | 0 | 0 | 0 | 0 | 1 |
| 15 | 0.5 | 0 | 0 | 0 | 0 | 0 |
| *Avg. soc. impact change* | | *0* | *0* | *-0.083* | *-0.083* | *0.42* |
| Overall avg. impact change | | -0.060 | 0 | -0.24 | -0.17 | 0.56 |




(a)




(b)




(c)

**Figure 4.14** Sensitivity analysis of indicators for Iwokrama across scenarios by sustainability sphere. (a) Environmental; (b) Economic; (c) Societal.

**Table 4.10** Greencastle's deviations from present impact values for scenarios 1 – 5.

| Indicator | Present | Scenario | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 1 | 2.5 | 0.5 | 0 | 0 | 0.5 | -0.5 |
| 2 | 2 | 1 | 0 | 0 | 1 | 0 |
| 3 | 2.5 | 0.5 | 0 | 0 | 0.5 | -1 |
| 4 | 1.5 | 0.5 | 0 | 0 | 0.5 | 0 |
| 5 | 2 | 1 | 0 | 0 | 1 | -1 |
| 6 | 3 | 0 | 0 | 0 | 0 | 0 |
| 7 | 3 | 0 | 0 | -1 | 0 | 0 |
| *Avg. envi. impact change* | | *0.5* | *0* | *-0.14* | *0.5* | *-0.36* |
| 8 | 2.5 | 0 | 0.5 | 0 | -0.5 | 0.5 |
| 9 | 2.5 | 0.5 | 0.5 | 0 | -0.5 | 0.5 |
| *Avg. econ. impact change* | | *0.25* | *0.5* | *0* | *-0.5* | *0.5* |
| 10 | 1.5 | 0 | 0 | 0 | -0.5 | 0 |
| 11 | 3 | 0 | 0 | 0 | 0 | 0 |
| 12 | 2.5 | -0.5 | 0 | 0 | -1.5 | 0.5 |
| 13 | 1 | 0 | 0 | 0 | 0 | 1.5 |
| 14 | 2 | -0.5 | 0 | 0 | -0.5 | 1 |
| 15 | 2.5 | -0.5 | 0 | 0 | -0.5 | 0.5 |
| *Avg. soc. impact change* | | *-0.25* | *0* | *0* | *-0.5* | *0.58* |
| Overall avg. impact change | | 0.17 | 0.17 | -0.048 | -0.17 | 0.24 |

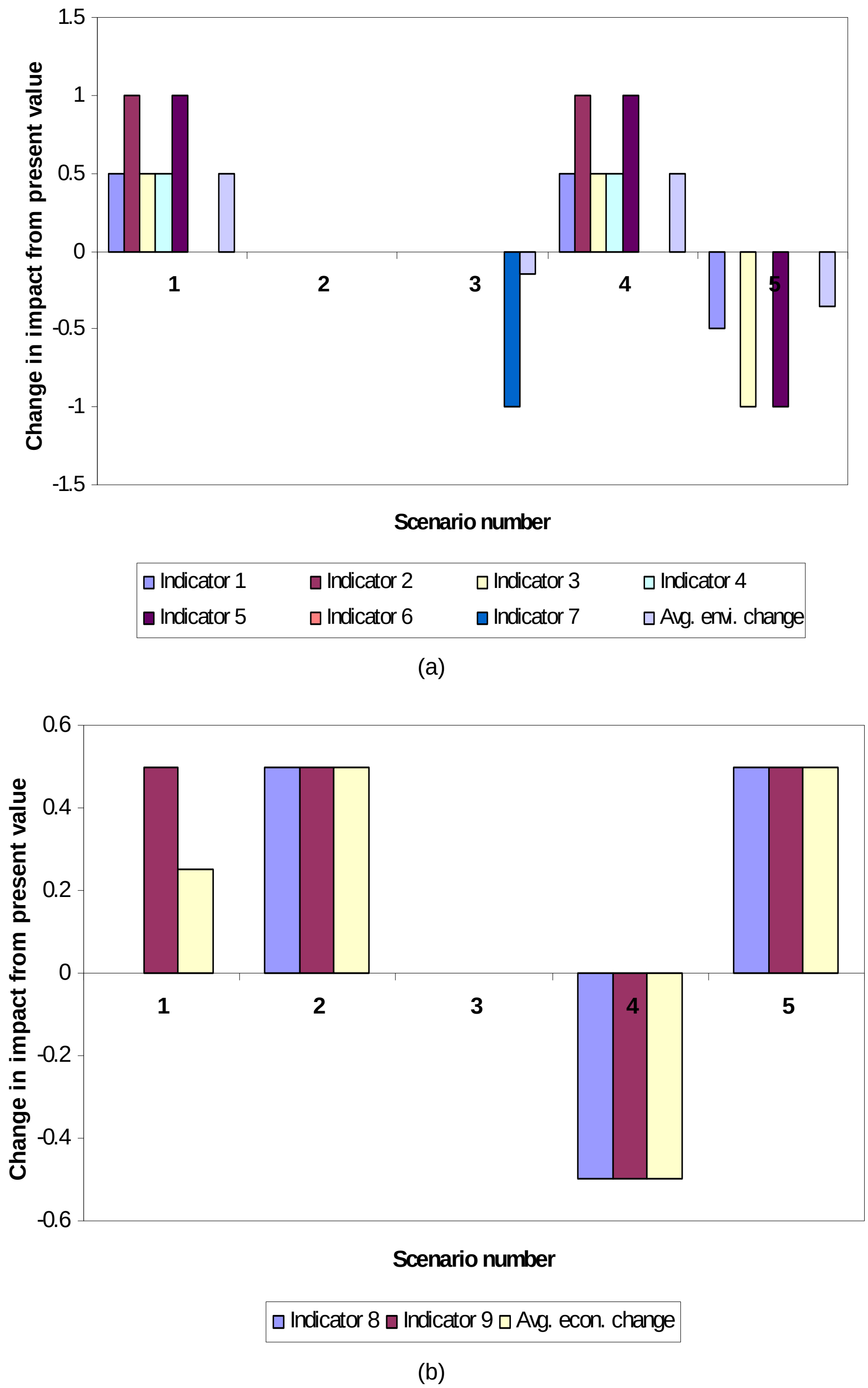
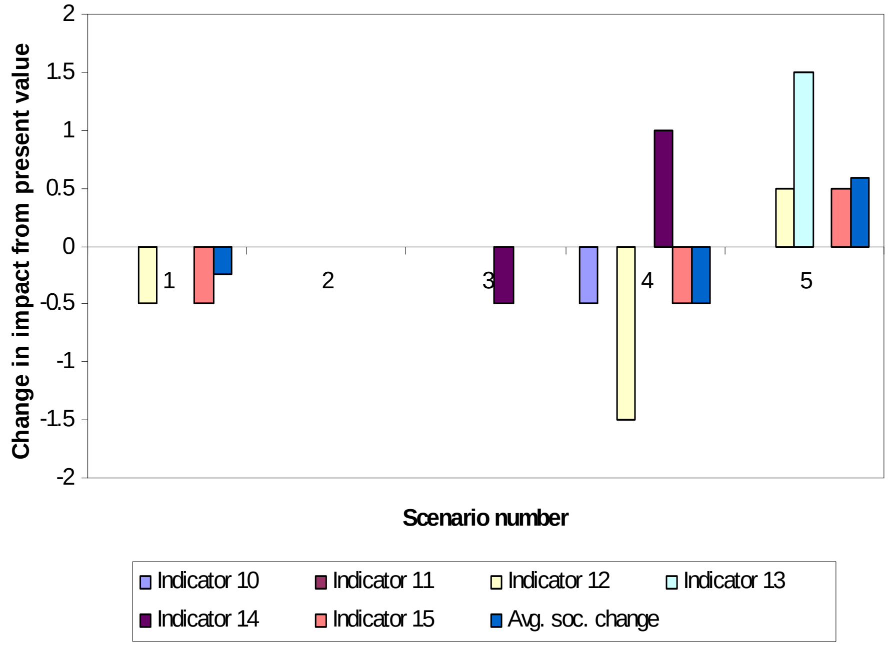



**Figure 4.15** Sensitivity analysis of (a) environmental and (b) economic indicators for Greencastle across scenarios.




(c)

**Figure 4.16** Sensitivity analysis of (c) societal indicators for Greencastle across scenarios.

In consideration of Tables 4.9 and 4.10 and Figures 4.14, 4.15 and 4.16 it can be seen that for scenario 5 Iwokrama would experience a greater change in overall impact from its present state than Greencastle despite still always maintaining a greater overall sustainability than Greencastle at present and through all 5 scenarios. Say, for example, in scenario 1 for Greencastle the change in environmental impact is the most crucial component of the sustainability of the ecotourism activities (average environmental impact = +0.5). Then, for this scenario, measures to reduce impact on the environment should take priority over those to protect economic impact and societal impacts, respectively.  Therefore, analysis of differential impacts from present values (as done in Tables 4.9 and 4.10) can be an essential planning tool where appropriate plans of action can be pre-determined.

## 4.4 Recommendations to Improve the Environmental Sustainability of Ecotourism Activities

If any ecotourism site's management is to improve its corporate environmental strategy for ecotourism activities there is a need to do an assessment audit and seek region specific recommendation options from successful ecotourism entities. The tool used for the assessment audit of each individual site was the Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis. The SWOT analyses were used to determine general strategies to enhance strengths while capitalizing on opportunities to improve areas of weakness while minimizing threats. The actual SWOT results by site are given below in Tables 4.11 and 4.12.

**Table 4.11** SWOT analysis for Iwokrama's ecotourism activities.

| | **Strengths - S** | **Weaknesses – W** |
|---|---|---|
| **SO Strategies** Use strengths to take advantage of opportunities<br>**WO Strategies** Overcome weaknesses by taking advantage of opportunities<br>**ST Strategies** Use strengths to avoid threats<br>**WT Strategies** Minimize weaknesses and avoid threats | 1 Area is considered pristine by WWF International.<br>2 There is a high degree of biodiversity readily visible.<br>3 Operations and management are centered on low environmental impact and have documented plans in place for each aspect of environmental management of their ecotourism activities.<br>4 Has several well trained staff with graduate degrees and training in environmental resource management. | 1 Area is too big to allow for proper monitoring on a regular basis on current capabilities and manpower.<br>2 Poor website layout, which is an essential marketing tool. Nevertheless the amount of information and accessibility to the public is good. (See www.iwokrama.org.) |
| **Opportunities – O**<br>1 Continue along path to ecotourism certification as attainment will put the destination in a higher category with greater appeal to ecotourists.<br>2 Pristine forest is a living laboratory for research in all areas of natural science.<br>3 Increasing the monitoring capabilities | **SO Strategies**<br>1 Highlight to Board of Trustees what having ecotourism certification can do for the environment, revenue and the communities while putting the destination amongst the world's best and few.<br>2 Able to attract some of the world's best research institutions for collaboration on scientific research and possibly monitoring while enhancing international exposure. | **WO Strategies**<br>1 There are possibilities for a number of other joint ventures/partnerships with Fairview and North Rupununi communities which can provide much needed manpower for monitoring. |
| **Threats - T**<br>1 Squatters may encroach and engage in non-sustainable practices.<br>2 Unreliability of public roads and air transportation into the area can affect operations (i.e. supplies, guest arrivals, timber transportation out etc.).<br>3 Reliance on use of river water as a supply source puts it at critical juncture for sabotage and potential health effects.<br>4 Similar ecotourism facilities available in neighboring Brazil when added with Brazil's cultural appeal can pull some potential customers. | **ST Strategies**<br>1 Cultural promotion of the Iwokrama area as both pristine and home to native Taino Indians. This needs to take place through a revamped website marketing, international tourism fairs as well as cable network advertisements.<br>2 Consideration of helicopter services (contract or partnership) to both improve accessibility for guests and researchers in wet seasons but also for times of major emergency. | **WT Strategies**<br>1 More frequent monitoring of the forest, surface water and roads. This may necessitate increased manpower, training and equipment; which can only come from increased budgetary allocations to the Monitoring Unit.<br>2 Increase the capacity of current rainwater harvesting mechanisms to reduce reliance on river water once piping can be done in a low impact manner.<br>3 A better designed website can certainly lend to stronger competitive advantage of Iwokrama when measured against more popular South American destinations. |

**Table 4.12** SWOT analysis for Greencastle's ecotourism activities.

| | | |
|---|---|---|
| **SO Strategies** Use strengths to take advantage of opportunities<br>**WO Strategies** Overcome weaknesses by taking advantage of opportunities<br>**ST Strategies** Use strengths to avoid threats<br>**WT Strategies** Minimize weaknesses and avoid threats | **Strengths - S**<br>1 Ridge to coast tourism allows for rare forms of ecotourism ventures.<br>2 There have been attempts to commence monitoring programs. | **Weaknesses – W**<br>1 Continued non-sustainable agricultural operations by lessees.<br>2 Low impact construction is not envisioned for boutique suites which can have severe environmental impacts.<br>3 No budgetary commitment of management to invest in required tools and equipment to do internal monitoring.<br>4 Good website layout but not enough information available to the public. (See www. greencastletropicalstudycenter.org.) Consult the Monterverde Institute's website (www.mvinstitute.org) for example of good site. |
| **Opportunities – O**<br>1 The ridge to coast nature of site allows for sustainable coastal ecotourism also.<br>2 Planned boutique suites present a very good area for green design and operation.<br>3 With expansion of ecotourism services there will be possibilities to increase job offerings to locals. | **SO Strategies**<br>1 Look at international success stories on how to implement coastal ecotourism with the view of correcting actions currently underway at Jack's Bay.<br>2 Development of ecotourism services offered to guests inclusive of sustainable sea activities e.g. kayaking, snorkeling.<br>3 Mangroves on site gives the site uniqueness even when compared to other coastal tourism sites in Jamaica and should be highlighted more in tours. | **WO Strategies**<br>1 There need to be tighter control of what activities lessees are allowed to be engaged in to promote GTSC's mission.<br>2 Establish protocol for storage and use of chemicals onsite for all ecotourism activities inclusive of materials and chemicals to be used during upcoming construction.<br>3 Despite the typical lack of monitoring by Caribbean agencies, GTSC and Greencastle's management has to lead by example and commit to the Terms of Reference of the Environmental Impact Assessment for the boutique suites construction. |
| **Threats - T**<br>1 Increasing population in Robin's Bay and Rosend can negatively affect sensitive flora and fauna.<br>2 Proximity to nearby coastal tourism hotels.<br>3 Social image of Jamaica with regards to violence can negatively affect business since the majority of the patrons are US and Europe based. | **ST Strategies**<br>1 To get competitive edge GTSC needs to start marketing its range of ecosystems rather than focusing on the beaches.<br>2 Need to intensify monitoring efforts even through increased academic partnership so correlations of population increases can be made over time.<br>3 Encouraging Jack's Bay operators to get its own security which sets it apart from other coastal amenities in the area. | **WT Strategies**<br>1 Utilize website to give Greencastle a competitive advantage over local coastal tourism facilities that currently do not have such.<br>2 Increase security measures at the Estate House and ensure current non-human defense mechanisms are installed at planned suites.<br>3 There needs to be a set tariff on revenues generated from ecotourism activities that are kept for GTSC obtaining monitoring tools and training. |

The Monteverde, Costa Rica site has been used to determine the most important areas for immediate action by IIC and GTSC to improve the sustainability of their ecotourism activities. This area was chosen as it is heralded as a success story with regards to sustainable ecotourism in the Caribbean region and can provide a framework of mentoring for IIC and GTSC. Through searching the literature, the recommendations were selected for each site and the literature with appropriate field methods and techniques is given (see Tables 4.13 and 4.14). Note in the event that appropriate literature could not have been found based on the Costa Rica experience other country-based references were utilized, but care was taken to ensure that the methods and application described therein were transferable to a rural and/or remote Caribbean setting.

**Table 4.13** Recommendations for IIC to improve sustainability of ecotourism activities at Iwokrama.

| Recommendation | Comparable reference site | Literature Reference | Projected impact |
|---|---|---|---|
| | | *Environmental* | |
| Investigation of the impact of the grey water being disposed of by Fairview households and the design of septic tanks for the community. | Monteverde, Costa Rica | Kumar, 2002 | Improved river water quality and reduced incidence of water related diseases. |
| There needs to be inclusion of low cost water quality monitoring within Fairview and expansion of the current onsite monitoring to include Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), nitrogen (N), phosphorus (P), fecal coliform and stream flow. | Santa Elena, Costa Rica<br>Quebrada, Costa Rica<br>Santa Elena and San Luis, Costa Rica | Feddersen, 2003; Sustainable Futures, 2002<br>Rhodes et al., 2006<br>Jacobson, 2006 | More robust monitoring program allows for greater protection of human, flora and fauna health. Also, there is more data for model development which can reduce monitoring needs in the future. |
| Increased knowledge on technologies at the household level to utilize grey water such as REEDBED. | Monteverde, Costa Rica | Newell, Craig and Harlow, 2005. | Improved river water quality and reduced incidence of water related diseases. |
| Expansion of recycling efforts throughout Fairview and eventually North Rupununi. | Amazonia, Brazil | Wells, 1994 | Reduced solid waste disposal problems and reduced amounts that make it into the river network. |
| There should be some testing of rainwater used for consumption and food preparation for heterotrophic bacteria as well as coliforms with possible implementation of batch solar disinfection (SODIS). This is an area for collaboration with the Fairview Village Health Center. | San Jose, Costa Rica<br>Tarahumara Sierra, Mexico<br>Rural areas of Trinidad | Sommer et al., 1997<br>Martin-Dominguez et al., 2005<br>Thomas and Mellowes, 2006 | Improved 'potable' rain water quality and reduced incidence of water borne diseases due to its ingestion. |
| | | *Societal* | |
| Management has to continue to push the Board of Trustees to attain ecotourism certification. | Monteverde, Costa Rica | Rivera, 2002 | Able to attract a different category of ecotourists and able to demand higher prices for services. |

**Table 4.14** Recommendations for GTSC to improve sustainability of ecotourism activities at Greencastle.

| Recommendation | Comparable reference site | Literature Reference | Projected impact |
|---|---|---|---|
| | | *Environmental* | |
| Investigation of the impact of the grey water being disposed of by Robin's Bay and Rosend households and the design of septic tanks for the community. | Monteverde, Costa Rica | Kumar, 2002 | Improved river water quality. |
| Internal environmental program should be a priority to truly assess sustainability. Basic monitoring should include pH, temperature, dissolved oxygen then expand to include BOD, COD, N, P, fecal coliform and stream flow. | Santa Elena, Costa Rica<br><br>Quebrada, Costa Rica<br><br>Santa Elena and San Luis, Costa Rica | Feddersen, 2003; Sustainable Futures, 2002<br><br>Rhodes et al., 2006<br><br>Jacobson, 2006 | More robust monitoring program allows for greater protection of human, flora and fauna health. Also, there is more data for model development which can reduce monitoring needs in the future. |
| There should be a drive to encourage and assist with households having their grey water directed to their septic systems. Especially for those households with out houses, there needs to be community education by GTCS on technologies at the household level to utilize grey water such as REEDBED. | Monteverde, Costa Rica | Newell, Craig and Harlow, 2005.<br><br>Kumar, 2002 | Improved river water quality. |
| Starting a recycling program at Greencastle to filter out into Robin's Bay and Rosend eventually. | Amazonia, Brazil | Wells, 1994 | Reduced solid waste disposal problems and reduced amounts that make it into the river network. |
| Alternative energy sources need to be analyzed for inclusion into operations especially for suites to be constructed. | La Esperanza, Costa Rica | Rojas and Aylward, 2002 | Reduction in Greencastle's carbon footprint and increases energy self sufficiency. |
| There should be signage that promotes conservation and environmental protection which is in lieu of staff training along these lines. | Amazonia, Brazil | Wells, 1994 | Serves as a reminder to guests and staff alike that they all need to partake in environmental management. |
| | | *Economic* | |
| A cost/benefit analysis should be done for Greencaslte to determine whether they should focus on traditional ecotourism or coastal ecotourism (the latter being less popular in Jamaica). | Caribbean region | Lundserg, Stavenga and Krishnamoorty, 1995 | GTSC can make a clear decision as to where best to spend development funds based on returns on investment. |
| Greencastle should utilize a quality control program (such as an anonymous consumer quality/satisfaction survey) to let its customers help in ranking them versus other locations which can serve useful in competitive pricing. | Global | Gartner, 1996 | This simple audit tool can gather valuable feedback from guests as to where changes need to be made to improve their services offered. |

**Table 4.14 (Continued)**

| | | | |
|---|---|---|---|
| Management should set aside funds per visitor that is placed in a fund for eventual certification adoption; implementation of above mentioned social recommendations; as well as community outreach activities. | Monteverde, Costa Rica<br><br>Monteverde, Costa Rica | Rivera, 2002<br><br>Kuo, 2002 | This firstly shows the commitment of management to sustainable development and once implemented can be used to project when certain vital components can be attainable based on funds accrued. |
| | *Societal* | | |
| GTSC needs to incorporate the communities more into the onsite activities at least by keeping them aware of basic plans. | Portsmouth, Dominica | CTO, 2006b | This portrays trust and good intent by Greencastle Estate. |
| To improve the acceptance of ecotourism and GTSC by the surrounding communities there needs to be improved outreach initiatives by hosting events at the school and/or Estate. | Matura, Trinidad | CTO, 2006b | This fosters inclusion of neighbors and togetherness; especially amongst current and potential staff members and Greencastle. |
| As business continues to grow, GTSC should enter into partnerships with community members to become business partners to supply different goods needed for the business; starting essential businesses requested by tourists; etc. | St. Helena, Jamaica | CTO, 2006b | In the eyes of the communities such a move shows commitment to improvement of the communities rather than coming across as selfish and greedy. |

## 4.5 Conclusions

The sustainability of ecotourism activities in the Caribbean was found to be assessable across 15 indicators among the 3 core pillars of sustainability: environmental, societal and economic. The chosen indicators were determined from analyses of the WTO’s set of core sustainability indicators and the PSR framework. These indicators were placed onto a target plot to create an assessment tool that can numerically represent the impacts of each indicator. Each indicator was analyzed for impact (on a scale of 0, no impact, to 3, high intensity impact) by a selection of a pool of questions for which the answers can suggest severity of impact. Five scenarios were developed and tested to ensure that the tool created responded to social and demographic changes. The assessment tool was able to respond to the changes that it was subjected to and the method utilized allowed for internal determinations of whether the focus should be on mitigating environmental, societal or economic impact based on the average impact differential across each of the 3 core pillars of sustainability.

# CHAPTER 5: MANAGEMENT OF ECOTOURISM

## 5.1 Introduction

In this chapter the management of ecotourism is taken to be the management of all onsite activities that contribute to the provision of a saleable ecotourism product. Management influences onsite ecotourism activities which, as highlighted in Chapter 4, can affect water quality. The management of ecotourism at the site level depends on both the Caribbean country that the activity is being undertaken in as well as the strength of the eco-facility's management team. In order to achieve more sustainable management of ecotourism, steps should be taken to strengthen the management at both the national and site levels. Thus there is a need to capture the current strength of management.

As a first approach, 2 frameworks for assessment of sustainable Caribbean ecotourism management are created from the perspectives of countrywide ecotourism industry sustainability as well as onsite sustainability indicators for management. Indicators are excellent for auditing for improvement, but do not tell of the current strength of an ecosite's management. Therefore a modified approach to Social Network Analysis (SNA) was utilized to quantify the management's strength at the 2 study sites.

### 5.1.1 Objective and Subtasks

This chapter aims to create tools for assessing sustainability, from a reductionist standpoint, for the sustainability of ecotourism management in the Caribbean as well as to provide a simple method for quantifying the strength of an ecohotel's management. The specific subtasks were to:

- Choose indicators for sustainable management (at both the national and site specific levels) in consideration of responses of the semi-structured interview (see Appendix A),
- Create an assessment tool for onsite ecotourism management that responds to changes to improve management,
- Utilize SNA to design a simple analysis method to determine strength of management networks in onsite ecotourism management in the Caribbean, and
- Provide site specific recommendations to improve strength of its ecotourism management at 2 Caribbean study sites.

## 5.2 Ecotourism Management at the National Level in the Caribbean

Literature on global ecotourism and/or tourism management at the national level is sparse. The sustainability of this level of management has not been studied much as most models often focus on the site specific management. As such there are not many tourism related indicators that have been developed for management of the industry on a countrywide level. International agency guidelines for general sustainable management for governments, especially those for developing countries, were considered for indicator selection taking into consideration their transferability to the Caribbean's ecotourism industry.

### 5.2.1 Indicator Selection

The guidelines put forward for governments by agencies inclusive of the World Bank, Caribbean Community (CARICOM), Departments of the United Nations, Organization for Economic Cooperation and Development (OECD) and Transparency International were audited for key pillars of sustainable management. The main areas of sustainability were determined to be: environmental, economic, societal, cultural and political. As such these were taken to be the pillars for assessment of ecotourism management in this work.

From these guidelines all applicable indicators were grouped and categorized into one of the core indicators of the guidelines (see Table 5.1). This shortlisted set of indicators was then placed through the ecotourism Pressure-State-Response (PSR) framework (as developed and detailed in Chapter 4). According to the United Nations Development Programme (UNDP, 2005), this framework allows for the connection of other pillars of sustainability to that of environmental sustainability on the country scale. With the inclusion of 2 other pillars (cultural and political) of sustainability the PSR framework for ecotourism presented in Chapter 4 was modified for assessment by inclusion of cultural and political responses along with the societal responses in the same loop (see Figure 4.7).

The final selection of indicators was put through this modified ecotourism PSR framework. The chosen indicators for assessment of a Caribbean nation's sustainability of ecotourism management are given in Table 5.2 with each indicator's PSR designation. These designations are of paramount importance in making recommendations to improve sustainability of the ecotourism management (UNDP, 2005).

**Table 5.1** Core indicators for assessment of sustainability of national ecotourism management.

| Sustainability pillar | Core Indicator | Suggested measure | Organization |
|---|---|---|---|
| Environmental | Existence of strengthening economic incentives programs for environmental protection | Environmental based incentives to corporations to enhance revenue generation for the country | United Nations Department of Economic and Social Affairs (UNDESA, 1992) |
| | Budgetary commitment to environmental protection | Created functioning agencies and organizations with responsibility for environmental protection | Organization of Economic Cooperation and Development (OECD, 2007) |
| Economic | Sustainable management of government funds and allocation of funds | Main revenue earners and country's gross domestic product history | Organization of Economic Cooperation and Development (OECD, 2007) |
| | | Current trend of divestiture of government's funds | United Nations Department of Economic and Social Affairs (UNDESA, 1992) |
| Societal | Accountability of government for social well being of citizens | Enhancement of national programs to improve skills of nationals | Caribbean Community (CARICOM, 2009) |
| | Involvement of nationals in country's plans | Free sharing of government related information to public | United Nations Millennium Development Goals Committee (UNMDG, 2008) |
| Cultural | Measures put in place to respect culture of all groups especially minority groups | Inclusion of minority and/or religious and cultural groups in national policy formulation | United Nations Millennium Development Goals Committee (UNMDG, 2008) |
| Political | Structure of government and its regulatory agencies | Effectiveness of law implementation and amendment | World Bank (World Bank, 2000) |
| | Government's corruption index | History of the country's corruption index | Transparency International (Transparency International, 2009) |

**Table 5.2** Classification of indicators for assessing the sustainability of national ecotourism management in the Caribbean.

| Sphere | Indicator | Applicable core indicator | Type of indicator |
|---|---|---|---|
| Environmental | Staff and budget for environmental monitoring | Budgetary commitment to environmental protection | Driving force |
| | Promotion of certification adoption & environmental training for eco-hoteliers | Existence of strengthening economic incentives programs for environmental protection | Driving force |
| Economic | Incentives for good practice | Sustainable management of government funds and allocation of funds | Response |
| | History of increasing tourism and ecotourism revenue | | State |
| | Government as majority shareholder in ecotourism ventures | | State |
| Societal | Creation of national community-based and formal tourism/ecotourism programs | Accountability of government for social well being of citizens | Response |
| | Availability of relevant information and data to communities and public at large | Involvement of nationals in country's plans | State |
| Cultural | Cultural respect shown through inclusion of ideologies & beliefs of different groups into planning for ecotourism | Measures put in place to respect culture of all groups especially minority groups | State |
| Political | Laws to regulate impact on the environment, tourism and ecotourism operations | Structure of government and its regulatory agencies | Driving force |
| | Ratified international and regional environmental and tourism-related conventions | | Driving force |
| | Government ministry and/or regulatory agencies with tourism/ecotourism development as part of mandate | | Driving force |
| | Level of monitoring of impacts of tourism and ecotourism by government | Structure of government and its regulatory agencies; government's corruption index | Response |
| | Government’s corruption level and international measure of transparency | Government's corruption index | State |
| | Membership history and role in World Tourism Organization (WTO), Caribbean Tourism Organization (CTO) and the Caribbean Community (CARICOM) | Structure of government and its regulatory agencies | State |
| | Increasing levels of internal visitor security measures in rural and remote areas | | Response |

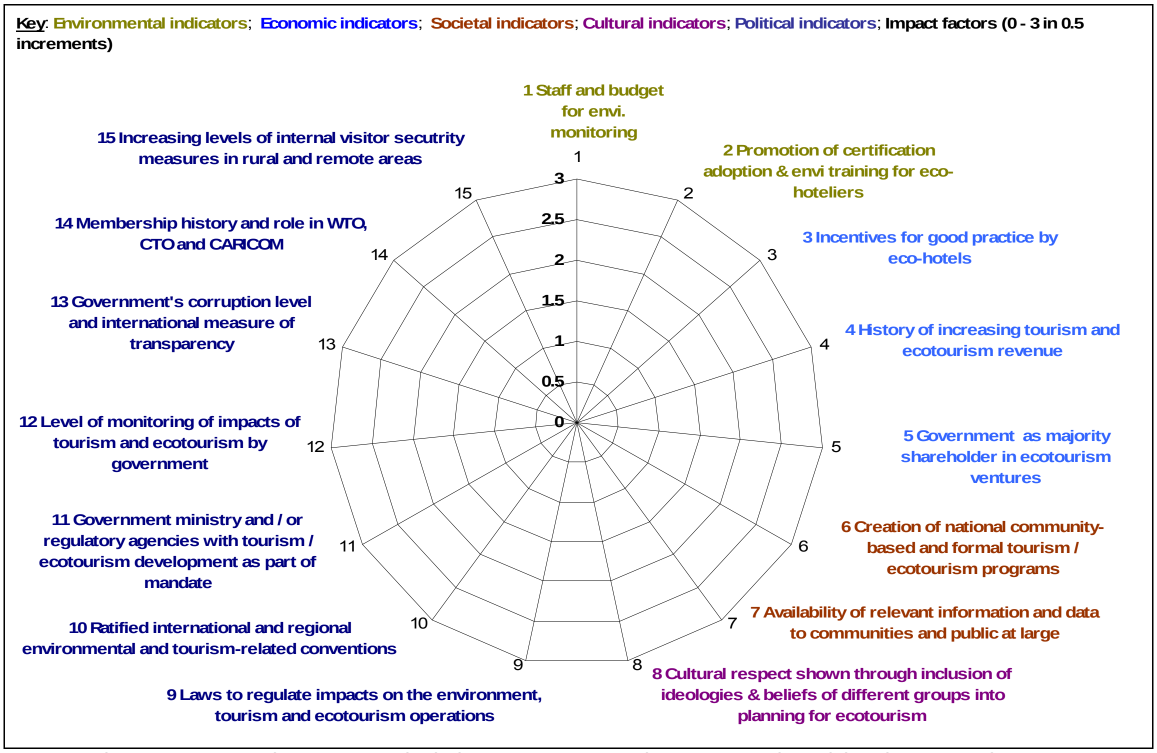
The 15 indicators chosen are given in Table 5.3 with the units of measure of each indicator in determining impact.

**Table 5.3** Selected indicators of sustainable national level ecotourism management and their units of impact measurement.

| | Indicator | Unit of measure |
|---|---|---|
| | *Environmental* | |
| 1 | Staff and budget for environmental monitoring | $/staff member/year |
| 2 | Promotion of certification adoption & environmental training for eco-hoteliers | Qualitative measure |
| | *Economic* | |
| 3 | Incentives for good practice | Tax $ saved per year of operation |
| 4 | History of increasing tourism and ecotourism revenue | Average net $ income per fiscal year |
| 5 | Government as majority shareholder in ecotourism ventures | Average % government shares |
| | *Societal* | |
| 6 | Creation of national community-based and formal tourism/ecotourism programs | Qualitative measure |
| 7 | Availability of relevant information and data to communities and public at large | $/visitor |
| | *Cultural* | |
| 8 | Cultural respect shown through inclusion of ideologies & beliefs of different groups into planning for ecotourism | Qualitative measure |
| | *Political* | |
| 9 | Laws to regulate impact on the environment, tourism and ecotourism operations | Qualitative measure |
| 10 | Ratified international and regional environmental and tourism-related conventions | |
| 11 | Government ministry and/or regulatory agencies with tourism/ecotourism development as part of mandate | |
| 12 | Level of monitoring of impacts of tourism and ecotourism by government | |
| 13 | Government's corruption level and international measure of transparency | |
| 14 | Membership history and role in World Tourism Organization (WTO), Caribbean Tourism Organization (CTO) and the Caribbean Community (CARICOM) | |
| 15 | Increasing levels of internal visitor security measures in rural and remote areas | |

### 5.2.2 Overall National Sustainability of Ecotourism Management in the Caribbean

As was done in Chapter 4, impacts for each indicator can be assessed on a scale of 0 (no impact) – 3 (high impact) in 0.5 increments across the 5 pillars of sustainability. The results obtained can then be easily represented on a target plot (see Figure 5.1).




WTO-World Tourism Organization; CTO-Caribbean Tourism Organization; CARICOM-Caribbean Community

**Figure 5.1** Target plot framework of indicators to assess a Caribbean nation's commitment to sustainable management of ecotourism.

Considerations that can be used in assigning impact factors are suggested below by indicator. These were used in tandem with the results of literature searches, researcher observations as well as the responses of informal interviews conducted. Note that the list hereunder is by no means exhaustive but rather should provide an idea of what was considered to make an assessment of potential impact so as to ensure that impacts inculcated aspects that were beyond simply the comparison of measured indicator values (where applicable). Also, many of the impacts require a perceived impact value which often necessitated a social methodology inclusive of interviews. As such, the considerations hereunder can form the basis of lines of questioning in social tools.

*Indicator 1 - Staff and budget for environmental monitoring*

- What fraction of the national budget is allocated to monitoring and studying the environmental impacts of tourism and ecotourism?
- How much staff is there in such units?
- What are the levels of expertise of such staff?
- What are the monitoring capabilities of monitoring units?
- How long have such units been in existence?
- Are there any staffing and/or equipment needs that have been requested and are not being met?
- Is any of the monitoring contracted out? If yes, do local consultancies have the required capabilities?
- Is staff sent for training to learn new methods and technologies for environmental monitoring?
- Has the budget for this unit been decreasing over years?

*Indicator 2 - Promotion of certification adoption & environmental training for eco-hoteliers*

- Has the government offered subsides to ecohotels that are interested in obtaining certification? If yes, what is the level of support promised?
- What methods are being used to promote certification adoption? Are they effective?
- Are eco-hoteliers provided with environmental based training by governmental ministries or agencies?
- Are the training sessions provided by governmental staff or external consultants?

- Is there any financial arrangement set up by government to facilitate the costs to obtain certification?
- Is the program in high demand? If no, why not?

*Indicator 3 - Incentives for good practice*

- What incentives are being offered?
- Are the incentives to local ecotourism business owners the same as that for non-local owners?
- What are the measures of good practice under such as scheme?
- How is good practice monitored and by which agency?
- How long have such programs been in place?
- Are incentives only for new ecotourism businesses?
- What are the qualifications that are to be met to gain entry into this program?
- What are the benefits to the country for an ecohotel partaking in such a program?

*Indicator - 4 History of increasing tourism and ecotourism revenue*

- How much of the country's tourism revenue in the past fiscal year came from ecotourism?
- In the past 5 years has the country's ecotourism revenues been increasing?
- Is tourism the number 1 revenue earner for the country? If yes, for how many years has this been the case?
- Has the regional and international visitor arrival statistics been steadily increasing over the last 10 years?
- Is the revenue from tourism and ecotourism divested among investments in strengthening the country's tourism product? If yes, how so?

*Indicator 5 - Government as majority shareholder in ecotourism ventures*

- Is the government a majority or minority shareholder in any local ecotourism venture? If yes, how long has this been the status?
- What type of ecotourism has the government chosen to become involved in (i.e. coastal or conventional land ecotourism)?
- Why did government choose to become involved in ecotourism ventures?
- Does the government have financial interest in any other form of tourism? If yes, what are they?
- At the time when the government's ecotourism ventures commenced were the surrounding communities strong holds of the ruling party?
- What was the initial investment the government made to become a shareholder?

*Indicator 6 - Creation of national community-based and formal tourism/ecotourism programs*

- What was the government's rationale for creating these types of programs?
- How long have these programs been ongoing?
- Have the annual budgetary allocations for these programs been growing since inception?
- Are there any formal tertiary programs offered at local universities toward tourism and hospitality qualifications?
- What are the offerings at the community level? What are the eligibility requirements?
- What is the rolling enrollment in such programs?
- Who are the typical students that are interested in these types of programs?
- Are the graduates of these programs assisted with job placement in the industry?
- How many of the programs' graduates remain in the industry?

*Indicator 7 - Availability of relevant information and data to communities and public at large*

- Does the country have a version of the Freedom of Information Act?
- How is government's information made available to the public?
- Are the routes of information dissemination sufficient?
- Is the level of information sufficient to keep the communities aware of plans for ecotourism?
- What is the frequency of information transfer to public domains?
- Which ministry/agency/organization is responsible for providing this information to the public?
- Are any measures in place to accommodate the disabled? If yes, what are they?

*Indicator 8 - Cultural respect shown through inclusion of ideologies & beliefs of different groups into planning for ecotourism*

- What are the religious and/or cultural factions that need to be given special attention when planning for ecotourism?
- Which regions are more associated with which religious and/or cultural faction? For each region, who should be included as the liaison on behalf of the community or religious organization?
- In amending ecotourism related legislation is it common for the ministry in charge to consult with local religious and community leaders?
- How long have these considerations been taken into account by government?

*Indicator 9 - Laws to regulate impact on the environment, tourism and ecotourism operations*

- Do environmental laws exist? If yes, are they amended regularly? When was the last amendment done for each environmental law? Is there a ministry or agency that has responsibility for environmental protection?
- What are the tourism laws? Is ecotourism specifically included these laws? If yes, to what extent is ecotourism regulated? Does tourism and ecotourism fall under the purview of a ministry or agency that has responsibility solely for tourism?
- When last have the tourism laws been amended? When were the laws created? How many amendments have take place since they were established?
- Are external consultants utilized to do studies before amendments are made or are they done in-house?
- How are the laws enforced? Is environmental policing enforced? Is there a special environmental court?

*Indicator 10 – Ratified international and regional environmental and tourism-related conventions*

- What are the environmental and tourism-related conventions that the country has entered into? How long ago did the country enter into these accords? Were these moves part of the lending agreement from international lending agencies (e.g. World Bank, Inter-American Development Bank)?
- Have steps been taken since ratifying the conventions to achieve the goals of the conventions?
- Is any governmental ministry or agency assigned the duty of ensuring the country does as it promised it would do in relation to environmental and tourism-related conventions?

*Indicator 11 - Government ministry and/or regulatory agencies with tourism/ecotourism development as part of mandate*

- How long ago has a ministry or agency been created with tourism as its main mandate?
- Does the ministry (or agency) also have non-tourism related sectors under its purview?
- Are there any other tourism related agencies that work with the ministry towards the mandate? When were these sub-agencies created?
- What is the budgetary allocation of the ministry and other agencies in relation to annual budget?

*Indicator 12 – Level of monitoring of impacts of tourism and ecotourism by government*

- What is the budgetary allocation for monitoring of the impacts?
- As the tourism industry grows (or grew) by indication of visitor arrival will the monitoring regimen become more sophisticated, frequent and intense in design and testing capabilities? If yes, how so?
- Is the monitoring shared among several different ministries or agencies? If yes, which are they?
- How long has this type of monitoring of tourism impacts been entered into?
- What type of monitoring is done? Does any of it need to be contracted out or is government staff able to undertake all monitoring?
- What have been the findings? Are the results readily available to the public? If yes, through which avenue does the public have access?

*Indicator 13 – Government's corruption level and international measure of transparency*

- According to Transparency International what is the current corruption index of country's current government?
- How has this current index changed in relation to the indices of the past 10 years?
- Are there any steps that are being put, or have been put, in place to increase government's transparency of operations?

*Indicator 14 – Membership history and role in World Tourism Organization (WTO), Caribbean Tourism Organization (CTO) and the Caribbean Community (CARICOM)*

- Is the country a member of the WTO? How long has that country been a member?
- Does that country have representation on special WTO boards? Is representation at annual meetings a priority?
- What is the country's role in the CTO?
- Does the country enact and enforce the recommendations that emerge out of WTO, CTO and CARICOM meetings/workshops/conferences? If yes, what is the average turnaround time? Who has to initiate this enactment?

*Indicator 15 – Increasing levels of internal visitor security measures in rural and remote areas*

- In the most recent budget, have there been funds allocated to increasing visitor security at ports and airports? If yes, how much has been allocated? How much has typically been allotted to this in the past?
- Have there been any recent incidents of visitor mistreatment? What are the statistics on this for the last 10 years?

- Has the country been on the Central Intelligence Agency's (CIA) travel advisory list recently for violence against visitors? How many times in the past, and when, did the country make this list?
- Have funds been allocated for the construction of police stations in more rural and remote locations?
- Are more police officers being hired for posts in and around the ecotourism areas?
- Have support emergency services been strengthened to handle visitor-related disasters?

Note that relevant information to assess the sustainability of Jamaica's and Guyana's management of ecotourism was not made readily available for this study, hence its exclusion here.

### 5.3 Site Specific Ecotourism Management

The sustainability of ecotourism management onsite as compared to at the national level takes on very different dimensions even when assessed along the same pillars of sustainability.

#### 5.3.1 Indicator Selection

The same approach to indicator selection as described in Section 5.2 above was utilized here. The core indicators pool, for which choice of final indicator hinged, is given in Table 5.4.

**Table 5.4** Core indicators for assessment of sustainability of site specific Caribbean ecotourism management.

| Sustainability pillar | Core Indicator | Suggested measure | Organization |
|---|---|---|---|
| Environmental | Conservation and preservation measures | Environmental monitoring (air, water, land) on a regular basis | World Tourism Organization (WTO, 2004) |
| | | Provision of modern tools for environmental monitoring | World Tourism Organization, World Travel & Tourism Council and Earth Council (WTO, WTTC and Earth Council, 1996) |
| | Sustainability management plan | Documented and updated environmental management plan | Partnership for Global Sustainable Tourism Criteria (GSTC, 2008) |
| | | National legal confines for tourism operations | |
| Economic | Customer satisfaction | Analysis of customer satisfaction | Asian Development Bank (ADB, 2009) |
| | Marketing approach | Marketing techniques utilized | Inter-American Development Bank (IDB, 2009) |
| | Ample staff | Availability of qualified workers | United States Agency for International Development (USAID, 2006) |
| Societal | Inclusion of community | Community participation in tourism planning | World Tourism Organization (WTO, 2004) |
| | Community perception of tourism | Inclusion of key community leaders for planning | Partnership for Global Sustainable Tourism Criteria (GSTC, 2008) |
| Cultural | Respect for indigenous and religious populations | Inclusion in planning phase of policy | Partnership for Global Sustainable Tourism Criteria (GSTC, 2008) |
| Political | Existence of relevant, current policy | Ensuring policies are in place as a clear contemporary guide | United Nations Department of Economic and Social Affairs (UNDESA, 1999) |

From the guidelines suggested by the various international bodies (listed in Table 5.4) indicators applicable to the Caribbean were shortlisted. The shortened list was then put through the modified ecotourism PSR framework and the final selection of indicators selected with a PSR designation (see Table 5.5).

**Table 5.5** Classification of indicators for assessing the sustainability of site specific ecotourism management in the Caribbean.

| Sphere | Indicator | Applicable core indicator(s) | Type of indicator |
|---|---|---|---|
| Environmental | Comprehensive Environmental Management Plan | Sustainability management plan | State |
| | Investment in onsite monitoring tools and equipment | | State |
| | Continuous training of staff to keep current with new methods and technologies | Conservation and preservation measures | Response |
| Economic | Trends in customer satisfaction | Customer satisfaction | Response |
| | Level of marketing and destination promotion | Marketing approach | Response |
| | Local qualified and well trained staff | Ample staff | State |
| | Site's profit and loss history | Customer satisfaction; marketing approach | State |
| Societal | Future onsite plans developed in collaboration with community stakeholders | Inclusion of community | Response |
| | Direct investment into community development | Inclusion of community; community perception of tourism | Driving force |
| Cultural | Cognizance of local beliefs & practices for planning of visitor activities | Respect for indigenous and religious populations | Driving force |
| | Solicitation of impacts of ecotourism on local practices from religious and/or community leaders | | Driving force |
| Political | Compliance with applicable laws, conventions, guidelines, etc. | Existence of relevant, current policy | Driving force |

The 12 chosen indicators can be used for measurement of impact. Table 5.6 summarizes the unit of measure for each indicator chosen.

**Table 5.6** Selected site specific management indicators and their units of impact measurement.

| | Indicator | Unit of measure |
|---|---|---|
| | *Environmental* | |
| ii | Comprehensive Environmental Management Plan | $/staff member/year |
| ii | Investment in onsite monitoring tools and equipment | $ invested per year |
| iii | Continuous training of staff to keep current with new methods and technologies | Qualitative measure |
| | *Economic* | |
| iv | Trends in customer satisfaction | Tax $ saved per year of operation |
| v | Level of marketing and destination promotion | $ invested into marketing per year |
| vi | Local qualified and well trained staff | Ratio of formally educated local staff to outsiders |
| vii | Site's profit and loss history | Average net $ income per fiscal year |
| | *Societal* | |
| viii | Future onsite plans developed in collaboration with community stakeholders | Qualitative measure |
| ix | Direct investment into community development | $/year/community |
| | *Cultural* | |
| x | Cognizance of local beliefs & practices for planning of visitor activities | Qualitative measure |
| xi | Solicitation of impacts of ecotourism on local practices from religious and/or community leaders | |
| | *Political* | |
| xii | Compliance with applicable laws, conventions, guidelines, etc. | Qualitative measure |

### 5.3.2 Overall Site Specific Sustainability of Ecotourism Management

Assignment of impact values can be done as previously described (i.e. 0 [no impact] to 3 [high impact] in increments of 0.5). The impact values can be represented as a visual tool in the form of a target plot as shown in Figure 5.2.

Key: Environmental indicators; Economic indicators; Societal indicators; Cultural indicators; Political indicators; Impact factors (0 - 3 in 0.5 increments)

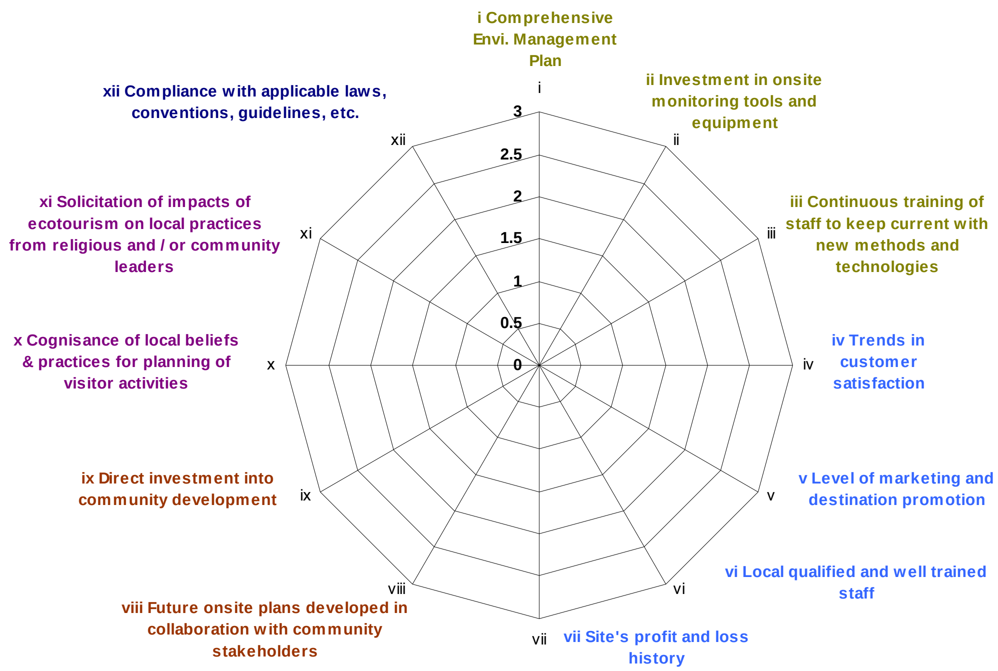



**Figure 5.2** Target plot framework of indicators to assess a Caribbean ecosite's commitment to sustainable management of ecotourism.

The assignment of the impact values should take into account the following types of considerations along with onsite informal interviews conducted and researcher observations. The non-exhaustive considerations utilized in assigning impact values in this study are:

*Indicator i – Comprehensive Environmental Management Plan (EMP)*

- Does the eco-facility have a documented EMP?
- How long ago did the eco-facility develop the first EMP?
- Is the EMP comprehensive (i.e. includes considerations of air, land, water and human in its planning)?
- Have fires been addressed?
- How often is the EMP reviewed and updated?

*Indicator ii – Investment in onsite monitoring tools and equipment*

- What has been decided upon to be monitored? How was this decided upon?
- What tools are being used to do the various aspects of monitoring?
- When did procurement of monitoring tools begin?
- Before owning your own tools were monitoring services contracted?
- How much money was initially invested to obtain required equipment?
- What monitoring aspects were first incorporated into the monitoring regimen?
- What is the schedule or frequency of monitoring?
- Are there any plans to add new parameters to the current monitoring plan?

*Indicator iii – Continuous training of staff to keep current with new methods and technologies*

- Is staff sent on local, regional and/or international training programs? If yes, how often are they sent? How are they chosen?
- Is there a budgetary allocation for staff training? If yes, what percentage of the annual budget is allocated to this?
- Does the eco-facility have the capability of providing in-house training?
- Does the eco-facility have onsite training facilities?

*Indicator iv – Trends in customer satisfaction*

- Is customer satisfaction information collected? If yes, how long has this type of information been collected?
- How is customer satisfaction gauged?
- Why was this method of testing selected?
- How often are the results analyzed?
- How are the results used to try to improve future customers' experience?

- What is the general tourist's perception on value for money?
- What has been the history of complaints of dissatisfaction by guests? If yes, how does management deal with these?
- What is the return visitor rate to your facility?
- Is your site rated in regional and/or international tourist guidebooks?

*Indicator v – Level of marketing and destination promotion*

- How is the destination currently marketed?
- Is marketing taken care of by contractors or by the site's management? What factors influenced this choice?
- Is management satisfied with marketing's influence on visitation?
- Are there any plans to revamp current marketing tactics?

*Indicator vi – Local qualified and well trained staff*

- What proportion of the skilled labor force is local? What proportion of current staff is foreign?
- Does the local market supply the level of skill required to operate your ecotourism business successfully?
- Is a recruitment agency utilized for obtaining staff?
- How are position openings advertised locally?
- Are the tourism-related training facilities in the country sufficient to provide qualified staff at a level satisfactory to your business? If no, what do these programs lack in creating the quality staff that your business prefers?
- Are locals employed at the highest tiers of management in your ecotourism business?

- Have tourists' complaints been linked to the lack of skill of locals in the past? If yes, what has been the frequency of these events?

*Indicator vii – Site's profit and loss history*

- How long has ecotourism existed?
- When was the first year that the business broke even? Since that year, has there been a steady increase in profit?
- What has been the order of magnitude of profits and loss in the past?
- Can any management decisions be chiefly attributed to these profits and/or losses?
- What are the future projected profit margins like for the site? How are these profits expected to be seen?

*Indicator viii – Future onsite plans developed in collaboration with community stakeholders*

- Are there any plans for increasing the size of the ecotourism product that can potentially affect the community?
- Were community stakeholders involved in discussions on future plans? If yes, were they allowed to have their concerns dealt with in tailoring the future plans?
- What forum is used to inform the community and community stakeholders of plans? How often are these types of sessions held?
- What level of detail is typically divulged to community stakeholders? Are the documents and/or materials used to share information appropriately termed to allow the majority of the community to know what the plans are?

*Indicator ix – Direct investment into community development*

- Has the eco-facility developed business partnerships within the community?
- What are the net tourism revenues accrued to the community?
- Since working with the community has there been a positive change in average family income? If yes, how long ago has this been noticed?
- How much of the ecotourism revenue is spent on upkeep of infrastructure in the community, construction and improvement of kindergarten and primary schools, etc.?
- What is the total number of community members employed in the ecotourism business?

*Indicator x – Cognizance of local beliefs & practices for planning of visitor activities*

- Are local religious and community leaders consulted before the eco-facility enters into new ventures onsite?
- What is the willingness of the religious and community leaders to meet with the eco-facility's representatives to discuss such issues?
- What are the groups that need to be considered? What are their beliefs and practices?
- Are any of the surrounding lands considered sacred and off limits to non-group members? What are the repercussions of uninvited entry?

*Indicator xi – Solicitation of impacts of ecotourism on local practices from religious and/or community leaders*

- In the past has there ever been any public show of disdain on the part of the community towards the ecotourism site's management? If yes, how long ago and what was done to quell the community's concerns? What were the concerns that the community had with ecotourism operations?

- Are religious and/or community leaders willing to meet amicably and discuss current and potential impacts of ecotourism on the community? Has this type of meeting ever been had?
- Are positive impacts being realized by the community? If yes, what are they?

*Indicator xii – Compliance with applicable laws, conventions, guidelines, etc.*

- What are the applicable laws that the facility needs to adhere to?
- Has the site ever been found to be in violation of any applicable law? If yes, what measures were put in place to reverse the violation? How is monitoring being done ensure that the violation does not repeat itself?
- Does the ecotourism site carry out regular scheduled audits to minimize risk of entering into violation status? If yes, is this audit done internally or contracted out?

Scenario A was created to test the ecohotel management framework created. The scenario used was that on the road to attainment of ecotourism certification and all employees and stakeholders were trained by a third party on their roles on sustaining ecotourism activities onsite. The impacts on the management were assessed by considering the respective indicator lists provided above along with the information obtained from interviews with management and staff at both sites. Also the scenario is assessed in consideration of a 6 month adjustment period after the training was completed. The assigned impacts for both the present state and for scenario A are shown in Table 5.7.

**Table 5.7** Summary of impacts for scenarios compared to present at both Greencastle and Iwokrama.

| | Iwokrama | | Greencastle | |
|---|---|---|---|---|
| Indicators | Present | Scenario A | Present | Scenario A |
| i | 0.5 | 0.5 | 3 | 2.5 |
| ii | 1 | 0.5 | 2.5 | 2.5 |
| iii | 1.5 | 0.5 | 3 | 2.5 |
| iv | 1.5 | 1 | 2 | 1.5 |
| v | 1 | 0.5 | 2.5 | 2.5 |
| vi | 1 | 0.5 | 2 | 1 |
| vii | 0.5 | 0.5 | 1.5 | 1.5 |
| viii | 0.5 | 0.5 | 3 | 2.5 |
| ix | 1 | 0.5 | 2.5 | 2.5 |
| x | 0.5 | 0.5 | 1 | 1 |
| xi | 0.5 | 0.5 | 2.5 | 2 |
| xii | 0.5 | 0.5 | 2 | 1.5 |

Similar to the analysis that was done in Chapter 4, target plots were used as the tool for ease of display and visual comparison. See Figures 5.3 and 5.4 below.

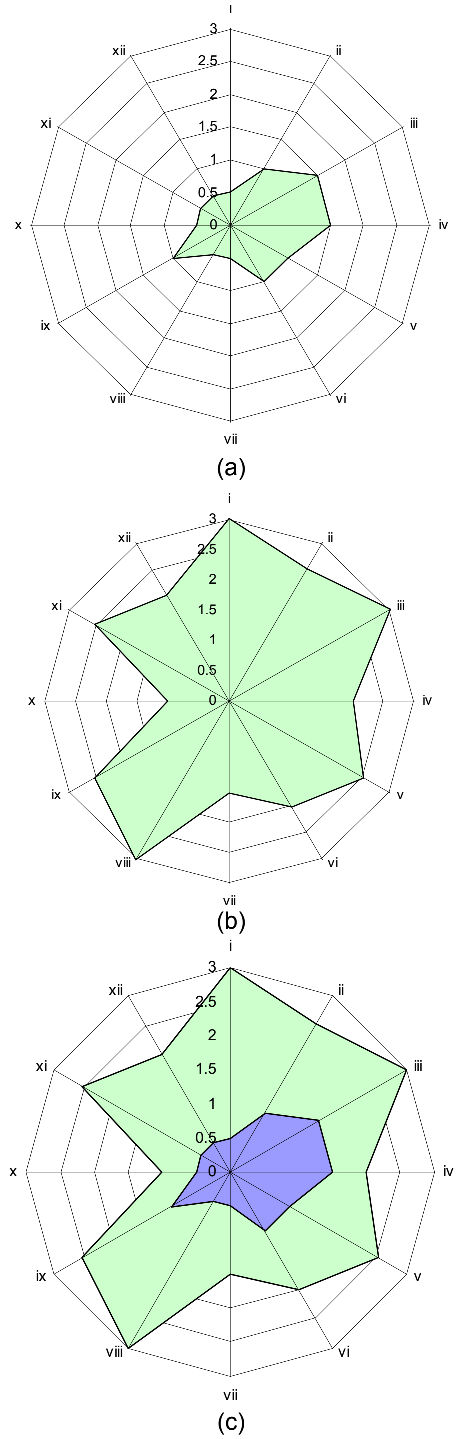



**Figure 5.3** Summary of impacts of the present state of management at (a) Iwokrama and (b) Greencastle on sustaining ecotourism. (c) is the overlay of (a) and (b). Plots indicate that Iwokrama's current management activities better promote sustainable ecotourism than that for Greencastle as most of Iwokrama's impacts are closer to the center.

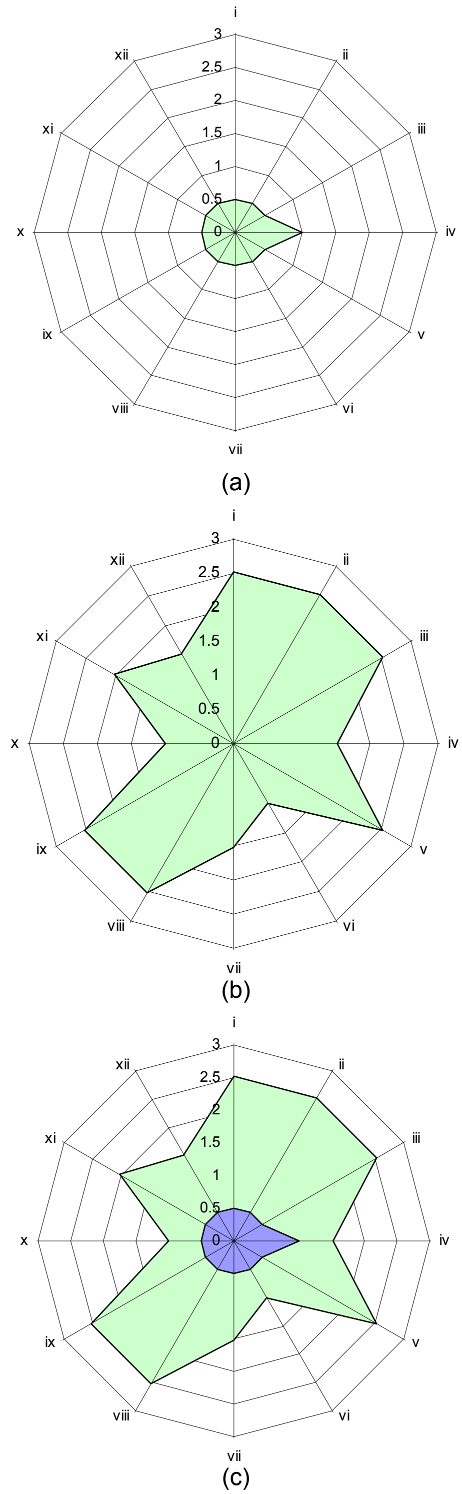


**Figure 5.4** Summary of potential impacts for scenario A at (a) Iwokrama and (b) Greencastle. (c) is the overlay of (a) and (b). This scenario positively impacts environmental, economic, societal, cultural and political indicators for both Greencastle and Iwokrama.

To gauge sustained impact an assessment of the deviations of impact values from the present need to be taken into account. In such a case, a negative deviation is more desirable than a positive one. In Table 5.8 below, deviations are characterized by sustainability pillar for each indicator. The more visual comparison of this result is shown in Figure 5.5.

**Table 5.8** Iwokrama's and Greencastle's deviations from present impact values for scenario A.

| | Iwokrama | | | Greencastle | | |
|---|---|---|---|---|---|---|
| Indicator | Present | Scenario A | Change from present value | Present | Scenario A | Change from present value |
| i | 0.5 | 0.5 | 0 | 3 | 2.5 | -0.5 |
| ii | 1 | 0.5 | -0.5 | 2.5 | 2.5 | 0 |
| iii | 1.5 | 0.5 | -1 | 3 | 2.5 | -0.5 |
| Avg. envi. impact change | | | -0.5 | Avg. envi. impact change | | -0.333 |
| iv | 1.5 | 1 | -0.5 | 2 | 1.5 | -0.5 |
| v | 1 | 0.5 | -0.5 | 2.5 | 2.5 | 0 |
| vi | 1 | 0.5 | -0.5 | 2 | 1 | -1 |
| vii | 0.5 | 0.5 | 0 | 1.5 | 1.5 | 0 |
| Avg. econ. impact change | | | -0.375 | Avg. econ. impact change | | -0.375 |
| viii | 0.5 | 0.5 | 0 | 3 | 2.5 | -0.5 |
| ix | 1 | 0.5 | -0.5 | 2.5 | 2.5 | 0 |
| Avg. soc. impact change | | | -0.25 | Avg. soc. impact change | | -0.25 |
| x | 0.5 | 0.5 | 0 | 1 | 1 | 0 |
| xi | 0.5 | 0.5 | 0 | 2.5 | 2 | -0.5 |
| Avg. cult. impact change | | | 0 | Avg. cult. impact change | | -0.25 |
| xii | 0.5 | 0.5 | 0 | 2 | 1.5 | -0.5 |
| Avg. pol. impact change | | | 0 | Avg. pol. impact change | | -0.5 |
| Overall avg. impact change | | | -0.225 | Overall avg. impact change | | -0.342 |

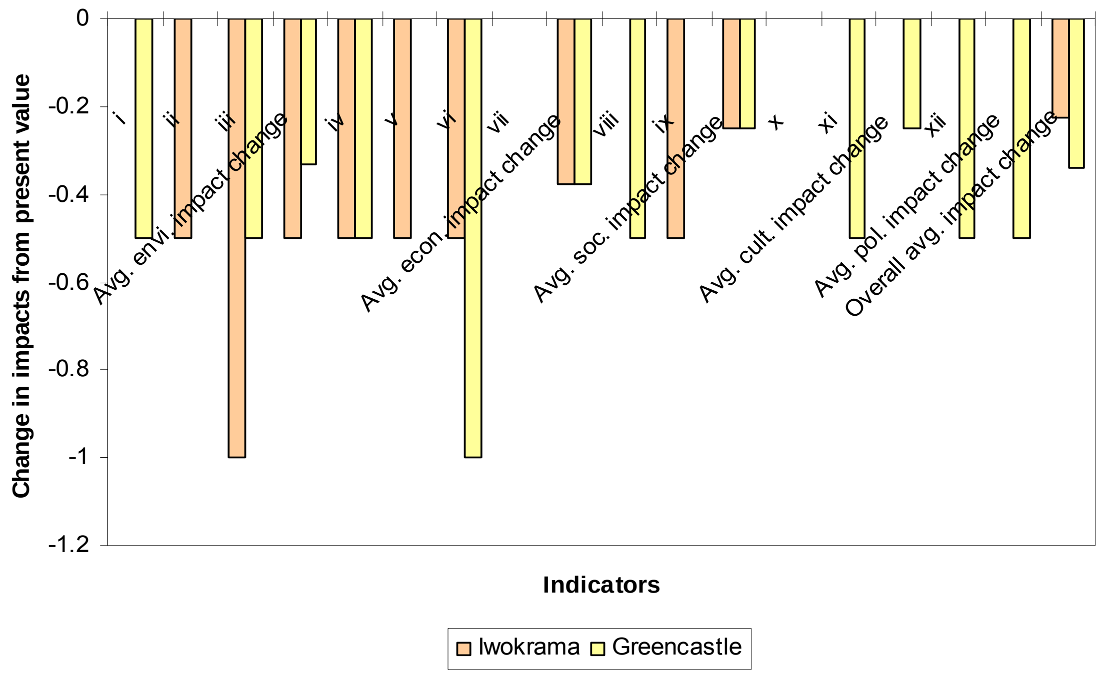



**Figure 5.5** Indicator sensitivity plot for scenario A. For both sites implementation of training shows reduction in negative impacts.

## 5.4 Quantification of Strength of a Site's Ecotourism Management

### 5.4.1 Introduction

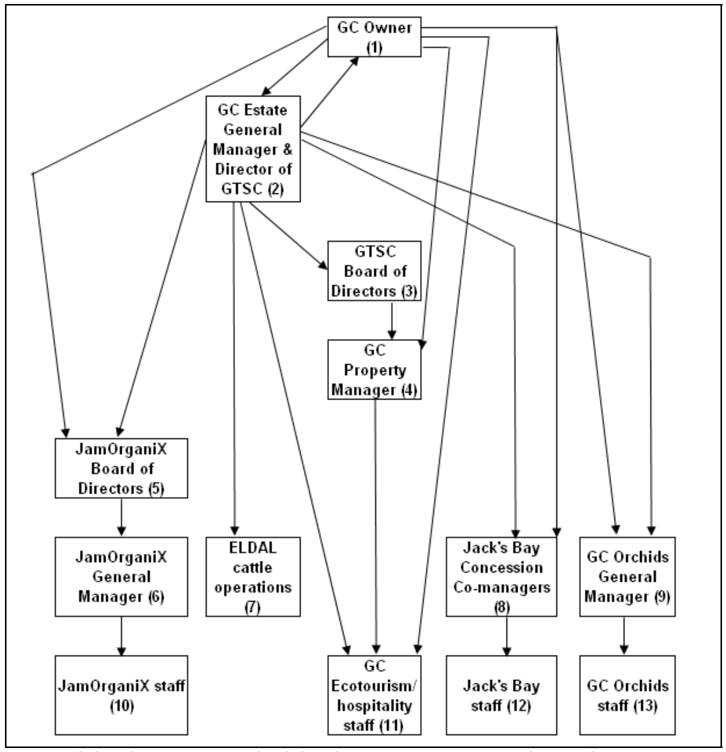
Social Network Analysis (SNA) was utilized to design a scheme by which the management of ecotourism can be quantified by use of Microsoft Excel™. SNA allows for every possible type of relationship between any two actors in the network to be highlighted (i.e. personal, professional, etc.). As such, it only considers a singular type of relationship (e.g. management) and the possibilities of interaction between 2 specific actors while ignoring all other actors in the network. This property was exploited for every actor in the network in order to determine the network strength and topography. Thus an egocentric management relationship based on 'organizational structure' was incorporated into SNA. Observation and surveying of non-managerial personnel involved in ecotourism were used to determine who the 'true' managerial players were. This information is critical for the adjustment of the network and for designation of roles and delegations of tasks for successful management of ecotourism onsite. SNA allows for an easy to use visual management tool of all actors involved in the ecotourism business. The most important steps in applying SNA with Microsoft Excel™ to ecotourism management are given in Table 5.9. Note that the Step 2 refers to the type of relationship that is of interest (i.e. all relationships between actors or only certain relationships). For this work the only relationship of interest is a management relationship and all others were ignored. Due to the lack of information at the micro management level for both sites, only macro management was assessed. Steps 3, 4 and 5 are discussed in greater depth below.

**Table 5.9** Key steps in applying SNA for sustainable ecotourism management (adapted from Hassan, 2009)

| |
|---|
| 1. Identify actors within each site that are managed or do the management to attain a saleable ecotourism product.<br>2. Choose level of SNA desired (i.e. management at the micro or macro level).<br>3. Characterize the relations among actors and draw the network.<br>4. Use Microsoft Excel™ to obtain SNA matrices.<br>5. Analyze data and interpret results. |

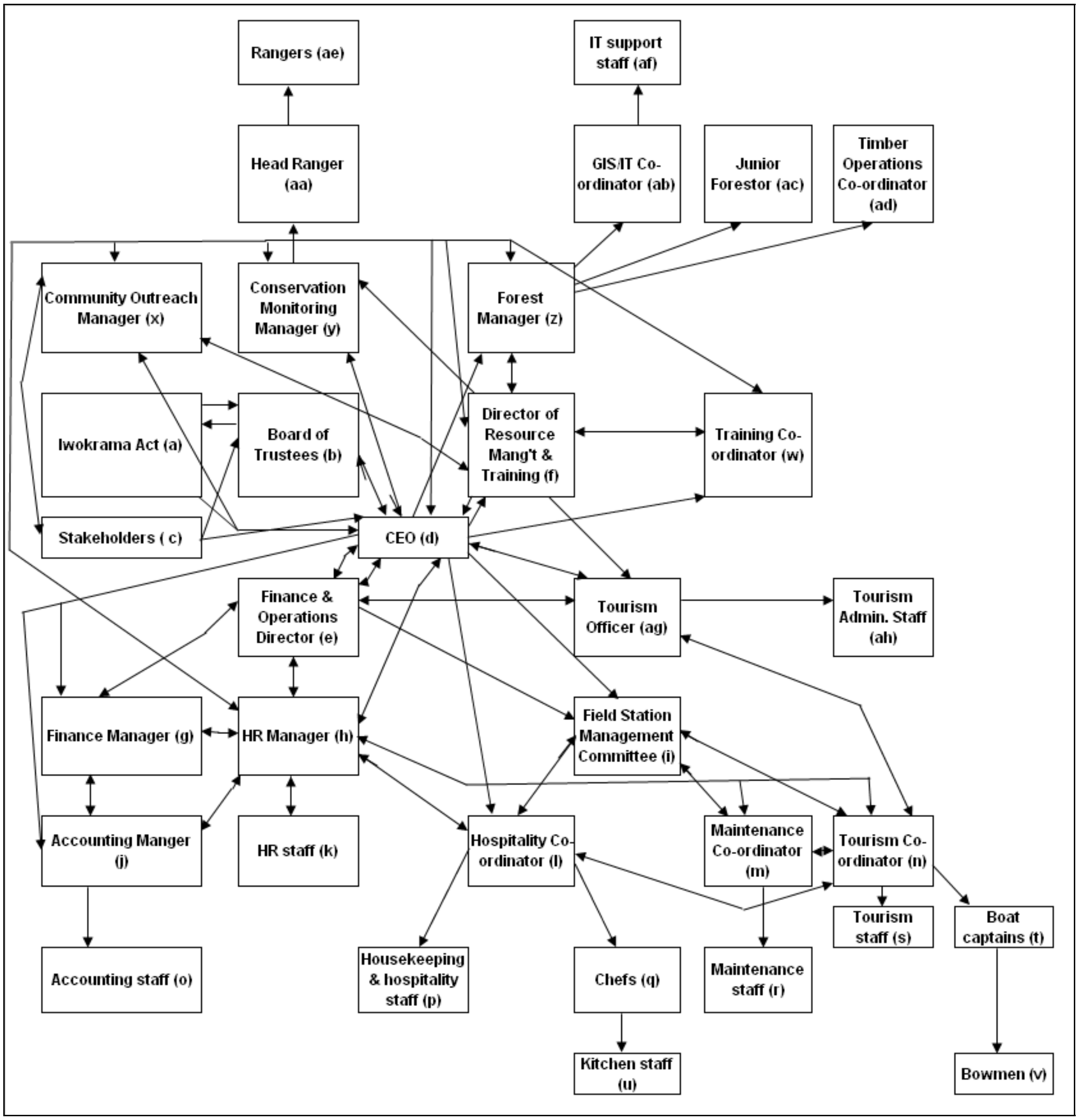
### 5.4.2 The Management Network

As a first approach, the organizational structure was used as the starting point in setting up the network. In both cases used in this work an upper level management player was asked to detail the internal managerial ties that would not be present on an organizational chart. This chart gives one-way ties however there are two-way ties among some players, which from organizational theory is how management should be entered into. These two-way ties represent transfer of crucial information among lateral and/or lower rank actors to a lateral/higher rank managerial actor. In the networks shown below one-way ties are represented as → and two-way ties are represented as←→.




GC - Greencastle; GTSC - Greencastle tropical Study Center;
ELDAL – Eastern Livestock Development Association Limited

**Figure 5.6** Management network for Greencastle's ecotourism product.




CEO – Chief Executive Officer; GIS – Geographic Information Systems;
IT – Information Technology; HR – Human Resources

**Figure 5.7** Current Iwokrama management structure for its ecotourism product.

In consideration of Figure 5.7 the Accounting Staff, for example, node is a clump that represents more than one person. Within that node it is possible to have an internal managerial structure but such micro structures were ignored in this study.

It should be noted that by simply drawing a network as in Figures 5.6 and 5.7 some key actors or management players can be identified. Table 5.10 details the main SNA relational characteristics that should be identified. In this work identification of these actors can be beneficial to the successful management of ecotourism in the future if the actors' positions are 'exploited' to enhance overall management of ecotourism. Though non-numeric, these indicators are important for planning purposes.

**Table 5.10** Relational characteristics used to identify key actors (adapted from Hassan, 2009; Hanneman and Riddle, 2005).

| Measure | Definition |
|---|---|
| Betweenness | This refers to the extent to which an actor acts as a 'broker' or 'gatekeeper' in the network. |
| Closeness | An actor is considered to be close when it has the shortest paths to all others. This means that actor can avoid the potential control of others. |
| Boundary spanners | A boundary spanner refers to an actor that has access to other networks. |
| Centrality | Centrality identifies the most important actors in a social network, which are usually nodes located in strategic locations within the network. The centrality value of the actors in asset management will therefore depend on the frequency of contact of an actor relative to that of other actors. |

### 5.4.3 Development of Matrices

Before matrices can be developed there needs to be a convention of assignment of managerial relationship existence between 2 actors. This is done in binary where 1 was used where there is a managerial relationship between two actors and 0 when there is no such managerial relationship. This is really a binary representation of all the possible managerial relationships among the actors in a given network. One assumption used in the assignment of the binary representation in the grid is that any given actor manages himself or herself. Table 5.11 highlights the Greencastle binary grid based on Figure 5.6.

**Table 5.11** Greencastle's binary managerial grid for ecotourism.

| **Management Player (node designation)** | *Node* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GC Owner (1) | *1* | **1** | **1** | 0 | **1** | **1** | 0 | 0 | **1** | **1** | 0 | **1** | 0 | 0 |
| GC Estate General Manager & Director of GTSC (2) | *2* | **1** | **1** | **1** | 0 | **1** | 0 | **1** | **1** | **1** | 0 | 0 | 0 | 0 |
| GTSC Board of Directors (3) | *3* | 0 | 0 | **1** | **1** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GC Property Manager (4) | *4* | 0 | 0 | 0 | **1** | 0 | 0 | 0 | 0 | 0 | 0 | **1** | 0 | 0 |
| JamOrganiX Board of Directors (5) | *5* | 0 | 0 | 0 | 0 | **1** | **1** | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| JamOrganiX General Manager (6) | *6* | 0 | 0 | 0 | 0 | 0 | **1** | 0 | 0 | 0 | **1** | 0 | 0 | 0 |
| ELDAL cattle operations (7) | *7* | 0 | 0 | 0 | 0 | 0 | 0 | **1** | 0 | 0 | 0 | 0 | 0 | 0 |
| Jack's Bay Concession Co-managers (8) | *8* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **1** | 0 | 0 | 0 | **1** | 0 |
| GC Orchids General Manager (9) | *9* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **1** | 0 | 0 | 0 | **1** |
| JamOrganiX staff (10) | *10* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **1** | 0 | 0 | 0 |
| GC Ecotourism/hospitality staff (11) | *11* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **1** | 0 | 0 |
| Jack's Bay staff (12) | *12* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **1** | 0 |
| GC Orchids staff (13) | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **1** |

Based on this binary grid key SNA matrices can be developed (Wasserman and Faust, 1994). These key matrices are the adjacency, relationship and reachability matrices. Each of these is then utilized with some matrix algebra to determine several important measures of the network. For the purposes of this work network density and centrality ratio concepts were utilized to identify management strength. Table 5.12 describes the different matrices utilized as well as the general theory behind network density and centrality ratio.

**Table 5.12** Quantitative measures of strength of management in SNA (adapted from Freeman, White and Romney, 1989; Hassan, 2009; Outhwaite and Turner, 2007).

| Numerical measure | Definition |
|---|---|
| SNA matrices | ▪ Adjacency - Adjacency tells us whether there is a direct connection from one actor to another (or between 2 actors for un-directed data).<br>▪ Relationship – This matrix shows the relations between actors using integers that represent the strength of the relation between 2 actors. The resulting matrix represents the sum of frequencies or the 'frequency of contact' required between 2 actors.<br>▪ Reachability – Reachability is a measure of path distance, the "length" or number of unique walks between actors. The reachability matrix is the product of the adjacency matrix with itself and it uncovers the number of paths that an actor can be reached. To determine path distances of more than one, the adjacency matrix is multiplied by itself as many times as the path requires. Reachability tells us whether two actors are connected or not by way of either a direct or an indirect pathways of any length. |
| Centrality ratio ($C_i$) | This ratio is the ratio of the aggregate relations involving the actor over all relations in the ecotourism management structure. The centrality can be found from: $$C_i = \frac{\sum_{j=1}^{N}(z_{ij} + z_{ji})}{\sum_{i=1}^{N}\sum_{j=1}^{N} z_{ij}} \qquad (5.1)$$ where $C_i$ is the centrality of the ith actor; $Z_{ij}$ is the value of a relation from the ith actor directed to the jth actor in the kth network. Note that i ≠ j and N is the number of actors in the network. |
| Network density | This is a measure of the percentage of all the possible ties present and varies from 0 to 1. This gives a ready index of the degree of dyadic connection in a population. For binary data this is simply the ratio of the number of adjacencies that are present divided by the number of pairs i.e. the proportion of possible dyadic connections actually present. Simply put it is the proportion of ties present to the maximum number of ties possible. It can be calculated by: $$\text{Network density} = \frac{T}{N(N-1)/2} \qquad (5.2)$$ where T is the number of ties present; N is the number of actors in the network. |

### 5.4.3.1 Management Density

For this work conventional network density in its defined state is not the most correct statistic to tell management's strength (Knoke and Kuklinski, 1982; Rogers, 1962; Taagepera, 2008). This is due to the fact that network density accounts for all ties among actors since all ties are usually two-way when measuring social/informal relations (e.g. friendship) for which SNA was developed. However in the case of a management relationship, as seen from Figures 5.6 and 5.7, there are many one-way ties. In consideration of modern theories of management and organizational theory that promote two-way interactions among actors (Nohria and Eccles, 1992; Hu, 2009), all one-way ties were considered half of a tie and only two-way ties were considered a whole tie. Thus the modified Equation 5.2 utilized was:

$$\text{Management density}\left(\rho_{Mgt}\right) = \frac{T_{two-way}}{N(N-1)/2} \qquad (5.3)$$

where $T_{two\text{-}way}$ is the number of two-way ties in the management network; N is the number of actors (or nodes) in the network.

### 5.4.4 Greencastle's Management Matrices

Greencastle is used below to highlight how these different matrices are able to give vital information about the ecotourism management structure in place. Iwokrama is neglected in this analysis because of the size of its matrices and formatting limitations herein. All the Iwokrama matrices are provided in Appendix F.

#### 5.4.4.1 The Adjacency Matrix

The objective of the adjacency matrix is to describe how many direct contacts an actor has with other actors in any particular network. This matrix is based upon the binary management grid developed, as shown in Table 5.11 above. To complete the adjacency matrix two calculations are computed by actor: degree of actor and standardized degree. The equations for tabulations are given below.

$$\text{Degree of actor } (A^o) = \sum_{N=1}^{N} \{\text{binary input of managerial relationship}\} \tag{5.4}$$

$$\text{Standardized degree } (S^o) = \text{Degree of actor} / (N-1) \tag{5.5}$$

where N is the number of actors in the network.

By the application of Equations 5.4 and 5.5 Greencastle's adjacency matrix was found as shown in Table 5.13.

**Table 5.13** Adjacency matrix for Greencastle.

| Management Player (node designation) | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | $A^o$ | $S^o$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GC Owner (1) | **1** | **1** | **0** | **1** | **1** | **0** | **0** | **1** | **1** | **0** | **1** | **0** | **0** | 7 | 7/12 |
| GC Estate General Manager & Director of GTSC (2) | **1** | **1** | **1** | **0** | **1** | **0** | **1** | **1** | **1** | **0** | **0** | **0** | **0** | 7 | 7/12 |
| GTSC Board of Directors (3) | **0** | **0** | **1** | **1** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | 2 | 1/6 |
| GC Property Manager (4) | **0** | **0** | **0** | **1** | **0** | **0** | **0** | **0** | **0** | **0** | **1** | **0** | **0** | 2 | 1/6 |
| JamOrganiX Board of Directors (5) | **0** | **0** | **0** | **0** | **1** | **1** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | 2 | 1/6 |
| JamOrganiX General Manager (6) | **0** | **0** | **0** | **0** | **0** | **1** | **0** | **0** | **0** | **1** | **0** | **0** | **0** | 2 | 1/6 |
| ELDAL cattle operations (7) | **0** | **0** | **0** | **0** | **0** | **0** | **1** | **0** | **0** | **0** | **0** | **0** | **0** | 1 | 1/12 |
| Jack's Bay Concession Co-managers (8) | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **1** | **0** | **0** | **0** | **1** | **0** | 2 | 1/6 |
| GC Orchids General Manager (9) | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **1** | **0** | **0** | **0** | **1** | 2 | 1/6 |
| JamOrganiX staff (10) | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **1** | **0** | **0** | **0** | 1 | 1/12 |
| GC Ecotourism /hospitality staff (11) | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **1** | **0** | **0** | 1 | 1/12 |
| Jack's Bay staff (12) | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **1** | **0** | 1 | 1/12 |
| GC Orchids staff (13) | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **1** | 1 | 1/12 |
| Degree of actor | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 31 | |

$A^o$ – degree of actor; $S^o$ – standardized degree

According to Hassan (2009), the degree of the actor can be interpreted as point centrality of the actor while the standardized degree of an actor measures the connectedness of an actor in any given network. So for this network both the GC Owner and the GC Estate General Manager are equally connected in the managerial network.

They are both central to the management and so have a high degree of involvement for the success of the management of ecotourism.

#### 5.4.4.2 The Reachability Matrix

This matrix is theoretically a measure of *path distance* or the *number of unique walks* between actors. In the design of a management system there should be at least 2 paths to by which actors can be managerially reached. As such this study only looked at how many 2 path distances currently exist. The matrix is obtained by multiplying the adjacency by itself. The outcome of this matrix tells the number of ways that each actor can be managerially reached within the network. Note that if there was interest in investigating 4 path distances then the adjacency matrix would be multiplied by itself 4 times.

**Table 5.14** Reachability matrix for Greencastle.

| Management Player (node designation) | | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GC Owner (1) | *1* | **2** | **2** | **1** | **2** | **3** | **1** | **1** | **3** | **3** | **0** | **3** | **1** | **1** |
| GC Estate General Manager & Director of GTSC (2) | *2* | **2** | **2** | **2** | **2** | **3** | **1** | **2** | **3** | **3** | **0** | **1** | **1** | **1** |
| GTSC Board of Directors (3) | *3* | **0** | **0** | **1** | **2** | **0** | **0** | **0** | **0** | **0** | **0** | **1** | **0** | **0** |
| GC Property Manager (4) | *4* | **0** | **0** | **0** | **1** | **0** | **0** | **0** | **0** | **0** | **0** | **2** | **0** | **0** |
| JamOrganiX Board of Directors (5) | *5* | **0** | **0** | **0** | **0** | **1** | **2** | **0** | **0** | **0** | **1** | **0** | **0** | **0** |
| JamOrganiX General Manager (6) | *6* | **0** | **0** | **0** | **0** | **0** | **1** | **0** | **0** | **0** | **2** | **0** | **0** | **0** |
| ELDAL cattle operations (7) | *7* | **0** | **0** | **0** | **0** | **0** | **0** | **1** | **0** | **0** | **0** | **0** | **0** | **0** |
| Jack's Bay Concession Co-managers (8) | *8* | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **1** | **0** | **0** | **0** | **2** | **0** |
| GC Orchids General Manager (9) | *9* | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **1** | **0** | **0** | **0** | **2** |
| JamOrganiX staff (10) | *10* | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **1** | **0** | **0** | **0** |
| GC Ecotourism/hospitality staff (11) | *11* | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **1** | **0** | **0** |
| Jack's Bay staff (12) | *12* | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **1** | **0** |
| GC Orchids staff (13) | 13 | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **1** |

From Table 5.14 over 74% of the actors have no 2 path distances to any other actor. This type of information is important when attempting to restructure management.

### 5.4.4.3 The Relationship Matrix

Unlike the adjacency and reachability matrices, the relationship matrix measures the *magnitude* of the managerial relationship between actors. The adjacency and reachability matrices focused on the *presence* of ties while this matrix tells of the *strength* of the management relations. The output matrix represents the sum of frequencies or frequency of contact required for the successful management of ecotourism. In order to attain the required information actors were interviewed during site visits and actors that were not present were contacted via phone and email after the visit to give their frequency of contact. For actors that could not be reached, the Greencastle General Manager and the Director of Resource Management and Training at Iwokrama were consulted to give conservative estimates on their behalf. Only integers were optional responses.

**Table 5.15** Relationship matrix for Greencastle.

| **Node** | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | Sum of freq. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *1* | **0** | **1** | **4** | **1** | **3** | **2** | **1** | **1** | **1** | **1** | **0** | **0** | **0** | 15 |
| *2* | **3** | **0** | **3** | **1** | **2** | **4** | **1** | **5** | **5** | **4** | **3** | **4** | **5** | 40 |
| *3* | **4** | **2** | **0** | **2** | **5** | **3** | **1** | **1** | **1** | **0** | **0** | **0** | **0** | 19 |
| *4* | **3** | **1** | **3** | **0** | **2** | **1** | **1** | **1** | **1** | **2** | **3** | **2** | **2** | 22 |
| *5* | **1** | **3** | **3** | **2** | **0** | **1** | **0** | **2** | **2** | **2** | **0** | **0** | **0** | 16 |
| *6* | **1** | **2** | **3** | **2** | **1** | **0** | **0** | **3** | **3** | **1** | **0** | **0** | **0** | 16 |
| *7* | **0** | **3** | **3** | **3** | **4** | **3** | **0** | **3** | **3** | **0** | **0** | **0** | **0** | 22 |
| *8* | **0** | **2** | **2** | **2** | **3** | **3** | **0** | **0** | **1** | **0** | **0** | **1** | **0** | 14 |
| *9* | **0** | **2** | **2** | **2** | **2** | **3** | **7** | **2** | **0** | **0** | **0** | **0** | **1** | 21 |
| *10* | **0** | **5** | **0** | **4** | **1** | **1** | **0** | **2** | **1** | **0** | **0** | **0** | **0** | 14 |
| *11* | **0** | **2** | **5** | **2** | **0** | **0** | **0** | **3** | **1** | **0** | **0** | **0** | **0** | 13 |
| *12* | **0** | **3** | **8** | **3** | **0** | **0** | **0** | **1** | **3** | **0** | **0** | **0** | **0** | 18 |
| 13 | **0** | **3** | **5** | **3** | **0** | **0** | **0** | **1** | **1** | **0** | **0** | **0** | **0** | 13 |
| Sum of freq. | 12 | 29 | 41 | 27 | 23 | 21 | 11 | 25 | 23 | 10 | 6 | 7 | 8 | 243 |

### 5.4.5 Centrality Ratio

The centrality ratio hinges upon the concept of *centralization*. Centralization, according to Hu (2009), refers to the degree to which a network in question approaches the configuration of a ‘star’ network. A star network being one that has a node in the center that connects to other nodes. The node that connects to the majority of the other nodes has the highest ratio of 1 while that with no connection has a ratio of 0. The centralization score, however, is expressed as a percentage from 0 (i.e. every member is connected) to 100 (i.e. all members are connected to only one member).

The global centrality or centrality ratio is determined from the relationship matrix according to Equation 5.1. The centrality values for an actor depend on the frequency of contact for ecotourism management. The centrality results for both Greencastle and Iwokrama are highlighted below.

**Table 5.16** Centrality measures by actor for Iwokrama

| Management player (node designation) | Centrality |
|---|---|
| Iwokrama Act (a) | 0.00893 |
| Board of Trustees (b) | 0.00893 |
| Stakeholders ( c) | 0.0893 |
| CEO (d) | 0.848 |
| Finance & Operations Director (e) | 0.339 |
| Director of Resource Mang't & Training (f) | 1 |
| Finance Manager (g) | 0.179 |
| HR Manager (h) | 0.509 |
| Field Station Management Committee (i) | 0.170 |
| Accounting Manger (j) | 0.116 |
| HR staff (k) | 0.0268 |
| Hospitality Co-ordinator (l) | 0.1607 |
| Maintenance Co-ordinator (m) | 0.0714 |
| Tourism Co-ordinator (n) | 0.134 |
| Accounting staff (o) | 0.00893 |
| Housekeeping & hospitality staff (p) | 0.00893 |
| Chefs (q) | 0.0268 |
| Maintenance staff (r) | 0.00893 |
| Tourism staff (s) | 0.00893 |
| Boat captains (t) | 0.00893 |
| Kitchen staff (u) | 0 |
| Bowmen (v) | 0 |
| Training Co-ordinator (w) | 0.0536 |
| Community Outreach Manager (x) | 0.125 |
| Conservation Monitoring Manager (y) | 0.0982 |
| Forest Manager (z) | 0.0714 |
| Head Ranger (aa) | 0.0268 |
| GIS/IT Co-ordinator (ab) | 0.0357 |
| Junior Forestor (ac) | 0.0179 |
| Timber Operations Co-ordinator (ad) | 0.0179 |
| Rangers (ae) | 0.0179 |
| IT support staff (af) | 0.00893 |
| Tourism Officer (ag) | 0.134 |
| Tourism Admin. Staff (ah) | 0.0268 |

**Table 5.17** Centrality measures by actor for Greencastle

| Management Player (node designation) | Centrality |
|---|---|
| GC Owner (1) | 0.375 |
| GC Estate General Manager & Director of GTSC (2) | 1 |
| GTSC Board of Directors (3) | 0.475 |
| GC Property Manager (4) | 0.55 |
| JamOrganiX Board of Directors (5) | 0.4 |
| JamOrganiX General Manager (6) | 0.4 |
| ELDAL cattle operations (7) | 0.55 |
| Jack's Bay Concession Co-managers (8) | 0.35 |
| GC Orchids General Manager (9) | 0.525 |
| JamOrganiX staff (10) | 0.35 |
| GC Ecotourism/hospitality staff (11) | 0.325 |
| Jack's Bay staff (12) | 0.45 |
| GC Orchids staff (13) | 0.325 |

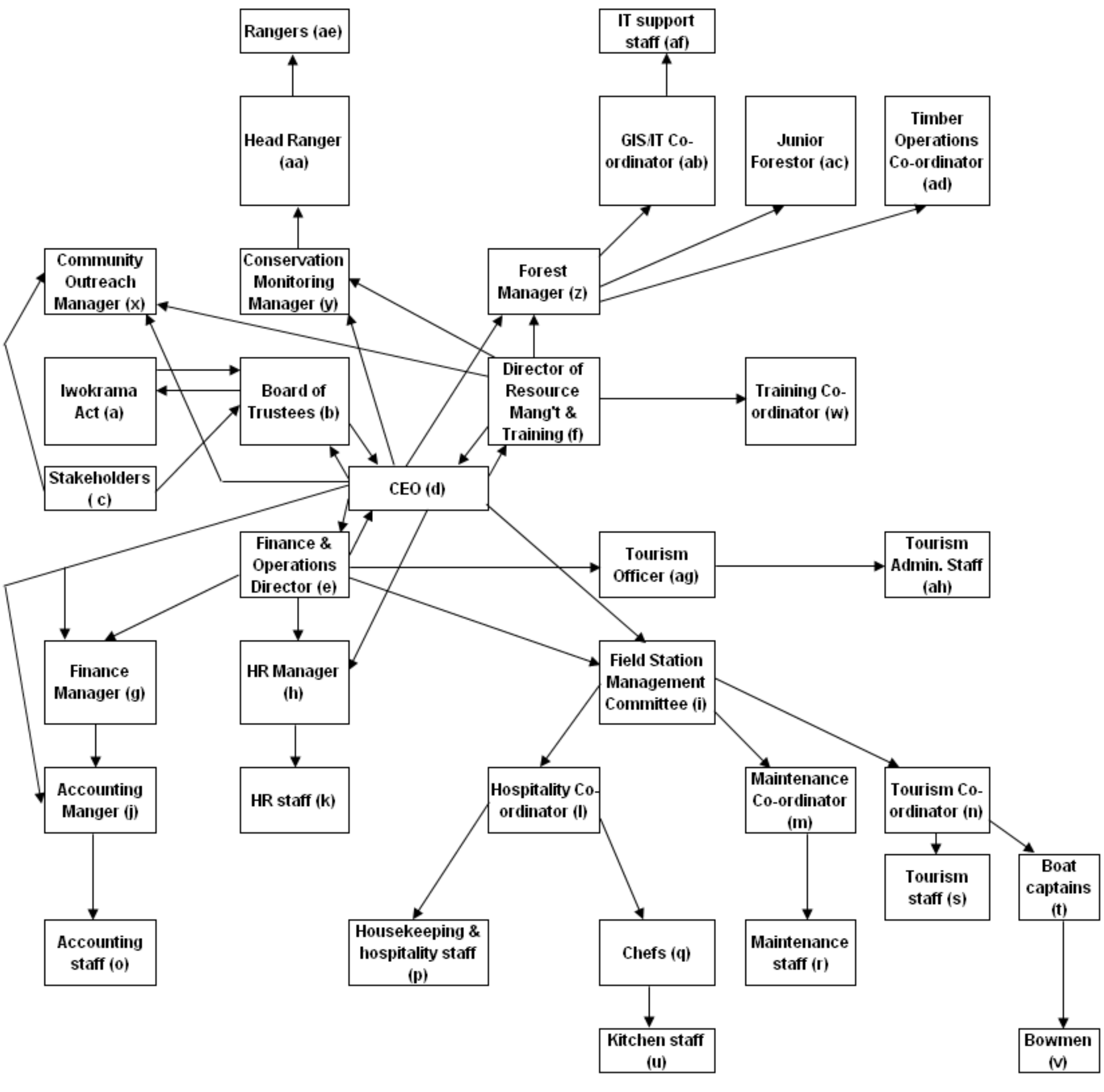
From Tables 5.16 and 5.17 it is seen that perfect centrality is had by Iwokrama's actor (f) and by Greencastle's actor (2). This implies that these 2 actors are in contact with every member in its network and more importantly that every managerial contact made in the respective networks can be performed through that actor.

In consideration of Iwokrama's centrality ratios (Table 5.16) it is clear that several actors are rarely utilized in the management of the ecotourism product with actors (u) and (v) never being consulted. By increasing centrality of actors across the business this reduces reliance on a single person for success.

### 5.4.6 Calculated Management Density

In any decision-making network, such as ecotourism management networks, a higher management density indicates a greater degree of interaction among actors in the network. In consideration of Equation 5.2 and Figures 5.6 and 5.7, the management density was found to be 0.0766 for Iwokrama and 0.1154 for Greencastle.

The Iwokrama management structure that is currently in place was changed in 2007. The pre-2007 management network is shown in Figure 5.8.




CEO – Chief Executive Officer; GIS – Geographic Information Systems;
IT – Information Technology; HR – Human Resources

**Figure 5.8** Pre-2007 management network for Iwokrama's ecotourism product.

The current structure has double the number of two-way ties/interaction for the same nodes as the pre-2007 structure. The pre-2007 structure had a management density of 0.03743. This shows that management density is able to respond to managerial changes in management networks and appears to be proportional with strength.

### 5.4.7 Recommendations to Improve Management Strength

From Figures 5.6 and 5.7 it is clear that Greencastle has the greater amount of one-way ties on the overall percentage basis however its small network size allows it to still have a much better management density than Iwokrama. Especially in the case of Iwokrama both sites should attempt to create more two-way ties. This would inherently improve the centrality of actors as well as the management density.

As has been alluded to in earlier chapters, the Monteverde Institute's management of ecotourism in Costa Rica has brought world acclaim to the success of the industry there not just in terms of revenue but holistic sustainable management. Therefore, the management structure of the Monteverde Institute was studied for comparison and recommendations to achieve similar status. However, due to certain confidentiality restrictions placed on the agreement of use of their information the actual network cannot be shown here. Based on the information provided by upper level Monteverde Institute managerial staff the following was the key findings of their ecotourism management network:

- Number of actors/nodes – 46
- Number of two-way ties – 827
- Management density – 0.79832
- Actor with perfect centrality – Community leader (i.e. lower management)

One of the key findings here that was not already discussed was the fact that the actor with perfect centrality was the community leader who is local and involved at the lower management level. By having this actor as the central person they are best able to reach the bulk of the workforce and hence be better able to influence any managerial fixes that may be required for more successful management of their ecotourism product.

### 5.5 Conclusions

This work showed that the assessment of the sustainable management of ecotourism in the Caribbean can be assessed among 5 pillars of sustainability: environmental, economic, societal, cultural and political. At the national level assessment can be done across 15 indicators while it can be done across 12 indicators for the site level assessment. The chosen indicators, at each level, were representative of suggested and core indicators of international agencies that have published on sustainable management practices for businesses. All indicators were fit to the PSR framework for final selection. Target plots, 1 at each level of assessment considered, of these indicators selected were created to visualize the results of the assessment. The actual results for the site specific assessment was done at the present state and for a created scenario such that each indicator was analyzed for impact (on a scale of 0, no impact, to 3, high intensity impact) based on a pool of questions linked to the severity of the impact. From the target plot for the scenario created and sensitivity analysis done it was shown that the tool created was able to respond to managerial changes at the site level. Hence the tools developed in this work provide useable assessment frameworks that can be transferred throughout the Caribbean's ecotourism industries.

A modified approach to SNA was taken to create a scheme by which management of ecotourism can be quantified at the site level. Conventional SNA matrices were used (i.e. adjacency, reachability and relationship) as well as a centrality ratio to show how valuable information about the management network can be achieved. The definition of management density and the proposed method of calculation can tell of the strength of the network quantitatively with a single number between 0 (worst strength) and 1 (best strength). Using these tools, the Iwokrama site was found to have a management density of 0.0766 and the Greencastle site had one of 0.1154. Compared to Costa Rica, these numbers are low and do not recognize the community leader as a central actor.

# CHAPTER 6: MEASURING SURFACE WATER QUALITY AS AN ECOTOURISM SUSTAINABILITY INDICATOR

## 6.1 Introduction

Any assessment of water resources mandates mastery of the understanding of both the water quantity and the water quality processes within a watershed (Harmancioglu et al., 1999). The lack of fresh surface water of adequate quantity and quality, will make sustainable development impossible (Bartram and Ballance, 1996). For the most part, it is assumed that ecotourism will engage in activities that are sustainable since the fundamentals behind ecotourism include poverty reduction, revenue generation and sustainable development. Various international certifications help to identify tourism destinations with reduced environmental impact, mainly through biodiversity counting and water and energy efficiency audits. Substantial measurements on water quality parameters have not been incorporated into certification procedures and questions remain on the impact of the watershed's ecotourism activities, inclusive of staff, native populations and visitors alike, on surface water quality. Ecotourism facilities throughout the world, inclusive of the Caribbean, are often located in rural and remote areas with limited potable water supply (Eagles, McCool and Haynes, 2002) and heavy reliance on harvested rainwater and surface water withdrawals (Manson, 2008). When coupled with the ecosystems services that fresh waterways provide for aquatic flora and fauna it becomes evident that concerns from both the human health and species propagation angles are legitimate (Meybeck, Chapman and Helmer, 1989; Chapman, 1996). Thus there is a need for water quality monitoring and management. According to Harmancioglu et al. (1999), water quality monitoring comprises all sampling activities to collect and process data on water quality for the purpose of obtaining information about the physical, biological and chemical properties of water.

### 6.1.1 Objectives and Subtasks

The main objectives with respect to water quality were to develop baseline water quality data at both of the Caribbean study sites with inclusion of ecotourism monitoring and/or management staff so as to be a hands-on training tool for them. Also this work sought to provide a conceptual water quality monitoring model that management can follow to achieve accurate low-cost monitoring. The subtasks to achieve these objectives were:

- Visit each site and carry out water sampling and *in situ* monitoring/analyses and *ex situ* laboratory analyses,
- Involve ecotourism management and staff in testing and monitoring exercises onsite, and
- Use literature and current Caribbean scientific research activities to devise a conceptual path for water quality monitoring within the region's ecotourism industry.

## 6.2 Choice of Sampling Locations and Parameters to Monitor

The decision on which parameters to monitor were made in conjunction with published literature on monitoring needs for surface water based on intended water use as well as cost and practicality factors. The actual sampling sites utilized in the study were chosen to ensure that data were collected throughout the entire watershed. Consideration was given to the practicality of getting to the points during the wet season as well as to the inclusion of input and output flows in the watershed. For the Jamaica site, all watershed input and output flows were sampled while at the Guyana site judgment had to be made to select relevant waterways to be sampled since the entire watershed was too expansive. The chosen sampling locations at the Guyana site particularly focused on the flows into and out of the watershed directly around the main ecotourism activities areas. Also the location selection considered the future onsite construction activity that is planned (as detailed in Chapter 4) so that impacts of these additions on water quality can be quantified over a longitudinal monitoring study. It is expected that once monitoring takes place longitudinally changes in land use, population and visitation can be used to correlate with the water quality results once the same sampling points are utilized throughout the longitudinal study. Note that this sampling regimen should continue monthly for at least 3 calendar years to transcend both the change in seasons as well as to allow for the inclusion of tourist arrival fluctuations. The points chosen for baseline development sampling and monitoring, at both sites, are shown in Figures 6.1 – 6.3.

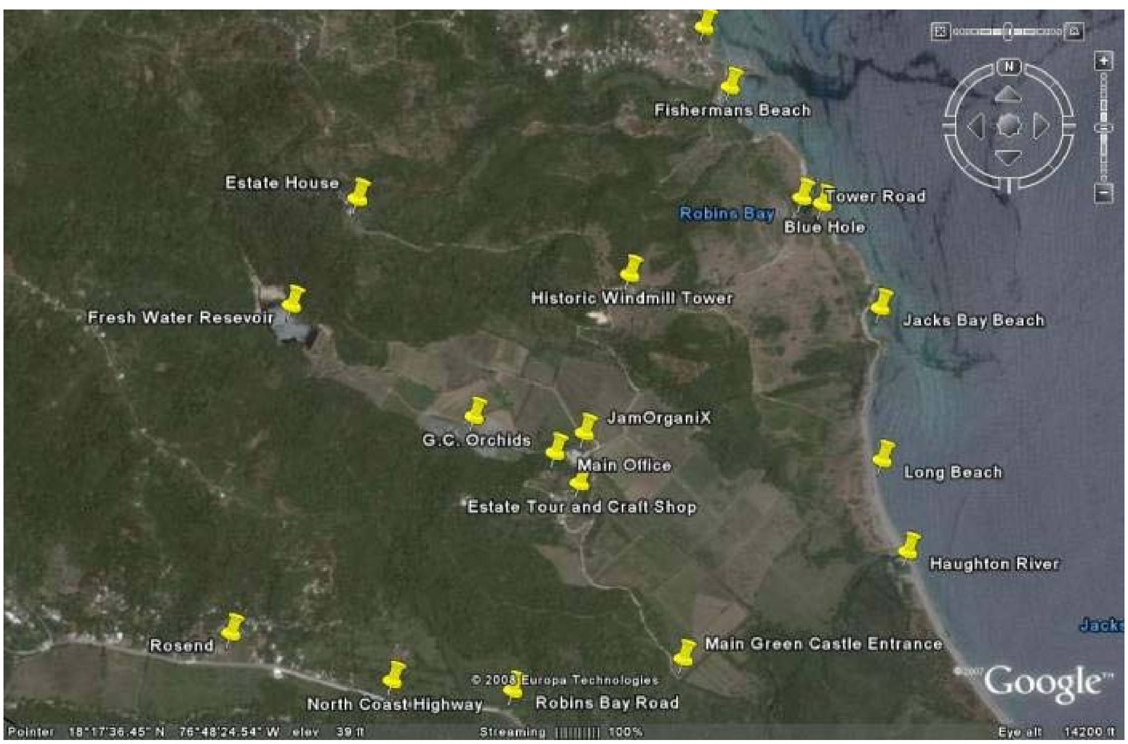



**Figure 6.1** Google Earth image showing the Greencastle amenities in relation to surrounding communities.

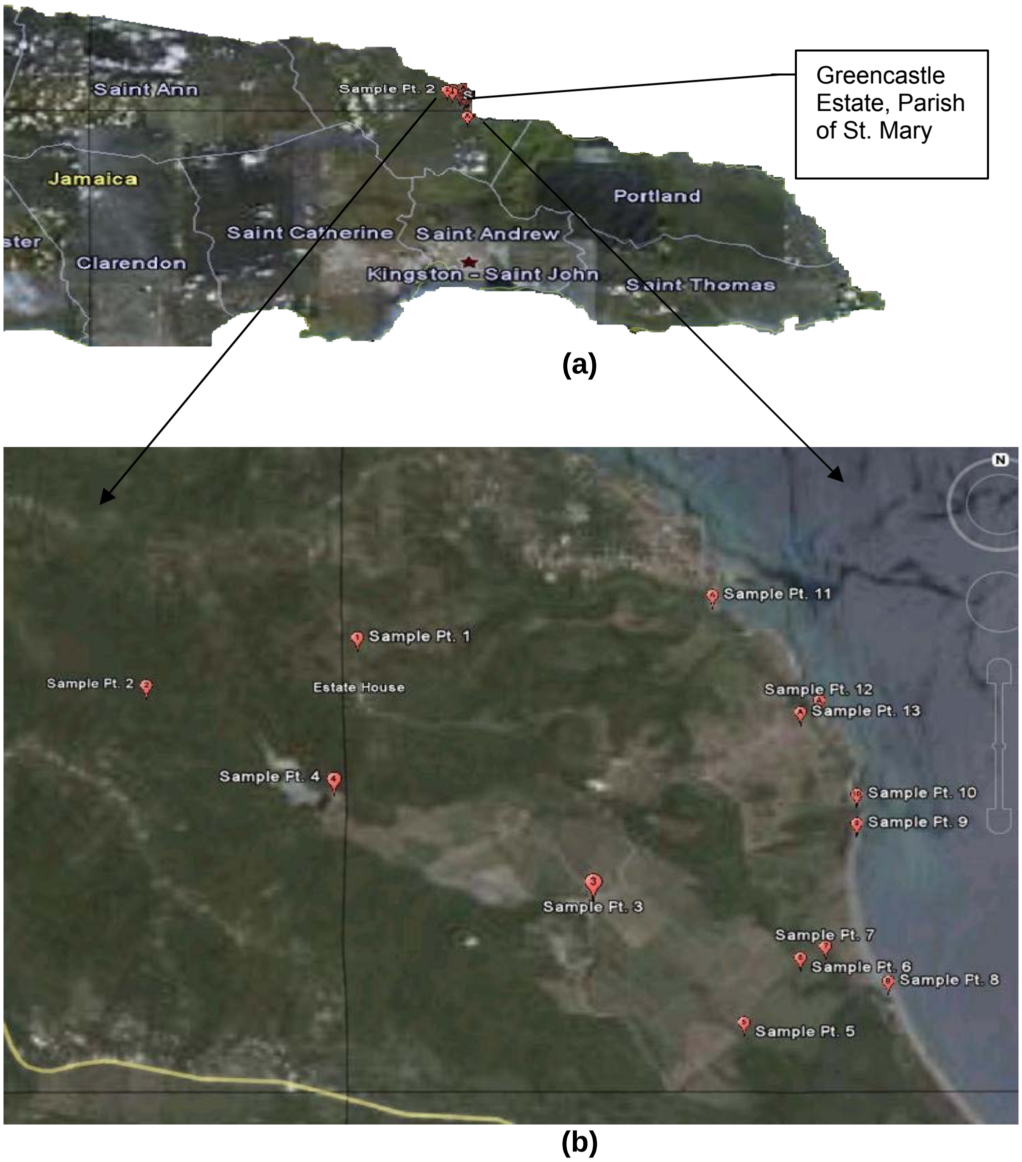



**Figure 6.2** Satellite images showing spread of sample points over Greencastle Estate. (a) General location of Greencastle within St. Mary's Parish. (b) Location of the chosen sample points throughout Greencastle.

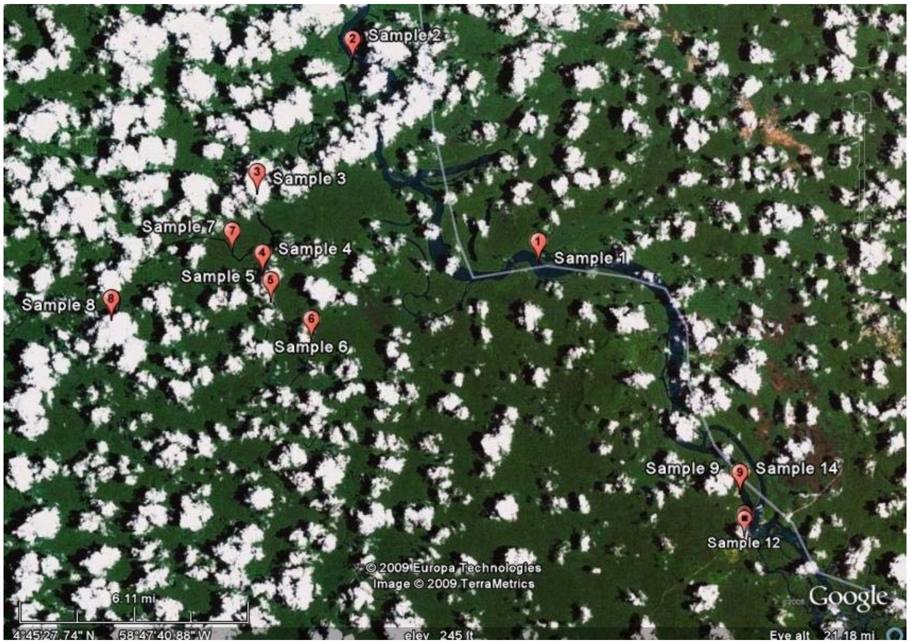



**Figure 6.3** Google Earth satellite image with the actual Iwokrama sample points.

### 6.2.1 Limitations to Sampling and Background Monitoring

Due to the great cost of travelling frequently to the study sites in Jamaica and Guyana collaborators are needed to assist with sampling and analyses in both territories. Testing for Chemical Oxygen Demand (COD), Total Organic Carbon (TOC), $NO_3^-$-N, five day Biochemical Oxygen Demand ($BOD_5$) and $NH_3$-N all must be done within 2 days of taking the sample which in itself is a limitation to the study and development of a more complete background monitoring dataset. As a result there needed to be a tailoring of the study parameters for certain sampling regimens from the entire list suggested by Chapman (1996).

Within 6 hours of sample collection, 100 mL of the grab sample has to be put through membrane filtration so as to incubate for 24 hours to then check for, and count, the *E. coli* colony forming units (CFUs) present in accordance with STM methods. Alkalinity measurements must be done within 24 hours of sample collection by titration of a known volume of sample with 0.02N $H_2SO_4$ to a methyl orange end point (before samples are acidified for preservation). This data allows for calculation and determination of carbonate species in surface waters.

### 6.3 Methodology

The field work had 2 components: grab water sampling and monitoring; and surveying of the community in the areas where ecotourism is taking place. On the initial visit to each site GPS coordinates were recorded for sampling to be done at those selected locations during a longitudinal study. These locations were chosen based on flow directions to ensure that every stream that enters and leaves the property of the chosen watershed segments is monitored. Once these sample points were chosen the appropriate judgment-biased sampling plan was developed to incorporate both the dry and wet seasons and tourist high and low seasons. Typical areas utilized by tourists, and residents were sampled both upstream and downstream.

With little or no form of baseline known to be available for both the Jamaican and Guyanese study watersheds, there was first a need to start building a database from this first visit. Grab water samples were taken and preserved for analysis according to the USEPA's standard operating procedure (SOP) for the collection of chemical and biological ambient water samples after which alkalinity measurements were carried out. The procedures and protocols followed for these testing schemes were detailed in Chapter 3 (Materials and Methods).

*In situ* measurements of simple stream quality parameters were done with the use of a Quanta Hydrolab$^{TM}$ multimeter. This meter gives readings of pH, temperature, dissolved oxygen, conductivity, turbidity, salinity and total dissolved solids. In the future it is envisioned that stream flow would be measured by use of a flow meter. The major issue with monitoring in these watersheds is cost to management. Thus if there is to be propagation of this work for continued sustainable development there needs to be some level of partnership.

### 6.4 Background Monitoring Data

Initial monitoring took on both social and water quality dimensions. Samples were then analyzed for select water quality parameters and Table 6.1 summarizes background results. The actual results by sample point, inclusive of GPS location, are given in Appendix D. To incorporate the possible interactions of the populations in and around the watershed social and environmental audit methods were utilized inclusive of the person-administered community survey, screening and scoping exercise as well as interviews with the ecohotels' management and community members (see Appendix) during the background monitoring period at each site. From the section on Water and Sanitation of the survey it was determined that all community respondents at the Iwokrama site that lived in the vicinity all depended on the river water as a household potable water source and only 14% of them did some form of pre-treatment before consuming the water. All the respondents that lived in the Iwokrama area also utilized latrines and let their grey water out onto the soil near their houses. However, none of the respondents at Greencastle utilized the river system as a source of potable water with 75% of them having on-lot septic systems and the remaining 25% having latrines. Nevertheless, all the respondents disposed of their grey water produced by discharging it onto the soil surface. The survey is one measure of assessing Land Use Land Change (LULC) at the household level which can affect the quality of water in the watershed.

**Table 6.1** Comparison of the background water quality data collected at both sites.

| Parameter | Ranges | | Average values | |
|---|---|---|---|---|
| | Iwokrama | Greencastle | Iwokrama n = 14 | Greencastle n = 13 |
| Temperature ($^{o}$C) | 26 - 28.27 | 25.61 - 33.05 | 27.27 | 28.21 |
| Specific conductivity (mS/cm) | 0.014 - 0.024 | 0.299 - 1.066 | 0.019 | 0.768 |
| Dissolved oxygen (mg/L) | 7.0 – 10.0 | 0.9 - 7.8 | 8.0 | 4.1 |
| DO (% sat) | 81 - 106 | 10.1 - 89.5 | 92.78 | 45.32 |
| pH | 5.39 - 6.25 | 5.99 - 8.22 | 5.79 | 7.43 |
| Turbidity (NTU) | 13 - 32.2 | 0.6 - 153 | 17.11 | 23.42 |
| Salinity (ppt) | all 0.02 | 0.31 - 13.9 | 0.02 | 4.92 |
| ORP (mV) | 31 - 109 | ND | 80.4 | ND |
| Total alkalinity (mg/L $CaCO_3$) | 20 - 80 | 100 - 542 | 41.54 | 296 |
| Caustic alkalinity (mg/L $CaCO_3$) | all 0 | 0 - 22 | 0 | 8.2 |
| Carbonate alkalinity (mg/L $CaCO_3$) | 20 - 80 | 100 - 542 | 41.54 | 287.8 |
| Total phosphate conc. (mg/L) | 0.298 - 0.477 | 0.611 - 2.569 | 0.399 | 0.923 |
| Polyphosphate conc. (mg/L) | 0.178 - 0.447 | 0.091 - 0.713 | 0.330 | 0.483 |
| Orthophosphate conc. (mg/L) | 0.030 - 0.119 | 0.131 - 2.477 | 0.069 | 0.539 |
| Nitrate ($NO_3^-$-N) (mg/L) | 0 - 3 | 1 - 15 | 0.9 | 8.9 |
| Total hardness (mg/L $CaCO_3$) | 40 - 100 | 40 - 232 | 55.38 | 136.89 |
| Ca conc. (mM) | 0.2 - 0.6 | 0.3 – 1.66 | 0.3 | 0.8 |
| Mg conc. (mM) | 0 - 0.4 | 0.1 - 0.96 | 0.2 | 0.56 |
| COD (mg/L) | 0 - 2 | 2 - 8* | 0.6 | 3.7* |
| *E. coli* (CFU/100mL) | 100 and 300# | ND | 200# | ND |
| Dissolved Al (ppb) | all <5 | all <5 | all <5 | all <5 |
| Dissolved As (ppb) | all <5 | all <5 | all <5 | all <5 |
| Dissolved Se (ppb) | all <5 | all <5 | all <5 | all <5 |
| Dissolved Pb (ppb) | all <5 | all <5 | all <5 | all <5 |
| Dissolved Cd (ppb) | all <5 | all <5 | all <5 | all <5 |

*Values obtained from June 2009 monitoring; ND - no data; #Based on replicates done only at the point of interest (i.e. Sample point 9 – Dock at Iwokrama)

The background concentrations obtained at both sites were matched against the various applicable water quality guidelines of the United States Environmental Protection Agency (USEPA, 2009a; 2009b). The results of the comparison are shown in Tables 6.2 and 6.3 for a single point of interest at each site. The point of interest at Iwokrama was sample point 9 which was at the boat docking area that is typically used for recreational swimming by ecotourists as well as the main place to embark and disembark boats for river voyages. For Greencastle the point of interest was taken as sample point 2 which was at the waterfall's pool onsite. This is a point that guests utilize for bathing and relaxation during terrestrial activity such as bird watching.

According to the USEPA recreational guidelines, the main indicator of quality are the levels of microbial constituents present in the water. Though this work did not quantify all the suggested microbes that can be examined in determining water quality it is clear from the *E. coli* results that the Iwokrama waters are not fit for recreational use by humans and definitely not as a potable water source without further treatment. Nevertheless this result corroborates with that attained by Rivera, Hazen and Toranzos (1988) for waters in a tropical rain forest. Since no analysis was done for the *E. coli* at Greencastle no conclusion on adherence to guidelines could be concretized. However from observations of watershed practices it is expected that Greencastle's surface water would not adhere to either the recreational or drinking water guidelines.

From Table 6.3 it can be said that the water at both Iwokrama and Greencastle generally met the criteria to support aquatic life. The chief parameters in this determination are the dissolved oxygen (and its associated parameters such as chemical oxygen demand and percentage of dissolved oxygen saturation), heavy metals and pH. This type of determination is critical to the propagation if ecotourism as at its core is biodiversity.

**Table 6.2** Compliance of water quality at point of interest in the surface water to recreational and drinking water guidelines of the United State Environmental Protection Agency (USEPA, 2009a; 2009b).

| Parameter | Values at point of interest | | USEPA guideline values | | USEPA guidelines met? | | | |
|---|---|---|---|---|---|---|---|---|
| | Iwokrama (IIC) Sample point 9 | Greencastle (GC) Sample point 2 | Drinking (Drink.) | Recreation (Rec.) | IIC Drink. | IIC Rec. | GC Drink. | GC Rec. |
| Temperature (°C) | 27.99 | 25.81 | - | 20 - 30 | NA | Yes | NA | Yes |
| Specific conductivity (mS/cm) | 0.014 | 0.74 | - | - | NA | NA | NA | NA |
| Dissolved oxygen (mg/L) | 7.86 | 7.84 | - | - | NA | NA | NA | NA |
| DO (% sat) | 99.7 | 89.5 | - | - | NA | NA | NA | NA |
| pH | 6.4 | 7.03 | 6.5 – 8.5 | 5.0 – 9.0 | No | Yes | Yes | No |
| Total dissolved solids (g/L) | 0 | ND | - | - | NA | NA | NA | NA |
| Turbidity (NTU) | 13.2 | 1.2 | <15 | <50 | Yes | Yes | Yes | Yes |
| Salinity (ppt) | 0.02 | 4.1 | - | - | NA | NA | NA | NA |
| ORP (mV) | 80 | ND | - | - | NA | NA | NA | NA |
| Total alkalinity (mg/L $CaCO_3$) | 60 | 336 | - | - | NA | NA | NA | NA |
| Caustic alkalinity (mg/L $CaCO_3$) | 0 | 0 | - | - | NA | NA | NA | NA |
| Carbonate alkalinity (mg/L $CaCO_3$) | 60 | 336 | - | - | NA | NA | NA | NA |
| Total phosphate conc. (mg/L) | 0.417 | 0.611 | - | - | NA | NA | NA | NA |
| Polyphosphate conc. (mg/L) | 0.298 | ND | - | - | NA | NA | NA | NA |
| Orthophosphate conc. (mg/L) | 0.119 | 1.117 | - | - | NA | NA | NA | NA |
| Nitrate ($NO_3^-$-N) (mg/L) | 1 | 6 | - | - | NA | NA | NA | NA |
| Total hardness (mg/L $CaCO_3$) | 40 | 132 | - | - | NA | NA | NA | NA |
| Ca conc. (M) | 0.0002 | 0.0006 | - | - | NA | NA | NA | NA |
| Mg conc. (M) | 0.0002 | 0.00072 | - | - | NA | NA | NA | NA |
| COD (mg/L) | 0.1 | 5.6 | - | - | NA | NA | NA | NA |
| *E. coli* (CFU/100mL) | 200* | ND | 0 | 126 | No | No | NA | NA |
| Dissolved Al (ppb) | <5 | <5 | 50 - 200 | 50 - 200 | Yes | Yes | Yes | Yes |
| Dissolved As (ppb) | <5 | <5 | <10 | <10 | Yes | Yes | Yes | Yes |
| Dissolved Se (ppb) | <5 | <5 | <10 | <10 | Yes | Yes | Yes | Yes |
| Dissolved Pb (ppb) | <5 | <5 | <10 | <10 | Yes | Yes | Yes | Yes |
| Dissolved Cd (ppb) | <5 | <5 | <5 | <5 | Yes | Yes | Yes | Yes |

*Based on replicates done only at the point of interest (i.e. Sample point 9 – Dock at Iwokrama); ND – no data; NA – not applicable

**Table 6.3** Compliance of water quality at point of interest in the surface water to aquatic organisms water guidelines of the United State Environmental Protection Agency (USEPA, 2009a).

| Parameter | Values at point of interest | | USEPA Aquatic Organisms guideline values | | USEPA guidelines met? | | | |
|---|---|---|---|---|---|---|---|---|
| | Iwokrama (IIC) Sample point 9 | Greencastle (GC) Sample point 2 | Acute | Chronic | Acute (IIC) | Chronic (IIC) | Acute (GC) | Chronic (GC) |
| Temperature ($^{o}$C) | 27.99 | 25.81 | Species dependant | | NA | NA | NA | NA |
| Specific conductivity (mS/cm) | 0.014 | 0.74 | - | - | NA | NA | NA | NA |
| Dissolved oxygen (mg/L) | 7.86 | 7.84 | 3.0 | 5.0 | Yes | Yes | Yes | Yes |
| DO (% sat) | 99.7 | 89.5 | 85 | 85 | Yes | Yes | Yes | Yes |
| pH | 6.4 | 7.03 | - | 6.5-9 | NA | No | NA | Yes |
| Total dissolved solids (g/L) | 0 | ND | - | 0.25 | NA | Yes | NA | ND |
| Turbidity (NTU) | 13.2 | 1.2 | 10% above seasonal norm | | NA | NA | NA | NA |
| Salinity (ppt) | 0.02 | 4.1 | 0.25 | 0.25 | Yes | Yes | No | No |
| ORP (mV) | 80 | ND | - | - | NA | NA | NA | NA |
| Total alkalinity (mg/L $CaCO_3$) | 60 | 336 | - | 200 | NA | Yes | NA | No |
| Caustic alkalinity (mg/L $CaCO_3$) | 0 | 0 | - | 200 | NA | Yes | NA | Yes |
| Carbonate alkalinity (mg/L $CaCO_3$) | 60 | 336 | - | 200 | NA | Yes | NA | No |
| Total phosphate conc. (mg/L) | 0.417 | 0.611 | - | 0.1 | No | No | No | No |
| Polyphosphate conc. (mg/L) | 0.298 | ND | - | - | NA | NA | NA | NA |
| Orthophosphate conc. (mg/L) | 0.119 | 1.117 | - | - | NA | NA | NA | NA |
| Nitrate ($NO_3^-$-N) (mg/L) | 1 | 6 | - | 10 | NA | Yes | NA | Yes |
| Total hardness (mg/L $CaCO_3$) | 40 | 132 | - | 300 | NA | Yes | NA | Yes |
| Ca conc. (M) | 0.0002 | 0.0006 | - | - | NA | NA | NA | NA |
| Mg conc. (M) | 0.0002 | 0.00072 | - | - | NA | NA | NA | NA |
| COD (mg/L) | 0.1 | 5.6 | 5 | 5 | Yes | Yes | No | No |
| *E. coli* (CFU/100mL) | 200* | ND | 126 | - | Yes | NA | ND | NA |
| Dissolved Al (ppb) | <5 | <5 | 750 | 87 | Yes | Yes | Yes | Yes |
| Dissolved As (ppb) | <5 | <5 | 340 | 150 | Yes | Yes | Yes | Yes |
| Dissolved Se (ppb) | <5 | <5 | - | 5 | NA | Yes | NA | Yes |
| Dissolved Pb (ppb) | <5 | <5 | 65 | 2.5 | Yes | Yes | Yes | Yes |
| Dissolved Cd (ppb) | <5 | <5 | 2 | 0.25 | ND | ND | ND | ND |

*Based on replicates done only at the point of interest (i.e. Sample point 9 – Dock at Iwokrama); ND – no data; NA – not applicable

## 6.5 Hands-on Staff Training

At each site both upper level management staff as well as middle and lower level staff who are involved in the site's ecotourism management observed and assisted in the field sampling and monitoring inclusive of the selection of sampling points. Their intrinsic knowledge of the lay of their properties gave novel insights on optimum monitoring sites in consideration of practicality to assessing proposed sampling points. This involvement is of particular importance in the adoption of a water quality regimen as diffusion without adoption cannot constitute sustainable practice. The opportunity was also taken to discuss with management what they can do, with or without the ability to do formal water quality monitoring, to reduce pollutant loadings to its surface waters. The discussion hinged on the reduction of stormwater runoff.

### 6.5.1 Impact of Stormwater Runoff on Water Quality

It needs to be clear that this study attempts to quantify the impact on water quality of the ecotourism activities of which tourist arrival and departure are subsets; such that ecotourism activities refer to the preparatory anthropogenic activities to allow for desired experiences by guests. That is, in order to see the direct impact of the presence of tourists there would be comparison of data during times of no or low tourist arrivals to that of peak tourist flow. This is depends on the assumed equity ratio of supply and demand, which the study subliminally tests whether pollutant loadings are unaffected by the presence of tourists, who can be modeled as transitory populations. However, it is possible that stormwater runoff can have a more disastrous impact than the presence of tourists on surface water quality. The impact of this stormwater is highly contingent upon the amount of impervious surface there is onsite, the slope where the impervious surfaces are constructed as well as grey water disposal techniques of households within the watershed (Pegram and Bath, 1995). The ecosite's management has the ability to influence all 3 of these areas through better onsite planning and community participation in design and construction of more sustainable water disposal methods.

## 6.6 Conceptual Water Quality-Management Model for Caribbean Ecotourism

The general and widely accepted network model that has been utilized in the planning and management of surface water quality globally is shown in Figure 6.4.

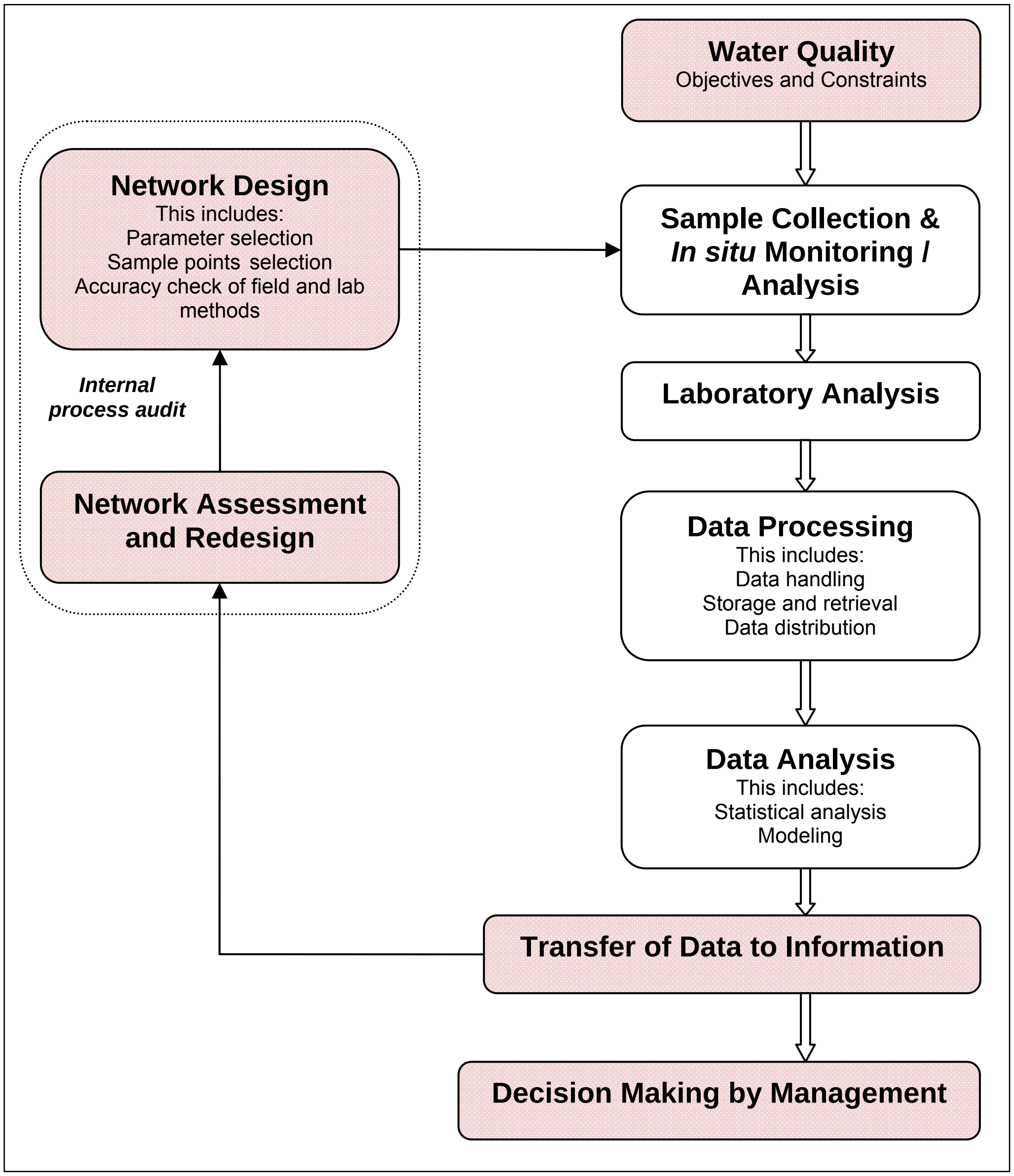



**Figure 6.4** General global water quality management model for natural water resources. Highlighted steps are typically done by the site's management all others can be contracted out or done by site's staff. (Adapted from Chapman, 1992; Krenkel and Novotny, 1980 and Harmancioglu et al., 1999)

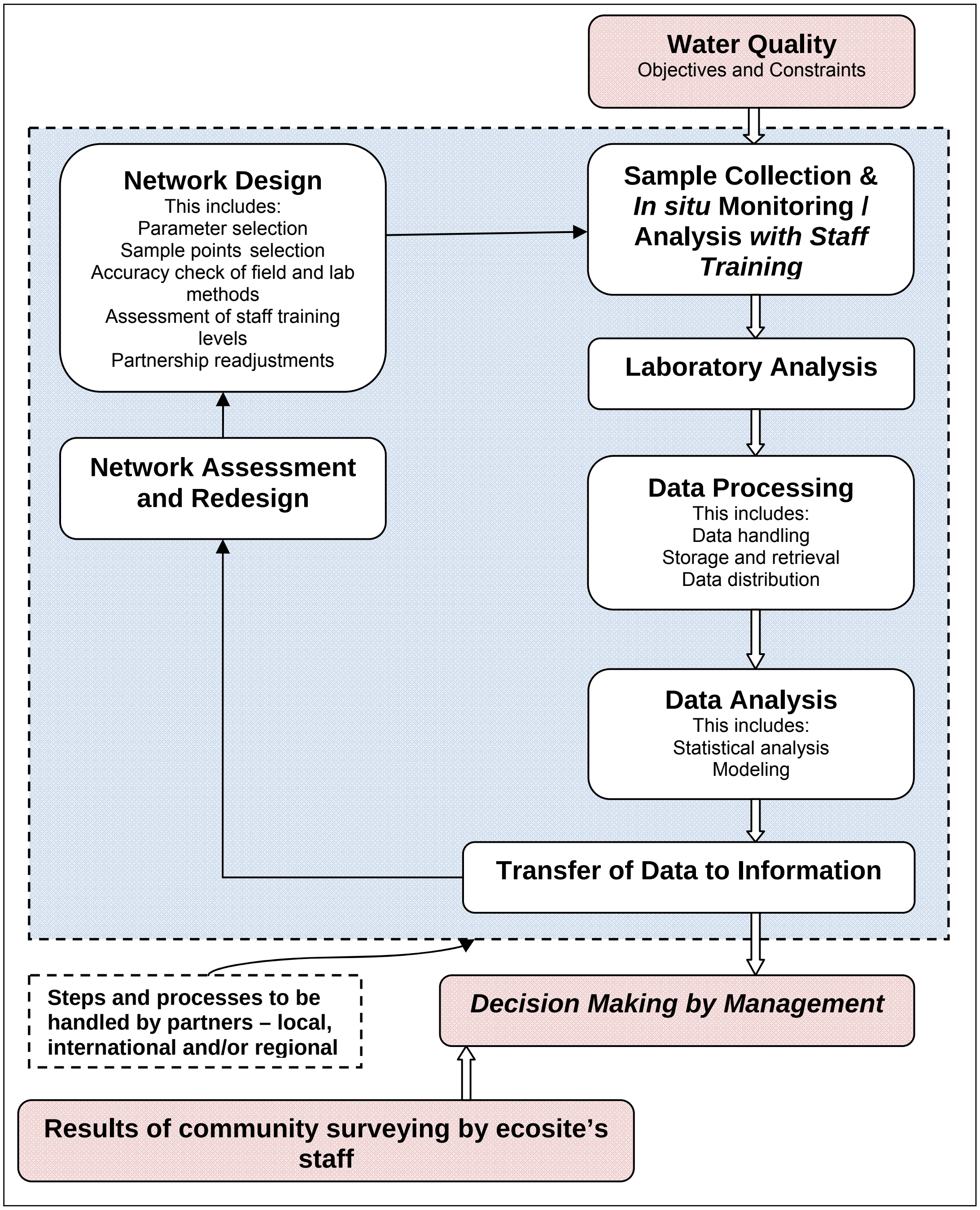



**Figure 6.5** Proposed conceptual water quality management model for surface waters in and around ecotourism sites in the Caribbean. Highlighted steps are typically done by the site's management all others to be carried out to partners. (Adapted from Chapman, 1992; Krenkel and Novotny, 1980 and Harmancioglu et al., 1999)

From Figure 6.5 the key step in the proposed model is partnership to carry out all the analytical and onsite water quality work as well as staff training in field methods and techniques. As a first approach this is suggested in consideration that most ecotourism operations in the Caribbean typically do not have the funds or skills required to design and implement a rigorous and dynamic water quality monitoring scheme. Partnerships can be at the local, regional or international level.

Local partnerships are the best option (i.e. most sustainable option) for the sampling, monitoring and analysis of samples as this is where the bulk of the cost will lie in the scheme. For regional and international partners the transportation of supplies to the site and water samples to their labs is not very feasible especially for time sensitive tests. As such local partnerships with universities, schools and volunteer organizations can be a good start to collecting valuable data. Volunteer organizations, especially those with an environmental protection mandate, could be capitalized upon such that they can operate similar to the Adopt-A-Pond Program works in Florida (see http://www.hillsborough.wateratlas.usf.edu/AAP/ for more details). Senior classes in high school have projects that can utilize the ecosites as the study areas where applicable. Though the Caribbean's universities still remain mainly teaching driven, there are a few researchers within the university structure that have interest in tourism and ecotourism. Once sought after, potential partnerships can be done for detailed water quality studies to be entered into as student projects at the undergraduate or graduate level. Though less feasible, similar arrangements can be entered into with regional and international universities where their students do international research at various ecotourism sites. This can also be done as a part of Study Abroad offerings for undergraduates through their colleges and universities. Local, international and regional partnerships can be entered into through the funding of proposals for water quality management studies written by collaborators. Though grant facilitation is not the norm for funding in the Caribbean it can be exploited to gain funds from large international corporations and agencies (e.g. Ford Motors, United Nations Environment Programme, World Bank) that annually fund projects that promote sustainable development in the developing world.

Regionally, several academic, public and professionals-based organizations lend their skills for the development of Caribbean science including the Caribbean Tourism Organization (CTO), the Caribbean Academy of Science (CAS) and CariScience. All these entities have regional and international partners that they match to projects of similar interests without cost. Spokespersons for CTO said that any person with a tourism project ongoing within a territory of the Caribbean Community (CARICOM) is eligible to be assisted in proper planning of their activities. This service they claim is highly underutilized very often due to the misconception of an associated cost.

Note that by the application of partners to a water quality monitoring/management project in consideration of communities' survey responses allows for a systems approach to management (Jackson, 2000). The ecotourism site will be responsible for determining changes in the water loadings of its surrounding communities (van Veelen and van Zyl, 1995) to be considered as part of its final management decisions. The other major aspect of the conceptual model is that partners train staff members in the water quality monitoring and sampling so as to continue to build the self-sufficiency of the personnel on site to do accurate water quality work.

### 6.6.1 Parameter Selection in Designing the Monitoring Network

Throughout the world rigorous water quality monitoring programs such as the United Nations Environmental Programme GEM/WATER programme and the Florida Water Atlas Project routinely disseminate data on comprehensive water quality testing collected by various entitites including volunteer organizations. The parameters reported in these types of programs are water discharge/head, total suspended solids, transparency, temperature, pH, conductivity, dissolved oxygen (including Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)), calcium, magnesium, sodium, potassium, chloride, sulfate, alkalinity, nitrate plus nitrite, total phosphorus (unfiltered), total phosphorus (dissolved), fecal coliform, reactive silica, heavy metals (cadmium, selenium, lead, mercury, iron, arsenic) and chlorophyll A (Turner II et al., 1995; UNEP, 2009). The selection of water quality parameters for the ecotourism industry in the Caribbean needs to be calculated in consideration of background monitoring data, water body usage, cost, USEPA aquatic life/organisms and recreational water quality guidelines and generally accepted water quality monitoring program requirements (see Table 2.4) (Lo, Kuo and Wang, 1996; Somlyody, Kularathna and Masliev, 1994; Ongley, 1998). According to Ongley (1999), when considering development of a monitoring network for the developing world there is need to understand the dynamics of the people in a given watershed in terms of their present, past and future avenues of environmental pollution. Due to the lack of data this type of social input is required in for selection of monitoring needs of today and tomorrow (Ongley, 1997). Thus the social data collected in this study (from researcher observation, the community survey, interview of management and staff, screening and scoping exercise and the checklist) was factored into the analysis to choose essential water quality parameters to be monitored.

Given the aforementioned criteria, the following parameters can be suggested for inclusion in a regular water quality monitoring schedule: BOD, COD, pH, temperature, dissolved oxygen (DO), dissolved oxygen saturated (DO%sat), total dissolved solids (TDS), $NO_3^{-}$-N, total phosphate, specific conductivity (SpC)/salinity, fecal coliform, heavy metals (lead, arsenic, cadmium, selenium, aluminum, nickel, mercury and zinc) and stream flow rate. Table 6.4 summarizes the importance of these selected water quality parameters.

**Table 6.4** Description of the suggested water quality parameters chosen for a Caribbean ecotourism water quality monitoring program (adapted from UN GEMS/WATER Programme, 2008).

*Temperature*

- Affects the speed of chemical reactions
- Affects the rate at which algae and aquatic plants photosynthesize
- Can cause mortality and influence the solubility of dissolved oxygen
- Aquatic organisms often have narrow temperature tolerances; moderate changes in temperature may have detrimental effects on aquatic life inclusive of bacteria, algae, invertebrates and fish

*Dissolved Oxygen*

- Oxygen dissolved in water is one of the most important components of aquatic systems
- Oxygen is required for the metabolism of aerobic organisms
- Amount of dissolved oxygen depends on temperature and to a certain degree on atmospheric pressure

*pH and Alkalinity*

- pH of an aquatic system is linked to biological productivity
- Values of pH between 6.5 and 8.5 usually indicate good quality of water
- A water's ability to buffer against acid is alkalinity
- Buffering capacity of a water body is its ability to dampen pH changes; it buffers pH changes that occur naturally as a result of photosynthetic activity of the chlorophyll-bearing vegetation
- The effect of alkalinity in water used for irrigation may be important in some instances because it may indirectly increase the relative proportion of sodium in soil water
- Excessive alkalinity can cause problems for swimmers by altering the pH of the lacrimal fluid around the eye, causing irritation.
- Alkalinity components (i.e. carbonate and biocarbonate) will complex some toxic heavy metals and reduce their toxicity.

*Turbidity*

- Simply refers to water clarity
- Turbidity is often caused by presence of phytoplankton or suspended or travelling clays and silts
- Water transparency is inversely related to turbidity and waters with high transparency values are typically of good quality
- Turbid waters can be dangerous for swimming, especially if diving facilities are provided, because of the possibility of unseen submerged hazards and the difficulty in locating swimmers in danger of drowning
- Turbidity has four effects on the fish and fish food populations, namely: by acting directly on the fish swimming in water in which solids are suspended, and either killing them or reducing their growth rate, resistance to disease, etc.; by preventing the successful development of fish eggs and larvae; by modifying natural movements and migrations of fish; by reducing the abundance of food available to the fish

*Salinity and Specific Conductivity*

- Salinity is an indication of the concentration of dissolved salts in a water body
- Conductivity is a measure of how well a water conducts electricity due to the presence of dissolved anions and cations
- The principal inorganic anions dissolved in water include the carbonates, chlorides, sulfates , and nitrates (principally in ground waters); the principal cations are sodium, potassium, calcium, and magnesium
- High concentrations of the cations and anions typically have laxative effects on animals and humans consuming these waters

*Nitrogen/Nitrate*

- Nitrogen is a primary driver of eutrophication
- Nitrate typically makes its way into natural waters through use of fertilizers, animal fecal waste and latrine/septic tank discharges
- High intake of nitrates constitutes a hazard primarily to warm blooded animals under conditions that are favorable to reduction to nitrite. Under certain circumstances, nitrate can be reduced to nitrite in the gastrointestinal tract which then reaches the bloodstream and reacts directly with hemoglobin to

**Table 6.4 Continued**

| |
|---|
| produce methemoglobin, consequently impairing transport |
| *Phosphorus/Phosphate* |
| ▪ Phosphorus is considered a key proponent of eutrophication |
| ▪ Phosphorus is present in natural waters primarily as phosphates |
| ▪ Phosphates often enter surface waters from natural weathering of minerals in the drainage basin, biological decomposition and runoff from anthropogenic activities (including agriculture) |
| *Stream Flow* |
| ▪ Increases with volume of water in the stream |
| ▪ Determines what types of organisms and habitats can be found in that stream |
| ▪ Stream velocity affects the amount of silt and sediment transported and hence can affect biological productivity |
| ▪ Streams with higher velocities tend to have higher levels of dissolved oxygen |
| *Biochemical Oxygen Demand and Chemical Oxygen Demand* |
| ▪ Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) are common measures of water quality that reflect the degree of organic matter pollution |
| ▪ BOD is a measure of the amount of oxygen removed from aquatic environments by aerobic micro-organisms for their metabolic requirements during the deterioration of organic matter |
| ▪ Systems with high BOD tend to have low dissolved oxygen concentrations |
| ▪ COD is a measure of the oxygen equivalent of the organic matter in a water sample that is susceptible to oxidation by a strong chemical oxidant |
| ▪ Consumption of dissolved oxygen could compromise the integrity of the ecosystem and lead to favorable conditions for growth of less than ideal species |
| *Fecal Coliform* |
| ▪ Associated with health risk and the loss of waterways as an ecosystem resource e.g. bathing ground for ecotourists |
| *Heavy Metals* |
| ▪ Trace metals can be harmful to aquatic organisms; effects include reduced growth rates, impaired reproduction and sometimes death |
| ▪ Acute and chronic toxicity will influence species numbers and diversity, altering community structure and function |
| ▪ Exposure to mercury can cause acute toxicity as well as neurological and reproductive problems in fauna. Of particular concern are species that consume large amounts of fish |

Table 6.5 presents the costs associated with carrying out most of the suggested water quality tests. The chosen materials are based on field appropriate USEPA approved and/or standard methods and equipment. Note that details are not provided for heavy metal analysis since commercially available field kits do not have the detection limit in the parts per billion range as expected based on the background monitoring data.

**Table 6.5** Cost and ordering details for implementing on site ecotourism water quality monitoring program in the Caribbean.

| Parameter | Required materials and/or equipment | Manufacturer and catalog numbers | January 2010 cost* (US$) |
|---|---|---|---|
| pH, temperature, total dissolved solids (TDS)/salinity/specific conductivity, turbidity, dissolved oxygen (DO), DO% saturation | Quanta Hydrolab™ multimeter | Hach® (014710HY; 014730HY; 005200 ; 004484; 004452; 004507HY) | 3605.00 |
| pH | pH 4, 7 and 10 buffers solutions | Fisher Scientific™ (SB101-4, SB115-4, SB107-4) | 319.38 |
| Turbidity | 10 NTU and 40 NTU standards | 40 NTU: Hach® (2746353); 10 NTU: Ricca Chemicals® (R8801000-4C) | 230.99 |
| Total dissolved solids (TDS)/salinity/specific conductivity | 500 μΩ/cm, 445 μΩ/cm and 200 μΩ/cm conductivity/TDS standards | Ricca Chemicals® (2249.20-32; 5887.5-32; 2240.45-32) | 136.60 |
| Fecal coliform/*E. coli* | Colilert-18 for 100 ml; 120ml vessel w/ 100ml line, sodium thio & shrink band; 100-pack sterile 97-Well Quanti-Tray; Colilert/Colilert-18 Comparator predispensed in a Quanti-Tray; 4 watt pocket UV lamp; One pair UV absorbing Goggles | IDEXX Laboratories® (WP200I-18; WV120SBST-200; WQT-2K; WQT2KC; WLG) | 1336.43 |
| Alkalinity | One burette; 0.02 N sulfuric acid; beakers; phenolphthalein indicator; methyl orange indicator | Fisher Scientific™ (Acid: SA226-4; Burette and beakers: 03-700B; FB-102-200; Methyl orange: SM54-500; Phenolphthalein: SP62-1) | 241.24 |
| Nitrate-Nitrogen | Test N' Tube kit; portable spectrophotometer | Hach® (2605345; DR2700-01#) | 2579.25 |
| Phosphate-phosphorus | Test N' Tube kit; portable spectrophotometer | Hach® (2742645; DR2700-01#) | 65.64 |
| COD | Test N' Tube kit; COD reactor; portable spectrophotometer | Hach® (2125825; LTV082.53.40001; DR2700-01#) | 916.00 |
| BOD | BOD incubator; BOD meter; BOD chemical kit; BOD nutrient buffer pillows; BOD bottles | Hach® (8505700; 1416066; 1486510; 2616200; 2943100) | 4182.53 |
| Sampling and washing | HDPE sampling containers; one acid and one base reservoir; conc. nitric acid, sodium hydroxide pellets | Fisher Scientific™ (A200-212; S320-500; 02-896-2F; 14-831-330A) | 593.61 |
| Stream flow | Flowmeter | Hach® (MODEL_2000-11) | 3713.00 |

*Cost is devoid of taxes and shipping charges; #Cost of portable spectrophotometer only included with Nitrate-Nitrogen as the same instrument is use for these parameters.

Where a site is able to do most of water quality testing on its own, it is envisioned that partnership will be needed for both the heavy metal testing as well as the analysis of all collected data. Trend analysis (Chang, 2008) is the most typical method used to analyze a watershed's surface water quality. This method involves collecting water quality data on a regular basis (typically monthly) for a minimum of 3 years and comparing data per parameter over time. This data is then analyzed through multivariate statistical techniques including cluster analysis, factor analysis, principal component analysis and discriminant analysis (Bargos et al., 1990; Ouyang, 2005; Singh, Malik, Mohan and Sinha, 2004) to inform which parameters are significant enough to warrant further investigation through monitoring.

One other method that is commonly used in watershed monitoring for water quality is that of regression or correlation analysis and is rooted in land use planning and management (Quian and Reckhow, 2007; Chang, 2008). How this method works is that on a regularly scheduled basis when water quality monitoring is done all the possible major regression correlations are selected and used to compare subsequent correlations obtained on future sampling schedules. If the future sampling produces different major regression correlations then there may be LULC within the watershed. The entire background monitoring data set generated was used to determine background correlations among parameters via regression analysis. Only correlations with regression coefficients greater than 0.6 (shown in Tables 6.6 and 6.7) were taken as significant for this study (Chang, 2008).

**Table 6.6** Summary of strong background correlations for Iwokrama.

| Independent variable | Dependent variable | Regression equation |
|---|---|---|
| Total hardness (mg/L $CaCO_3$) | Mg conc.(M) | $y = 25.701e^{2994x}$<br>$R^2 = 0.62$ |
| Total hardness (mg/L $CaCO_3$) | Ca conc.(M) | $y = 125000x + 15$<br>$R^2 = 0.7728$ |
| Total phosphate conc. (mg/L) | Polyphosphate conc. (mg/L) | $y = 0.6696x^{0.4639}$<br>$R^2 = 0.6911$ |
| Carbonate alkalinity (mg/L $CaCO_3$) | Total alkalinity (mg/L $CaCO_3$) | $y = x$<br>$R^2 = 1$ |
| ORP (mV) | Total phosphate conc. (mg/L) | $y = 145.56Ln(x) + 221.63$<br>$R^2 = 0.5525$ |
| Dissolved oxygen (mg/L) | DO (%sat) | $y = 3.0642e^{0.0103x}$<br>$R^2 = 0.6174$ |
| Specific conductivity (mS/cm) | DO (%sat) | $y = -0.0004x + 0.0544$<br>$R^2 = 0.7086$ |
| Temperature ($^oC$) | DO (%sat) | $y = 6.4314Ln(x) - 1.8388$<br>$R^2 = 0.6067$ |
| Temperature ($^oC$) | Specific conductivity (mS/cm) | $y = -160.28x + 30.276$<br>$R^2 = 0.6685$ |

**Table 6.7** Summary of strong background correlations for Greencastle.

| Dependent variable | Independent variable | Regression equation |
|---|---|---|
| Total alkalinity (mg/L $CaCO_3$) | pH | y = -1086.3Ln(x) + 2479.5<br>$R^2$ = 0.8728 |
| Carbonate alkalinity (mg/L $CaCO_3$) | Salinity (ppt) | y = -80.232Ln(x) + 415.99<br>$R^2$ = 0.7516 |
| Salinity (ppt) | pH | $y = 3E\text{-}09x^{10.493}$<br>$R^2$ = 0.6463 |
| DO (% sat) | Dissolved oxygen (mg/L) | y = 12.936x - 7.3226<br>$R^2$ = 0.965 |
| Carbonate alkalinity (mg/L $CaCO_3$) | pH | y = -1128.7Ln(x) + 2554.8<br>$R^2$ = 0.8652 |
| Total hardness (mg/L $CaCO_3$) | Specific conductivity (mS/cm) | y = 176.82x + 2.7913<br>$R^2$ = 0.5546 |
| Polyphosphate conc. (mg/L) | Orthophosphate conc. (mg/L) | y = 0.6222e-0.7776x<br>$R^2$ = 0.936 |
| Total alkalinity (mg/L $CaCO_3$) | Temperature ($^oC$) | y = 2E+07x-3.3206<br>$R^2$ = 0.645 |
| Caustic alkalinity (mg/L $CaCO_3$) | Polyphosphate conc. (mg/L) | y = -38.177x + 28.595<br>$R^2$ = 0.8858 |
| Turbidity (NTU) | Total phosphate conc. (mg/L) | y = 76.894x - 48.632<br>$R^2$ = 0.951 |
| Total hardness (mg/L $CaCO_3$) | Ca conc. (M) | y = 99267x + 62.39<br>$R^2$ = 0.7682 |
| Total alkalinity | Ca conc. (M) | y = 239190x + 118.31<br>$R^2$ = 0.8246 |
| Carbonate alkalinity (mg/L $CaCO_3$) | Total hardness (mg/L $CaCO_3$) | $y = 129.66e^{0.0058x}$<br>$R^2$ = 0.7571 |

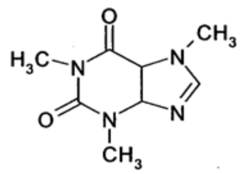
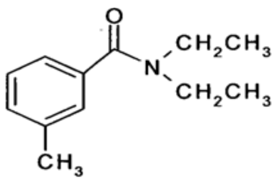
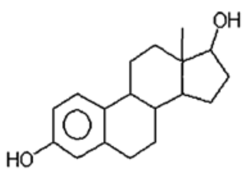
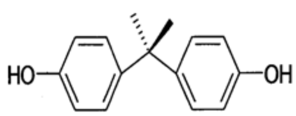
The above correlations are of importance in determining possible Land Use Land Change (LULC) issues within the watershed that as well as outside the watershed that may be affecting the quality therein. Once these correlations are done after each sampling schedule is complete, variations in strong correlations over relatively small time steps (i.e. a month) are able to give postulations in ongoing LULC (Rhodes, Newton and Pufall, 2001). Note that in order to utilize a correlation for model development there is need to have at least 3 years of continuous data to ensure the LULC, climatic, seasonal, and social dynamics are incorporated for a more 'true' stabilized representation (Chapman, 1992; Chapman, 1996). Or in theory, if within this 3 year period the same correlations remain as significant and there are minimal changes in LULC within the watershed (as determined through the regular community surveys and watershed audits) then the consistent correlations can be used in water quality modeling (Feher, Galambos and Lehoczki, 1999).

## 6.7 Emergent Chemicals of Concern for Future Monitoring and Management

The chemicals of concern are those associated with pharmaceuticals and personal care products inclusive of steroids. Pharmaceuticals can be used internally or externally by humans and domestic animals and include all drugs available by prescription or over-the-counter. According to Daughton (2001), many of these compounds are highly bioactive and all usually occur at trace concentrations when present in the environment. Once in the environment, generally the drugs are absorbed by the organism and are subjected to metabolic reactions of the body. However, a significant amount will leave the organism unmetabolized via urine or feces and will end up in sewage or manure (Hirsh et al., 1999).

Some of the most popular chemicals of concern, due to their endocrine disrupting properties, are caffeine, DEET (N,N-diethyl-meta-toluamide), bisphenol A and β-estradiol. These are of concern due to their global use, presence and potential harm to aquatic life. Thus it is suggested that these analytes be the added to surface water quality programs as soon as practical. A summary of the chemical attributes of these analytes are highlighted in Table 6.8.

**Table 6.8** Selected chemical attributes of suggested analytes.

| Structure | Chemical formula | Molecular weight | Chemical name | Common name | CAS number | Typical use |
|---|---|---|---|---|---|---|
|  | $C_6H_{10}O_2N_4$ | 194.2 | 1,3,7-trimethylxantine | Caffeine | 58-08-2 | Stimulant |
|  | $C_{12}H_{17}NO$ | 191.3 | N-N-diethyl toluene | DEET | 134-62-3 | Insect repellent |
|  | $C_{18}H_{24}O_2$ | 272.3 | Estra-1,3,5(10), 7-triene-3,17diol | 17β-estradiol | 50-82-2 | Reproductive hormone |
|  | $C_{15}H_{16}O_2$ | 228.3 | 2,2-bis-(4-hydroxyphenyl) propane | Bisphenol A | 80-05-7 | Plasticizer |

1,3,7-trimethylxantine (i.e. caffeine) is one of the most widely consumed global drugs with the global average consumption of about 70 mg per person per day. The major source of caffeine in domestic wastewater comes from unconsumed coffee, tea, sodas, or discarded medication. Therefore, caffeine can be highly persistent in the aquatic environment. DEET is commonly found as an active ingredient in many insect repellent products and is reported to be used by approximately 33% of the United States' population annually. DEET is registered for human use only in the concentration range of 4 to 100% DEET for direct skin contact. Similarly, bisphenol A is another endocrine disruptor used industrially for polycarbonate plastic and epoxy resins. This type of plastic and resin is widely applied to the production of digital media, medical equipment and items as well as vision lenses. Effluents from facilities that manufacture epoxy and polycarbonate plastics and elution from the products containing it are suspected to be the major source of this contaminant in the environment (Suzuki, 2004).

In the case of β-estradiol, it is traditionally known to be excreted through feces and released from sewage treatment plants after treatment in their effluent and according to Barel-Cohen et al. (2006) it is one of the most potent endocrine disrupting compounds. The advent of synthetic hormones in several oral contraceptives studies have shown their prevalence even in grey water (Robert and Thomas, 2006). In the Caribbean areas chosen for study there is known to be no sewer network and all the dwellings are either using outdoor pit latrines or indoor toilets on a septic tank–soak away system.

Lee et al. (2004), Harries et al. (1997) and Jobling et al. (2006) all corroborated that DEET has immense potential to have endocrine disrupting effects on wildlife. Further to this, it is well known that DEET is the most common active ingredient in insect repellents (Lee et al., 2004), a product expected to be in use by eco-tourists. It is for this reason that it has been included into the contamination analysis. Interesting to note is that Brazil is now mandating the permissible concentrations of DEET in visitors' insect repellents in certain parts of their rainforest in lieu of the above (Trotz, 2007).

The monitoring of these and similar compounds generally require the use of gas chromatography with mass spectroscopy (CG-MS). Most of the methods are currently being tested and developed for standardization.

## 6.8 Conclusions

By visiting each of the 2 sites and conducting an initial sampling and monitoring scheme, background concentrations for various water quality parameters of concern in the natural environment were attained while simultaneously training ecotourism staff on water quality management methods and considerations. One important consideration dealt with was that of stormwater runoff and areas that management needs to focus on to reduce its pollutant loading effect. To solidify the importance of ecotourism's management on surface water quality a conceptual path was suggested in consideration of the state of the industry in the Caribbean. The main thrust was for the inclusion of partners – local, regional and international – to assist with water quality management, data analysis and simultaneous training of staff.

# CHAPTER 7: PATHWAY TO UNDERSTANDING THE DYNAMICS OF ECOTOURISM ACTIVITIES, ONSITE MANAGEMENT AND WATER QUALITY

## 7.1 Introduction

The reductionist methods developed in the previous Chapters can be applied to gather core data for the understanding of the impacts of ecotourism activities and its management on surface water quality. Before impacts can be directly quantified, there is need to ensure that each reductionist tool or method developed has been implemented, understood and the resulting data has been documented. Thus there are key steps that need to be done prior to any quantification of impacts.

### 7.1.1 Objective and Subtasks

The objective of this chapter is to develop a how-to guide for ecotourism facilities in the Caribbean to initiate monitoring and data collection and analysis that leads to future quantification of impacts. The subtasks are:

- Prioritize key chronological steps for ecotourism facilities in the Caribbean that considers cost and typical staffing capabilities through the Caribbean's ecosites.
- Describe the output of each step including how it should be documented.
- Explain how the outcome of each step feeds into the pathway for quantification of impact.

## 7.2 The Key Steps

As highlighted in Chapter 6, there would be a need for most ecotourism facilities to seek out partnerships for water quality sampling and monitoring with the first option being local partners. This is one of the major steps in the process that relies heavily on third parties and thus is necessitates priority in pathway initiation. All the other steps, with relative priority for initiation are shown in Figure 7.1.

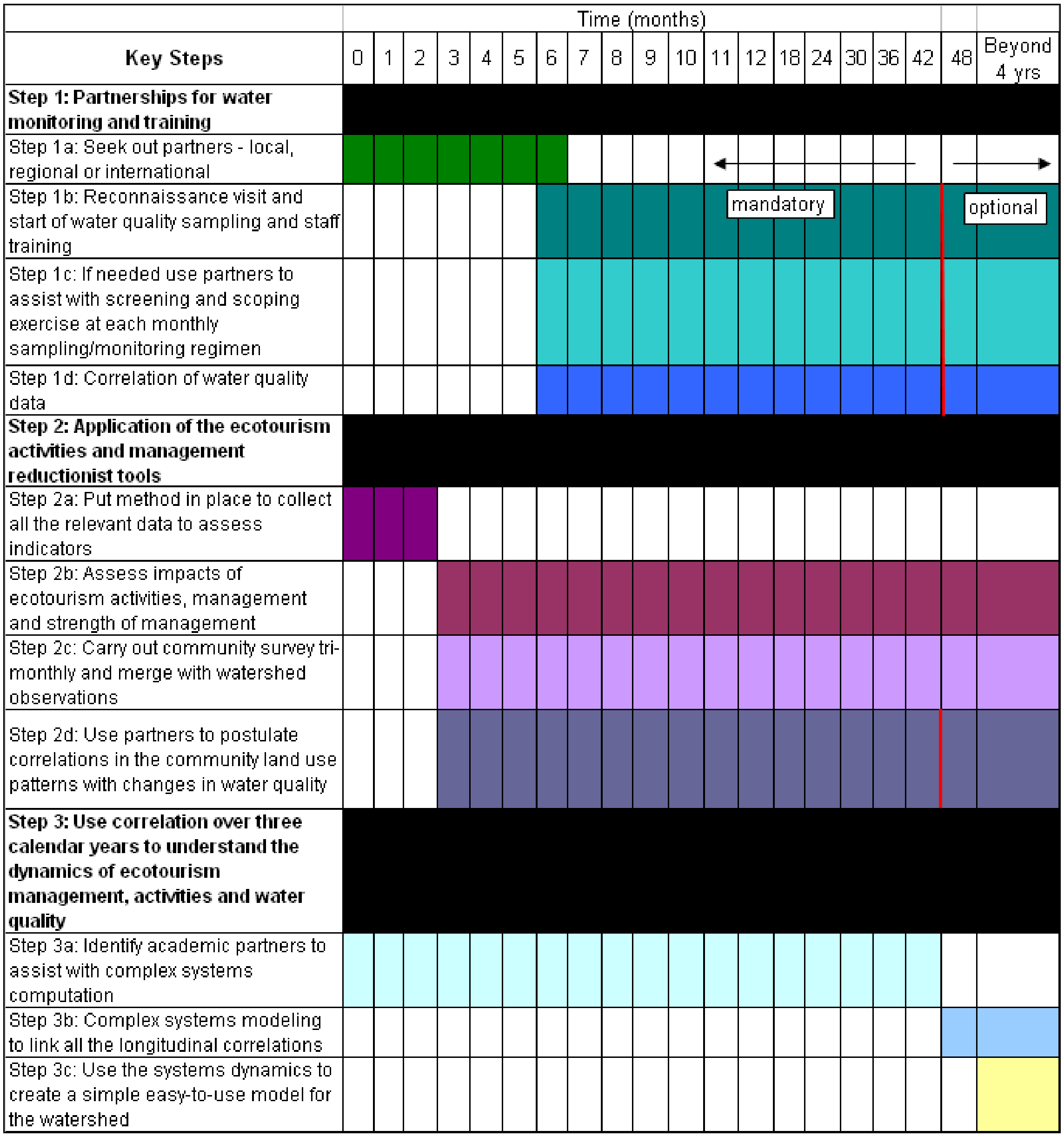



**Figure 7.1** Timeline for key steps in the impact quantification process.

## 7.3 Description of the Key Steps

From Figure 7.1 it can be seen that the 3 key steps all need to occur concurrently however the rate determining step in the pathway is listed as Step 1.

### 7.3.1 Step 1

Unlike the 2 study sites utilized in this work, most ecotourism facilities throughout the Caribbean lack financial and/or human resource capabilities to carry out its own water quality sampling, monitoring and testing. As such partnerships are at the crux of the success of this proposed pathway. Ideally partners for water quality monitoring, sampling and staff training should be sourced locally to enhance the sustainability of the project but if needed regional and international partners should be sought. Sourcing partners should first focus on seeking out local environmental protection and awareness non-profit organizations as well as local colleges and universities with departments of natural sciences, environmental studies and/or engineering. Chapter 6 gave more details on seeking out regional and international partners if needed. As described in Chapter 6, partners should be willing to undertake sampling and monitoring at least once monthly for at least 3 calendar years.

Once partners have been determined, there needs to be a reconnaissance visit to establish baseline water quality data and staff training needs, while commencing the staff training. At this time details will be worked out as the choice of duplicate sampling locations by season as well as water quality monitoring points as marked by GPS coordinates for continuous use of these points. Since most sites would not have the level of expertise to evaluate the screening and scoping exercise developed then the partners should initiate these exercises with staff being trained to do them. These exercises should be done monthly when water quality is being tested to allow for any changes in water quality to be correlated with noted land use patterns. The water quality data should be correlated through simple regressions analysis after every season (i.e. wet or dry) within the 3 year data collection period. This type of analysis can tailor the monitoring regimen to focus on parameters of significant correlations once land changes have been deemed to have stopped. The entire Step 1 process is shown in Figure 7.2.

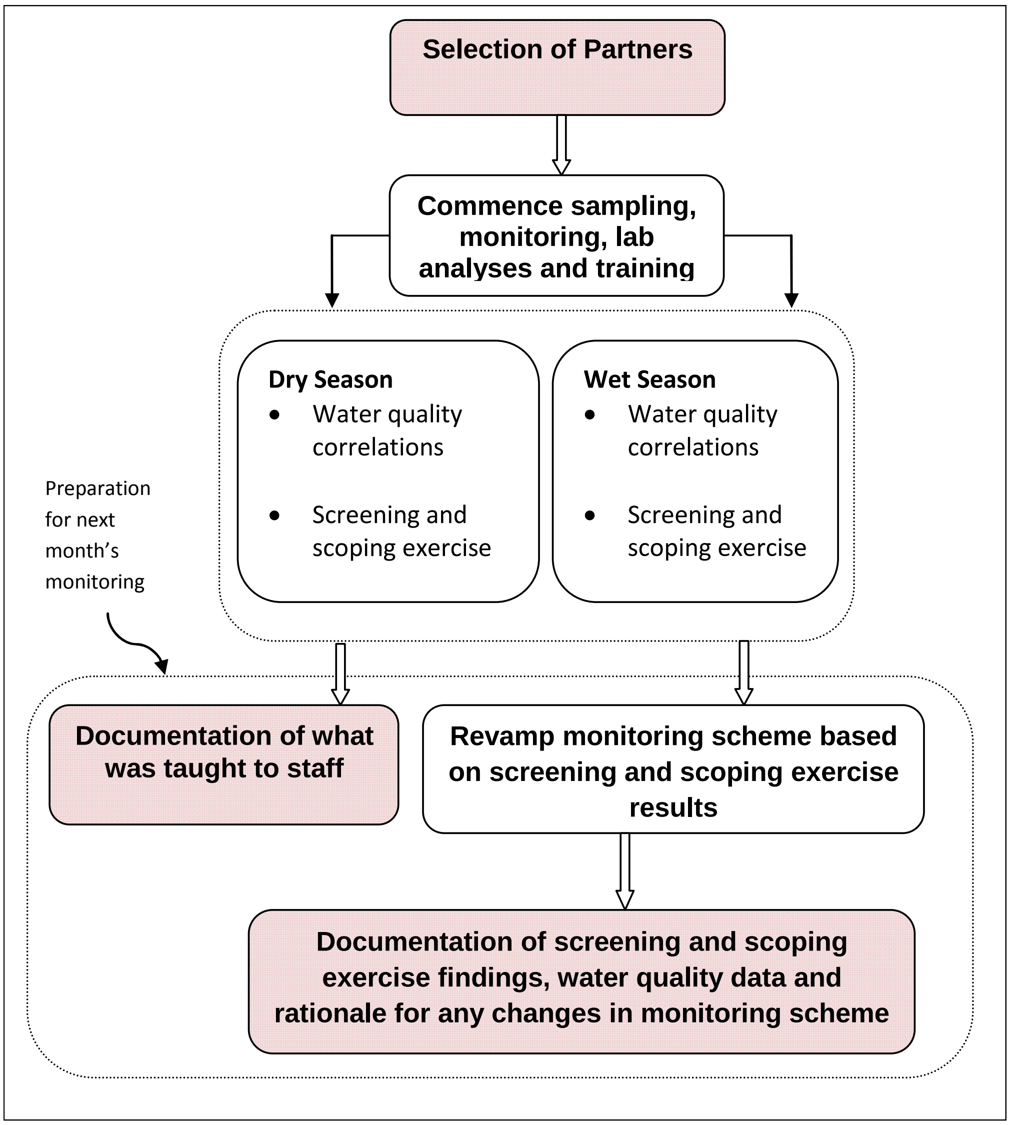



**Figure 7.2** Main sections involved in Step 1. Shaded areas are those carried out by the ecosoite's management while all others are done by partners.

The key outputs of Step 1 are the water quality datasets as well as the screening and scoping exercises results. Both of these information sets are important for the analyses in Steps 2 and 3. Figure 7.3 illustrates how the results of Steps 2 and 3 are connected to the overall outcome of quantification of impacts of the ecotourism industry on water quality.

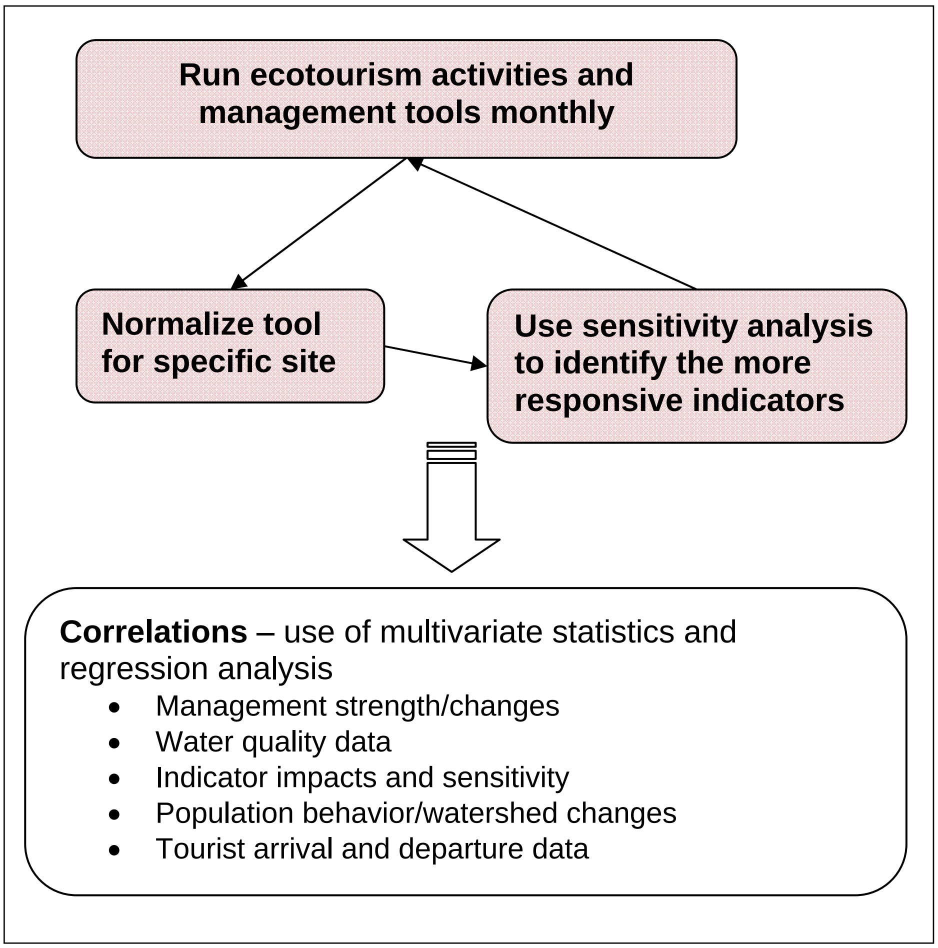



**Figure 7.3** Main sections involved in Step 2. Shaded areas are those carried out by the ecosoite's management while all others are done by partners.

### 7.3.2 Step 2

This step is mainly driven by the ecosite's management and hinges on the collection of data for indicator assessment according to the units of measure given in Chapters 4 and

5. Once systems are in place to adequately measure each indicator and record the results, a baseline needs to be established for ecotourism activities and management impacts as well as the strength of the management. This also sets the baseline for any sensitivity analyses that would need to be done. Also, the assessment of ecotourism activities and management indicators need to coincide with water quality monitoring so as to make correlations of changes in indicator impact values with that of water quality. Further to this, the continuous monthly iteration of the ecotourism activities and management indicator tools will serve to normalize the tools as well as highlight indicators that have a greater correlation with water quality.

As was described in Chapters 4 and 5, the impact values for each indicator is perceptively based on a non-exhaustive list of questions. However, as each reductionist tool is being iterated over time, a definitive site specific list of questions can be finalized for the assessment of each indicator. More so, the ecosite's management can decide exactly what would constitute an impact value of 0 (no impact), 0.5, 1, 1.5, 2, 2.5 or 3 (high impact) in consideration of the historical correlations to water quality. The Step 2 process is summarized in Figure 7.4.

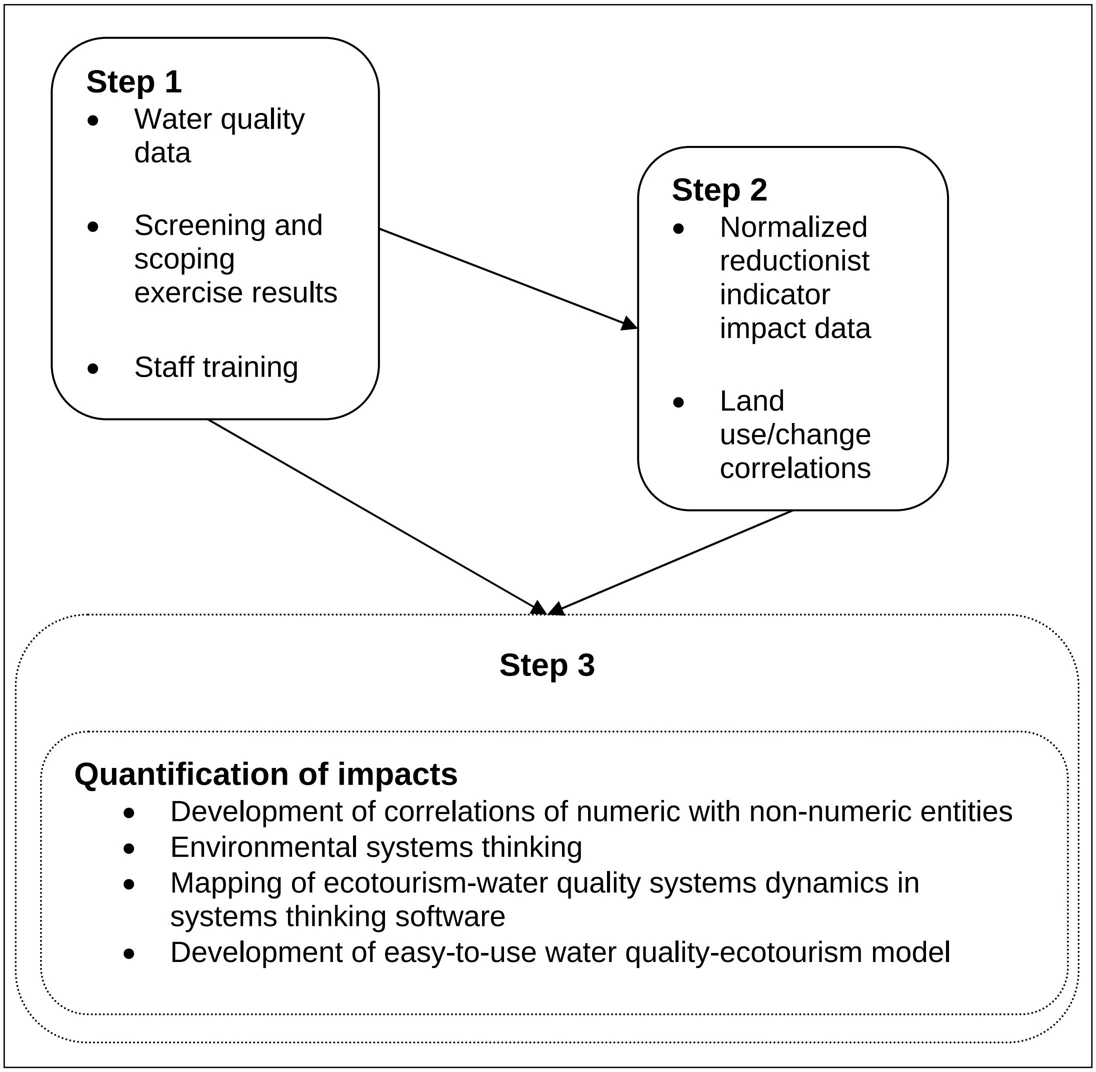



**Figure 7.4** Map of how the key steps are connected with the main outputs from each step highlighted.

Steps 1 and 2 represent the main areas for holistic data collection. As such to allow for proper correlations in Step 3 the required data sets should be obtained once monthly over a 3 year period and collected around the same time. The core pieces of information that need to be collated are:

- Date
- Season (i.e. wet or dry)
- Weather conditions and notes

- GPS coordinates for sampling points with explanations if points used were different from those previously agreed upon to be continuously used
- Water quality results (i.e. BOD, COD, pH, temperature, dissolved oxygen (DO), dissolved oxygen saturated (DO%sat), total dissolved solids (TDS), $NO_3^-$-N, total phosphate, specific conductivity (SpC)/salinity, fecal coliform, heavy metals (lead, arsenic, cadmium, selenium, aluminum, nickel, mercury and zinc) and stream flow rate)
- Key findings of screening and scoping exercise
- Land use changes by populations inside and outside the watershed (through survey results and observations)
- Notes on any changes in methods utilized from previous monitoring schemes
- Staff training carried out and staff members trained/present at water quality monitoring
- Partners involved in the exercise and their roles
- Summary of the impact of ecotourism activities and management indicators with sensitivity or change from baseline values
- Computation of the strength of the ecotourism’s management with explanation notes for any variation from the baseline value
- Correlation of indicator impacts with water quality results to determine which indicators are more directly linked to water quality for both ecotourism activities and ecotourism management
- Tourist arrivals and departures since last monitoring date
- Notable changes in the population living in the watershed of concern

By recording this type of data monthly over a 3 year longitudinal study period the dynamics of the ecotourism activities, management and water quality will be more fully understood.

### 7.3.3 Step 3

Application of systems thinking to create the required link between ecotourism activities, onsite management and water quality requires partnerships with institutions that are familiar with environmental systems dynamics computations. At the end of Step 2 there will be numerous complex correlations that need to be merged with non-numeric inputs in STELLA®. It is imperative that the systems thinking is correct to allow STELLA® to create a numerical model that represents the dynamics of ecotourism activities, water quality and management and gives an output of water quality at key points within the watershed that responds to changes in management strength, tourist arrival and watershed changes. The computational partner will then have to simplify the output model into a simple easy-to-use Microsoft Excel™ model that is useable by the ecosite's management where the inputs will be basic parameters found to be significant through correlations. As a first approach to illustrating the use of STELLA® for this type of model development in ecotourism some basic scenarios were evaluated and the results obtained are shown in Appendix G.

## 7.4 Conclusions

Like with any other complex system the understanding of the ecotourism-water quality dynamics of the Caribbean calls for a longitudinal time investment with relatively short time steps of analysis. Once this takes place with tight quality assurance and control of data, then quantification of the impacts of the industry on surface water quality can be realized. Since most of the ecotourism facilities throughout the Caribbean do not have readily trained personnel or resources to attain the type of data needed, partnerships are needed for initiation of data collection, correlation of water quality with activities and presence of ecotourists, and the ecosite's staff training.

# CHAPTER 8: SUSTAINABILITY IN FORMAL CARIBBEAN PRIMARY AND LOWER SECONDARY EDUCATION: A TRINIDAD AND TOBAGO CASE STUDY

## 8.1 Introduction

The inculcation of sustainability into higher, or tertiary, level education has been widely studied by scholars and sustainability-based organizations (e.g. the Association for the Advancement of Sustainability in Higher Education and the Sustainability Endowments Institute) for both the American and British college structures. Both college structures are currently in place throughout the Caribbean Community (CARICOM) and so these published works can be easily transferrable to the Caribbean setting when sustainability needs to be introduced at the higher level of formal education. Table 8.1 highlights the main colleges in select CARICOM territories by their educational structure.

**Table 8.1** Educational structure of main colleges in Jamaica, Guyana and Trinidad and Tobago.

| Country | Tertiary Institution | Educational Structure |
|---|---|---|
| Guyana | Kru Kru Cooperative College | American |
| | The Schools of Nursing | British |
| | University of Guyana | British |
| Jamaica | University of the West Indies, Mona | British |
| | University of Technology | American |
| | Northern Caribbean University | American |
| | University College of the Caribbean | American |
| | Edna Manley College of Visual and Performing Arts | British |
| Trinidad and Tobago | College of Science, Technology and Applied Arts | American |
| | University of the West Indies, St, Augustine | British |
| | University of Trinidad and Tobago | American |
| | University of the Southern Caribbean | American |
| | Cipriani Labor College | British |

At the primary and secondary education levels the system that currently exists throughout the CARICOM is intrinsically unique in examination structure and curriculum content. Hence, region specific plans can reach the United Nations Educational, Scientific and Cultural Organization (UNESCO) goal for the United Nations Decade of Education for Sustainable Development (2005-2014). During this decade UNESCO aims to “integrate the principles, values, and practices of sustainable development into all aspects of education and learning, in order to address the social, economic, cultural and environmental problems we face in the 21st century” globally. This decade has 4 chief areas of focus which are: the promotion of basic education; reorienting education to address environmental education and sustainability; public outreach; and development of specialized training in a holistic way.

For the CARICOM region the focus of this work is on primary and lower secondary schools since this level of education represents the level attained by the bulk of the total population (UNESCO, 2008). At the ecotourism sites used in this study the majority of the non-managerial employees had education levels in the primary to lower secondary range.  According to the Caribbean Examinations Council (CXC), Trinidad and Tobago currently has an organized and exemplary system in place (CXC, 2009; Jaimungalsingh, 2009) and it is for this reason that that educational system was chosen for scrutiny. A description of CXC is given in Chapter 4.

### 8.1.1 Objective and Subtasks

The chief objective of this chapter was to examine the current state of sustainability in CARICOM’s primary and lower secondary education. Further, this chapter seeks to enhance sustainability inclusion in formal primary and secondary education through recommendations.  To meet these objectives the specific subtasks were to:

- Audit all textbooks currently used in the primary and secondary schools throughout Trinidad and Tobago to determine which ones contain sustainability related concepts,
- Audit the curricula of core primary and secondary subjects for sustainability inclusion, and
- Provide conceptual models for diffusion of sustainability education into CARICOM's primary and lower secondary education in both the short term (by 2014) and long term (2014 and beyond).

## 8.2 Description of the Education Structure in the Caribbean

Typically, kindergarten (or pre-primary education) applies to students beginning at age 3 and is usually run by private institutions and is highly voluntary on the part of parents. There is usually a nominal fee associated with this service. Students would remain at the pre-primary level for 2 years, often entering the primary school domain at age 5. Primary education usually ends after 7 years, that is after 2 years at the Infants or Grade 1 level and then 1 each at the Standards 1 through 5 (or Grades 2 through 6) levels. Education there culminates with a secondary school placement exam. Placement usually considers test scores, student preferences and geography.

Important to note is that at the primary school level each territory is responsible for its own coordination and assessment of students. Each member state has a department or ministry of education under which this responsibility falls. So at the primary level this ministry or department is responsible for selecting curriculum, developing teacher guides and/or modules, selecting approved textbooks for use and final national exams for placement of primary school students into secondary schools. These final exams focus on academics in the realm or Language Arts (i.e. English language, writing and literature), Mathematics, Science and Social Studies. This is the only stage where CXC is involved in ensuring that the tests are suitably measured and commensurate against curriculum outcomes and other territories' tests. This is of particular importance since there is now a single market and economy throughout CARICOM that allows for free movement of people among these territories.

Most students would enter secondary school at age 12 and would exit around age 17 after completion of 5 years of study (Forms 1 through 5 or Grades 7 through 11 depending on territory). In the fifth year of this lower secondary school study students take regional exams set and administered by CXC in an attempt to attain a Caribbean Secondary Education Certificate (CSEC). At this lower secondary level all students in most territories are mandated to take English Language and Mathematics. A student must have attained passes in both Mathematics and English Language along with 3 other subjects to be considered as successfully graduate from high school. This is considered the minimum requirement for formal employment throughout CARICOM.

Subjects can be taken at either the Technical or General Proficiency levels. According to CXC, the General and Technical Proficiencies provide students with the foundation for further studies and entry to the workplace. The full complement of the current offerings by CXC is highlighted in Table 8.2 which gives the proficiency level at which each subject can be taken as well as whether the subject has a School Based Assessment (SBA) and/or Practical component. SBA components represent 20% of the overall final grade assigned for a particular subject. SBAs are individual research projects led at the school level by the subject teacher based on guidelines on topics suggested by CXC. SBAs typically commence in late Form 4 and end in Early Form 5.

CXC subjects, with the exception of Mathematics and English Language (i.e. English A) generally fall into 6 main clusters. These are: Science; Languages; Modern Studies; Business; Technical Vocational Studies; and Creative & Expressive Arts. All schools do not offer all subjects often due to space and budgetary constraints. Most schools however, offer subjects in clusters 1 - 4 above. All schools allow students to focus or major in a single cluster while mandating students to do at least one subject from their non-major cluster. This focus usually begins in Form 4.

**Table 8.2** Classification of subject offerings by the Caribbean Examinations Council.

| Subject | Cluster core | Proficiency level | SBA requirement? | Practical assessment? |
|---|---|---|---|---|
| Agricultural science | Science | General | Yes | No |
| Biology | Science | General | Yes | No |
| Building Technology | Technical Vocational Studies | Technical | Yes | Yes |
| Caribbean History | Modern Studies | General | Yes | No |
| Chemistry | Science | General | Yes | No |
| Clothing & Textiles | Technical Vocational Studies | Technical | Yes | Yes |
| Construction Technology | Technical Vocational Studies | Technical | Yes | Yes |
| Economics | Business | General | Yes | No |
| Electronic Document Preparation & Management | Business | General | Yes | No |
| English A | All clusters | General | No | No |
| English B (i.e. Literature) | Languages | General | No | No |
| Food & Nutrition | Modern Studies | General | Yes | Yes |
| French | Languages | General | No | Yes |
| Geography | Modern Studies | General | Yes | No |
| Home Economics Management | Modern Studies | General | Yes | No |
| Human & Social Biology | Science | General | No | No |
| Industrial Technology | Technical Vocational Studies | Technical | Yes | Yes |
| Information Technology | Technical Vocational Studies | General | Yes | Yes |
| Integrated Science | Science | General | Yes | No |
| Mathematics | All clusters | General | No | No |
| Modern Languages | Languages | General | No | Yes |
| Mechanical Engineering Technology | Technical Vocational Studies | Technical | Yes | Yes |
| Music | Modern Studies | General | Yes | Yes |
| Office Administration | Business | General | Yes | No |
| Physical Education & Sport | Creative & Expressive Arts | General | Yes | Yes |
| Physics | Science | General | Yes | No |
| Principles of Accounts | Business | General | Yes | No |
| Principles of Business | Business | General | Yes | No |
| Religious Education | Modern Studies | General | Yes | No |
| Social Studies | Modern Studies | General | Yes | No |
| Spanish | Languages | General | No | No |
| Technical Drawing | Technical Vocational Studies | Technical | Yes | Yes |
| Theatre Arts | Creative & Expressive Arts | General | Yes | Yes |
| Typewriting | Technical Vocational Studies | General | Yes | Yes |
| Visual Arts | Creative & Expressive Arts | General | Yes | Yes |

*SBA – School Based Assessment

CXC subjects are graded on a scale of I (best) to VI (worst) based on the ranking of subject specific profiles being rated from A (outstanding) to F (poor). See Table 8.3 for details. Grades I, II and III are all considered passes but only Grades I and II are considered acceptable for higher level educational placement.

**Table 8.3** Caribbean Examinations Council grade and profile descriptions (adapted from CXC, 2009)

| | Grade Level | Description |
|---|---|---|
| Overall Subject Grade | I (75 - 100 %) | Student has a comprehensive grasp of the key concepts, knowledge, skills and competencies required by the syllabus. |
| | II (65 – 74 %) | Student has a good grasp of the key concepts, knowledge, skills and competencies required by the syllabus. |
| | II (55 – 64 %) | Student has a fairly good grasp of the key concepts, knowledge, skills and abilities required by the syllabus. |
| | IV (45 – 54 %) | Student has a moderate grasp of the key concepts, knowledge, skills and competencies required by the syllabus. |
| | V (35 – 44 %) | Student has a limited grasp of the key concepts, knowledge, skills and competencies required by the syllabus. |
| | VI (0 – 34 %) | Student has a very limited grasp of the key concepts, knowledge, skills and competencies required by the syllabus. |
| Profile Grade | A | Outstanding |
| | B | Good |
| | C | Fairly Good |
| | D | Moderate |
| | E | Weak |
| | F | Poor |

CXC exams are offered in both January and May/June annually. The January session was created for private candidates while the other session is largely for the secondary school candidates. At both sessions, the same subject is done at the same date and time in each territory and at each testing center.

Students that are very successful at the lower secondary level are encouraged to continue on an optional 2 year advanced level program. This 2 year program is equivalent to the first year of college in the British system of education. Thus persons successfully completing these 2 years at Form 6 (first year called Lower 6th and second called Upper 6th) are candidates for 3 year degrees at regional universities. Persons with successful completion of the CSEC would only have the option of doing technical/vocational studies or attending regional colleges and/or universities that adhere to the American teaching structure. The subjects and exams taken by Form 6 students are all governed in all territories by CXC. The only required subject for all Form 6 students is Communication Studies. Typically students do only 2 or 3 subjects of choice in addition to Communication Studies at this advanced level. A pass in both Communications Studies and 2 other subjects constitutes a Caribbean Advanced Proficiency Examination (CAPE) Certificate.

The education system currently employed throughout the Caribbean Community is by no means perfect. Though the drop-out rates have declined since the establishment of CXC, dropping-out still persists at every level of formal education (see Figure 8.1).

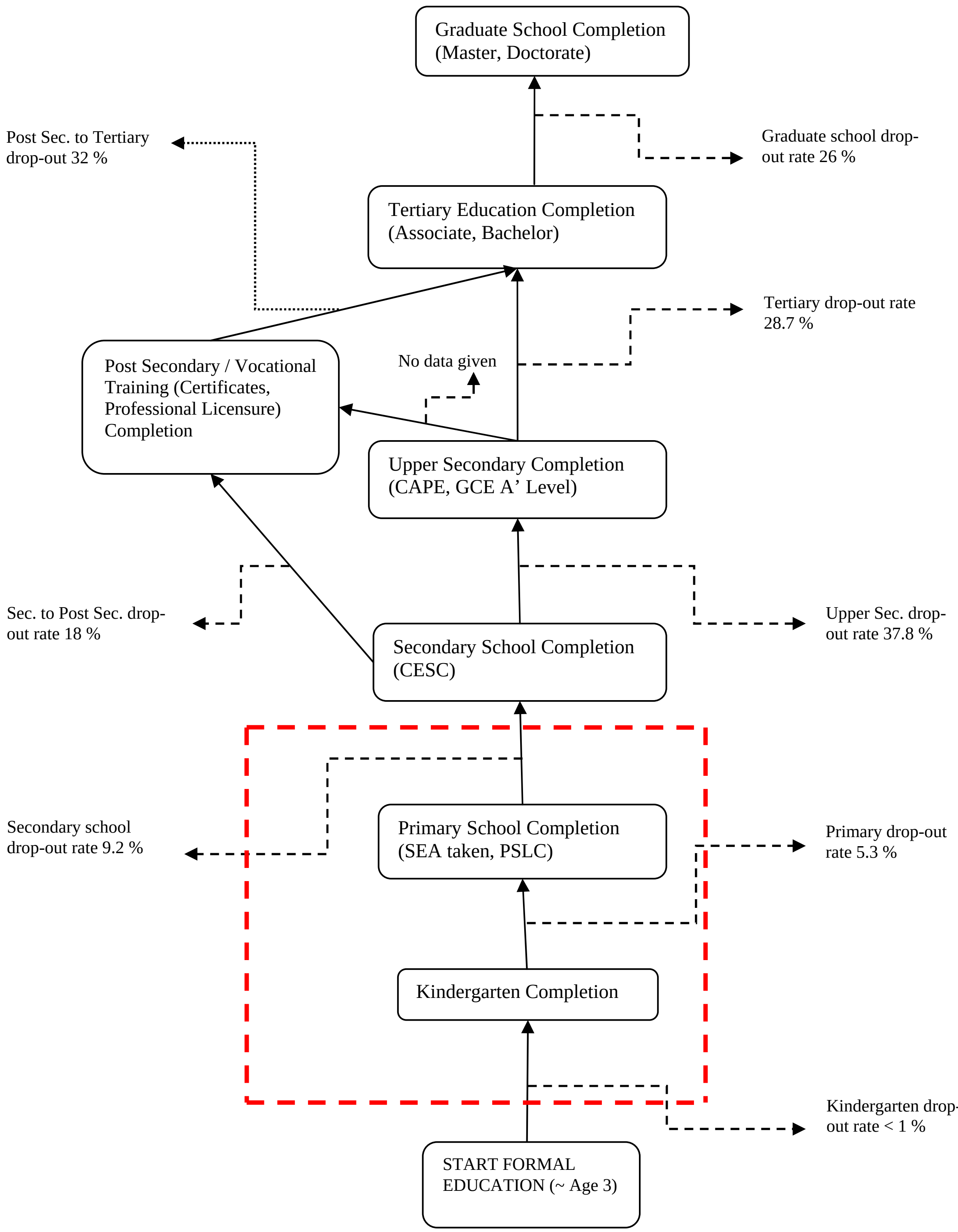



**Figure 8.1** CARICOM's 2007 estimate of drop-out and retention of students in formal education. Red boxed area represents lowest drop-out rates (i.e. all < 10%) (adapted from UNESCO, 2008).

### 8.2.1 Trinidad and Tobago's Education System

The entire primary and secondary school system is structured around 3 terms (or semesters):

- Term 1: Early August to Mid December,
- Term 2: Early January to Mid march, and
- Term 3: Early April to Early July.

The primary schools' final assessment (called the Secondary Entrance Assessment (SEA) Examination) is administered by the Ministry of Education in the middle of Term 2 annually. This exam tests Writing, Language Arts and Mathematics. Note that throughout the primary school career students are exposed to other subjects which are considered functional and non-testable for SEA. Such subjects are Physical Education, Visual and Performing Arts, Science, Social Studies and Spanish. The Ministry of Education (MOE) provides curriculum for all the subjects – core and functional – throughout the entire primary tier. However, according to Jaimungalsingh (2009), Standards 3 – 5 teachers very often focus on the testable SEA subjects since national prestige is annually bestowed upon the best students in the exam and the schools from which they hail. To reduce the possibility of dismissal of subjects seen as vital by the MOE, National Primary School Tests were instituted in 2002. At the end of each term all primary schools, public and private, administer to Standards 1 & 3 students Mathematics and Language Arts tests and to Standards 2 & 4 students Science and Social Studies tests. These tests are conducted on the same dates and times in all schools. The scores from these intermediary exams do not factor into the final SEA score but the MOE is working on changing this to give greater focus on functional subjects by teachers. Note that the Primary School Leaving Certificate Examination (PSLCE) assesses academic achievement at the primary school level in the Republic of Trinidad and Tobago. The PSLCE is written by adults or adolescents who did not complete primary school (taken at the same time as the SEA). The Examination covers the following subjects: English comprehension and composition; English language; Mathematics; Science; and Social Studies.

Since 2002 the ‘no child left behind concept’ has been applied to the SEA exam where all students taking the exam are placed into secondary schools. Also since then, all Forms 1 – 3 students have a mandatory group of subjects to be taken. These subjects are: Mathematics; English language (with Literature); Spanish; Science; Social Studies; Physical education; Visual & performing arts; and Technology education. Forms 1 - 3 is the best place to capture all secondary school students through curriculum reform. Note that the schools with SEA performers at the highest tier often encourage their students to take up to 12 subjects at this level up till Form 5. The subjects and the time allocations are as follows (per week basis) for the 8 core subjects: English – 6; Mathematics – 5; Science – 4; Physical Education – 2; Spanish – 4; Technology Education – 4; Social Studies – 4; Visual and Performing Arts – 4. A period is typically 40 or 45 minutes.

Many students are not successful in attaining a full CXC or even partial CXC certificate on their first attempt. For such students that are interested in trying to attain a full certificate there are 2 options. Firstly, directly upon the unsuccessful completion of Form 5, once still below the age of 18, they can request permission to repeat the Form 5 year at a school of their choice at the discretion of the Principal. Or the other approach is to take evening classes at approved centers throughout the country at no cost to the students. This caters to the adult and/or working student. Students are allowed to enroll in the latter option as many times as they wish since they are responsible for the cost of writing the exams.

Under the National Curriculum Policy's Secondary Education Modernization Programme (SEMP), Trinidad and Tobago's MOE has undergone curriculum development for the 8 core subjects for Forms 1-3 based on the CXC objectives and learning outcomes. According to Jaimungalsingh (2009) this represents what CXC envisions for the rest of CARICOM by 2020 and is using the results of the Trinidad and Tobago pilot to tailor initiation in the other territories. The MOE has also provided teacher modules for each theme in each of the core subjects. These modules contain subtopics with suggested lesson plans; detailed learning outcomes; suggested in class activities as well as homework assignments. CXC provides modules for the Forms 4, 5 and 6 syllabi for all its subject offerings. Under SEMP the government has set up a Textbook Evaluation Committee to decide on the most appropriate textbooks for all primary and secondary schools to use. The government provides the books for students through a rental program. Hence, only these approved books can be used in public schools in preparation for national and/or regional examinations. This system has been implemented in schools since the start of the academic year in 2007.

## 8.3 Methodology

From the basic understanding of the formal education system in Trinidad and Tobago and what is envisioned for the rest of CARICOM it was decided that Forms 1-3 form the crux of the secondary school focus. The entire primary school structure was also considered in this study i.e. Infants through Standard 5. The procedure undertaken is detailed in 3 key steps in Table 8.4.

**Table 8.4** Summary of methodology employed.

| Step | Description | Rationale | Expected Outcome |
|---|---|---|---|
| 1 | Examination of minimum teacher credentials. | To determine if/where teacher training would be required. | Recommendations on the most effective ways (i.e. in terms of cost and time) for teachers to become trained in basic sustainability concepts. |
| 2 | Textbook audit of all recommended 2009-2010 textbook in tandem with relevant curriculum. | Will assist in determining if/where sustainability is currently included in curriculum and textbooks and to what degree. | If sustainability is not included in either the curriculum, topics can be suggested for inclusion. If the textbooks do not contain sustainability concepts then cost effective ways can be suggested to initiate teaching while textbooks and curricula are revamped. |
| 3 | Use the results of Steps 1 & 2 to devise conceptual models for infusion of sustainability into primary and secondary education. | In an attempt to try and meet UNESCO's 2014 goal there are a few things that could be put in place in the short term to allow for quick diffusion while longer term plans are being formalized. | Conceptual short (up to 2014) and long term (post 2014) models for inclusion of sustainability concepts into formal education in the Caribbean. |

An audit of the books utilized constituted reading the book for the core themes therein which were then cross referenced with the curriculum. This was done to determine if any book in question had sustainability concepts despite not being part of the curriculum and vice versa. All the 2009-2010 primary and secondary level books utilized (along with the results of the audit process) are found in Appendix E. Note that the current modules that are being used by Forms 1-3 teachers for the various subjects were not considered for audit solely because they are classified as confidential by Trinidad and Tobago’s MOE.

## 8.4 Results and Discussion

### 8.4.1 Step 1

Structure of teaching in primary schools, both public and private, is such that 1 teacher is assigned to a single class to teach all subjects for the academic year. In the secondary school system 1 teacher per subject area, depending on their degree specialization, is the norm. This was found to be true throughout CARICOM. This means that teachers in the primary and secondary school system have different backgrounds and expertise. This is concretized by considering the broad minimum teacher requirement in Table 8.5.

**Table 8.5** Teacher requirements for different stages of educational development in Trinidad and Tobago.

| | | |
|---|---|---|
| Primary | Infants | 5 Caribbean Secondary Certificate Examination (CSCE) General/Technical passes (Grades I, II or III) inclusive of Mathematics, English A and one subject in the Natural Sciences. |
| | Standard 1 - 5 | 5 Caribbean Secondary Education Certificate (CSCE) General passes (Grades I, II or III) inclusive of Mathematics, English A and one subject in the Natural Sciences with Certificate in Teaching. |
| Secondary | Forms 1 - 3 | 3 Cambridge General Education (GCE) Advanced Level / Caribbean Advanced Proficiency Examination (CAPE) passes inclusive of General Paper OR Associate Degree from an accredited college. |
| | Forms 4 - 6 | First degree from an accredited college or university. |
| | Evening classes | 3 Cambridge General Education Advanced Level / Caribbean Advanced Proficiency Examination (CAPE) passes inclusive of General Paper OR Associate Degree from an accredited college. |

Teachers will need to be brought to the same level on sustainability before they can teach their students. Considering the varying level of credentials that teachers tend to have, an introductory workshop series is deemed the most effective way to train teachers on basic sustainability concepts.

The current structure of the academic year allows teachers to be off during July and August of each calendar year. Most CARICOM territories have instituted mandatory workshops that teachers need to attend during this break period. As such, it is recommended that a sustainability workshop series be conducted annually with increasingly progressive depth in sustainability science. Making these sessions mandatory holds the potential to reach a very broad spectrum of teachers. Since all primary and secondary schools are now equipped with internet-ready computers it is envisioned that regional workshops can be held in one territory while being streamed live for access in other territories.

Facilitation of these workshops can be organized through partnerships that the regional universities and colleges have with global universities (e.g. the University of the West Indies' Faculty of Engineering and the University of South Florida's College of Engineering). For the longer term, the MOE can seek out new partnerships with leaders in the field of sustainability. Assistance for these types of arrangements can be facilitated by UNESCO's Regional Caribbean Office in Kingston, Jamaica (Champagnie, 2009). Such partnerships can be exploited for the diffusion of sustainability education which assists in meeting the Millennium Development Goal 8 (Global Partnership) and indirectly Goal 7 (Environmental Sustainability).

### 8.4.2 Step 2

All the 2009-2010 textbooks that are in use in primary schools and Forms 1-3 in Trinidad and Tobago were audited for sustainability inclusion. The books were audited in consideration of the respective subject curriculum. All curricula were obtained from the Trinidad and Tobago MOE's website (http://www.moe.gov.tt/, all obtained in September 2009). The audit results are detailed in Appendix E by book title.

Of the 47 secondary school book audited (across 24 curricula) and the 49 primary school books audited (across 6 curricula) only the Standard V Science text incorporated sustainability at the primary school level and at the secondary school level just the Form 2 Social Studies text and the Form 3 Science and Social Studies texts. Nowhere in any book was the term sustainability or sustainable development utilized, but some concepts were highlighted. Important to note that these were the only places that did include sustainability in the curricula and so were the only places that the sustainability theme emerged in the texts. The books audit found that the textbooks were exactly tailored to meet the needs of the respective curriculum only, with virtually no additional information (certainly not on sustainability) included in the books. Hence, a change/revision of books for formal sustainability education is needed at the primary and Forms 1-3 levels. Overall, the audit also determined that the best subjects for the initial injection of the sustainability concepts are within the existing frameworks of the Science and Social Studies curricula at both the primary and secondary school levels.

Despite getting teachers trained (as mentioned in Step 1 above) there is need to provide teachers with modules on various aspects and related concepts of sustainability. As was described above this is the tradition in the CARICOM education structure and would be necessary to guide the teachers in the early stages of implementation when textbooks do not yet contain the relevant materials. In accordance with CARICOM's modules standards they should include, at the various level of education, the following key components to be considered workable: detailed learning outcomes; suggested teaching/learning strategies; resources to aide teaching/learning; and suggested assessment (both in class and through out-of-class work).

Since module development at the Forms 4, 5 and 6 secondary level is contingent upon CXC's inclusion into syllabi then this can be a long term goal. When this happens students can be given the opportunity to explore sustainability in subjects beyond Form 3. One great place for this is in subjects that have an SBA component (see Table 8.2 above). The SBA represents independent work by students on key areas of the syllabus so once sustainability is included in CXC's examinable curricula then it can be studied through research in a myriad of subjects (inclusive of business subjects). This research is conducted at the local level with the teacher directing the work and can be a great source of data collection. Data, and its sharing, is one area that is plaguing the Caribbean region and this is one way of attempting to alleviate that (Trotz, 2007).

It is expected that any suggested changes will take quite some time before they can be formalized for implementation. However, on a less formal scale it is envisioned that the many student groups that are institutionalized within schools can be utilized for initiating the teaching of sustainability in schools. Throughout CARICOM the various MOE's have encouraged the creation of extracurricular groups. Some of the more common groups that align with sustainability's core concepts include 4-H (Head, heart, hands, heath) Club; Girls Guides; Red Cross and Boy Scouts at the Primary school level. Typical groups at the Secondary school level with a sustainability mandate include Young Leaders; Science Club and The UNESCO Club. At the schools the clubs/groups are led by teachers and supported by the national and/or international chapters. Thus, after teachers have gained some training in sustainability they can pilot efforts in these student groups.

### 8.4.3 Step 3

There are numerous educational theories that can and have been used to model, even conceptually, implementation/teaching/learning of educational concepts/programs. From the literature, the most applicable theory in this case (i.e. where learning is being done by the implementer to be taught concurrently) is the Kolb Learning Style theory. This theory was developed by David Kolb in 1984 as a means of describing an individual's learning habits as experiential.

According to Kolb (1984) and Chapman (2006), Kolb's learning theory sets out 4 distinct learning styles (or preferences), which are based on a four-stage learning cycle (which might also be interpreted as a training cycle). This training aspect of the cycle makes it perfect for the formative years of the envisioned model for adaptation of sustainability concepts into the formal primary and secondary school structures where the respective Ministries of Education need to be 'trained' in how to effectively reach this objective.

Kolb (1984) includes this cycle of learning as a central principle of his experiential learning theory, typically expressed as a four-stage cycle of learning, in which immediate or concrete experiences provide a basis for observations and reflections. These observations and reflections are assimilated and distilled into abstract concepts producing new implications for action which can be actively tested, in turn creating new experiences (Chapman, 2006). Kolb (1984) said that ideally (and by inference not always) this process represents a learning cycle or spiral where the learner touches all the bases, i.e., a cycle of experiencing, reflecting, thinking, and acting. Immediate or concrete experiences lead to observations and reflections. These reflections are then assimilated (absorbed and translated) into abstract concepts with implications for action, which the person can actively test and experiment with, which in turn enable the creation of new experiences.

Kolb's model works on 2 levels (Kolb, 1984; Howard, Carver and Lane, 1996). These 2 levels are the Active-Reflective scale (or Processing Continuum) and the Sensing-Intuitive scale (or Perceptive Continuum). The modified Kolb cycle is now considered to be a four-stage cycle (Chapman, 2006):

- Concrete Experience (CE);
- Reflective Observation (RO);

- Abstract Conceptualization (AC); and
- Active Experimentation (AE).

This four-stage cycle is contingent upon a four-type definition of learning styles, for which Kolb used the terms (Kolb, 1984; Chapman, 2006): Diverging (CE/RO); Assimilating (AC/RO); Converging (AC/AE); and Accommodating (CE/AE).

Figure 8.2 depicts a modified Kolb cycle using the aforementioned abbreviations.

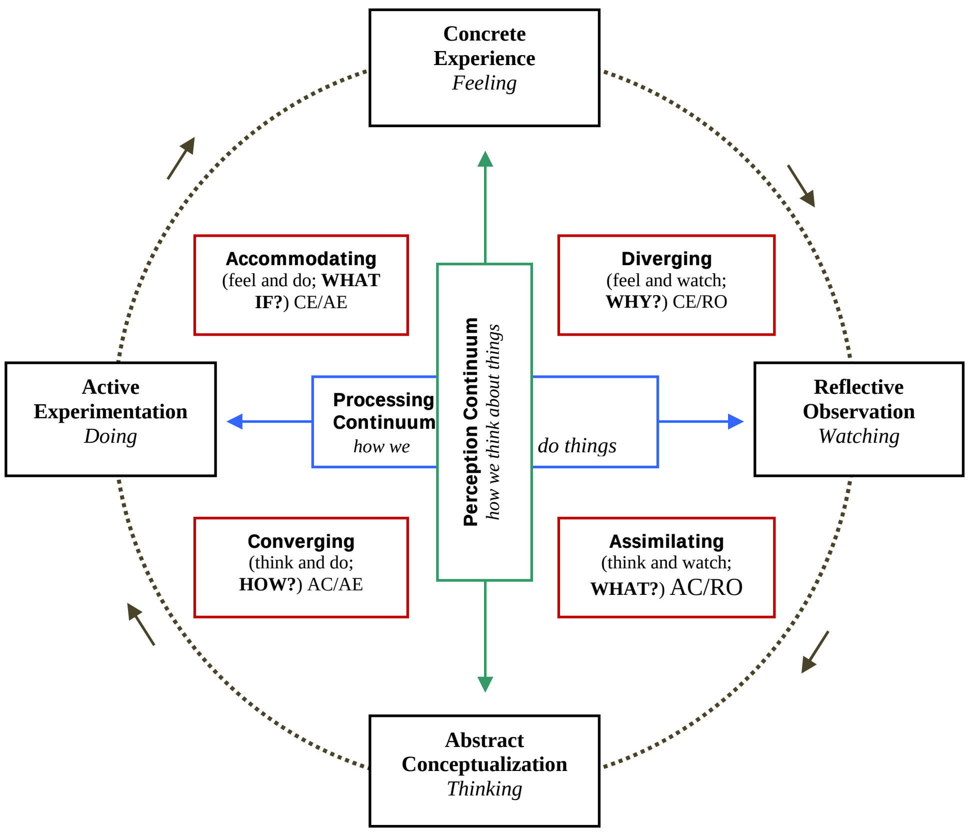



**Figure 8.2** Modified Kolb Cycle of Experiential Learning (adapted from Kolb, 1984; Howard, Carver and Lane, 1996; and Chapman, 2006).

### 8.4.4 The Pre-2014 Conceptual Model

This model is based on the relevant Ministries of Education throughout CARICOM actually learning how best to implement sustainability curricula in primary and secondary schools through an experiential process. Figure 8.3 details how this process should be undertaken.

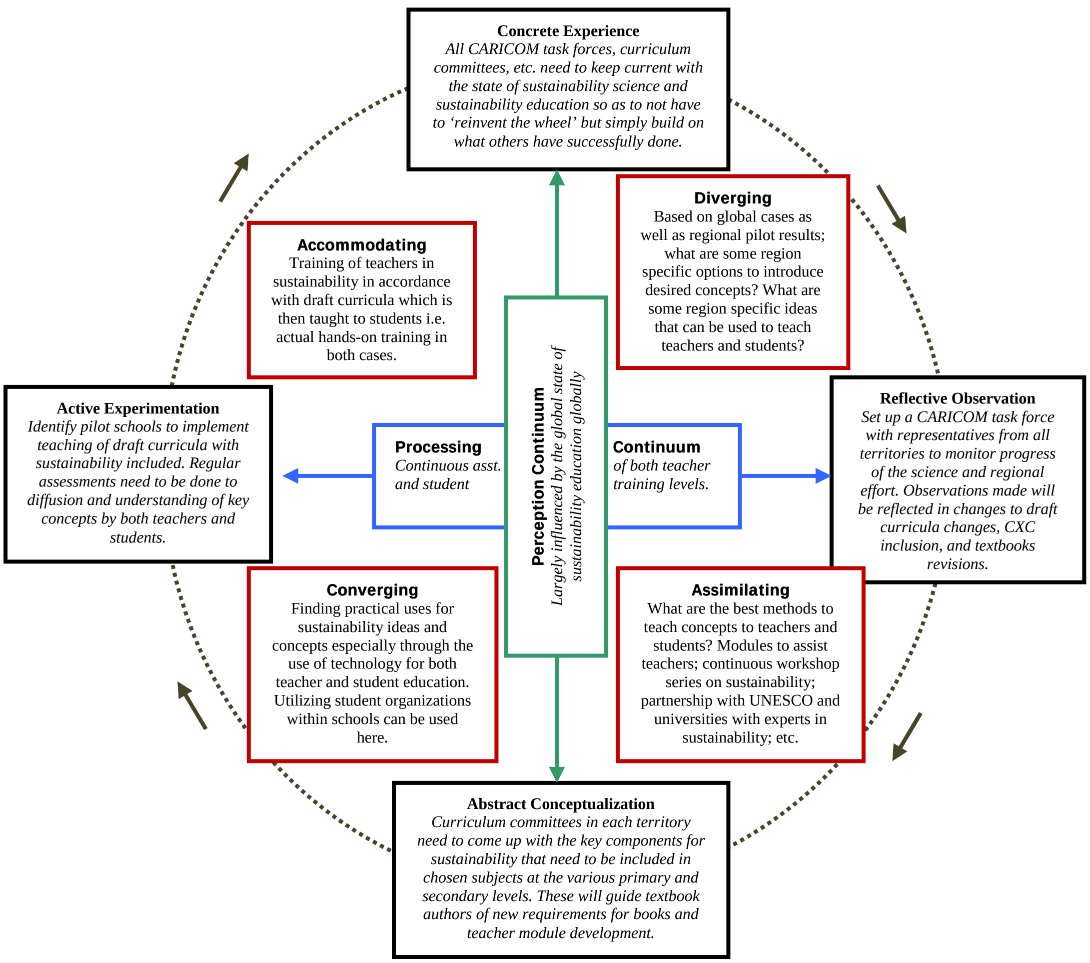



**Figure 8.3** Pre-2014 Caribbean primary and secondary schools conceptual model for sustainability education.

The core of this model is that administrators of education throughout CARICOM will become more acquainted with sustainability education through immersion. This is seen as the best approach if the goal of the UNESCO Decade of Education for Sustainable Development is to be at least somewhat realized in the Caribbean.

### 8.4.5 The Post-2014 Conceptual Model

The underpinning assumption of this model is that the Pre-2014 model was successful at infusing sustainability into curricula and teachers obtained basic training. Thus this model is concentrated on teaching students the concepts as described in the curricula according to the 4 different learning styles described by Kolb (1984). Some suggested teaching techniques from the literature are given by learning style in Table 8.6.

**Table 8.6** Kolb (1984) learner styles and suggested teaching techniques (adapted from Kolb, 1984; Chapman, 2006 and Crede, 2009).

| | Active Experimentation (AE) (doing) | Reflective Observation (RO) (watching) |
|---|---|---|
| Concrete Experience (CE) (feeling) | *Accommodating* - This is a 'hands-on' learning style and relies on intuition rather than logic. Suggested techniques: nature immersion - field trips, outdoor projects, etc.; teamwork - both in class and out of class; service-based learning; creative thinking. | *Diverging* - These learners prefer to watch rather than do, tending to gather information and use imagination to solve problems. Suggested techniques: brainstorming; small group pair-and-share; cooperative learning; active listening. |
| Abstract Conceptualization (AC) (thinking) | *Converging* - These learners like to solve problems and will use their learning to find solutions to practical issues. Suggested techniques: collaborative learning; inquiry-based learning. | *Assimilating* - This type of learner prefers a concise, logical approach. Suggested techniques: readings and lectures; seminars; critical thinking. |

According to educational theory, the implementation of curriculum is highly dependent on effective teaching. Kolb (1984) suggests that effective teaching comes from mixing teaching tactics to meet the various types of learners that every classroom will have. This is particularly important when new concepts are being introduced into curricula where some students did not have an early grounding of some concepts. To demonstrate this point a sample Standard 2 module on water quality was put through the Kolb cycle and is shown in Table 8.7.

**Table 8.7** Sample teacher module that demonstrates application of Kolb theory.

| | |
|---|---|
| *Module: Surface water quality – TURBIDITY (Std. 2)* | Class teaching time: 2.5 hours<br>Student out of class time: 1.5 hours |

*Learning Objectives*

1. Describe turbidity, what causes it and how it can be measured.
2. Discuss why turbidity should be monitored.
3. Distinguish turbidity readings for polluted surface waters versus drinking water.
4. Understand how turbidity influences sustainability healthy communities.

*Suggested Teaching Techniques by Learner Type*

1. Diverging (CE/RO)

Show online video related to turbidity and surface water quality as they directly impact humans who depend on these waterways. Based on this video small groups can be created to list the key points highlighted in the video which will then be shared with the class. The activity helps to highlight the caring, integration and human student developmental dimensions while building on foundational knowledge.

2. Assimilating (AC/RO)

Traditional instruction of new material based on water quality and turbidity. However the teacher should utilize probing questions at the higher cognitive levels to foster critical thinking within the topic of study. Further to this, homework sets should be assigned based on the lecture and textbook readings. This approach allows for students to build on their foundational knowledge for other applied exercises.

3. Converging (AC/AE)

Students can be split into teams and given topics related to the impact of turbid freshwaters on sustaining the health of communities (humans, flora and fauna) and do in class debates. Related homework should include having to come up with points to support the views of their teams. This type of exercise promotes student development through integration, human and foundational application dimensions.

4. Accommodating (CE/AE)

a. Divide into teams to make a secchi disk by repurposing materials as much as possible. This activity will augment the integration dimension of student development.

b. Formulate a simple experiment that uses the secchi disk, river/sea water and/or drinking water to evaluate turbidity such that the student teams are involved in sample collection (if practical) and conduction of the experiment. For linkages to the local community, these tests should be linked to a waterway or monitoring site of interest. Reports on the experiments should be done in groups. Activity will assist in developing the application and integration dimensions of students.

*Suggested Additional Teacher Resources*

Making a secchi disk: http://dipin.kent.edu/makedisk.htm & http://serc.carleton.edu/microbelife/research_methods/environ_sampling/turbidity.html

Turbidity basics: http://www.epa.gov/volunteer/stream/vms55.html & http://www.lenntech.com/turbidity.htm

Lesson plan on water quality: http://web.vims.edu/bridge/lesson.html?svr=www & http://www.cln.org/themes/water.html

Since sustainability as a subject is continuously expanding there is need for rolling revamps along the educational cycle. The items include: teacher training; curriculum changes to match current trends; on going research in the field to determine what students should be learning; revisions to sustainability modules; and postulations of impacts in the Caribbean region. This means that the Pre-2014 Conceptual Model needs to be continued with audit and assessment of the process through results of the various standardized examinations and teacher evaluations.

### 8.5 Conclusions

The sustainability of the Caribbean's tourism industry, inclusive of ecotourism, depends largely on the region's ability to maintain product quality through an informed and educated labor force (Holder, 1996). The concept of education being iterative with development has been widely accepted globally (Francis and Iyare, 2006). Thus any form of education of the labor force, present and future, only lends to greater possibility for sustainable development (Holder, 1996). It was from the position of the need for general future-workforce training, inclusive of those that will enter the ecotourism industry, that this study on sustainability education in the Caribbean was born. From the study conducted it was determined through audit of current curricula and textbooks in use in Trinidad and Tobago, and the Caribbean by extension, that sustainability is, virtually, not addressed in the formal primary and secondary school system. If the Caribbean is to meet the UNESCO 2014 goal there is need to implement a few changes in the near future. A conceptual path was suggested in Pre-2014 immersion-based model based on the Kolb training cycle since this period was modeled as a preparatory or training period in how to teach sustainability beyond 2014. The Post-2014 model focuses on effective teaching as necessitated by Kolb (1984) and educational theorists for the years of formal sustainability education infancy in the Caribbean.

# CHAPTER 9: CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE WORK

## 9.1 Summary

The genesis of ecotourism was hinged on sustainability but the literature suggests that globally there has been a departure from this original thought. One rationale for this, given by the World Tourism Organization (WTO), is the lack of our current ability to quantify impacts of the industry (Shah, 2000). This body of work provides frameworks for quantifying impacts of ecotourism – activities and management - in the Caribbean from a sustainability perspective and more so using simple everyday computer software i.e. Microsoft Excel. This is of particular importance when one considers the user-friendliness, reachability and applicability of the tools created as being pivotal to diffusion and adoption throughout the Caribbean. Though not the best approach, the chosen indicators were based on suggested sustainability indicators by international agencies.

Current impacts of ecotourism globally are highly qualitative. Using the assessment tools, proposed ecotourism managers, monitoring agencies and site planners can quantify current and potential impacts of ecotourism on the environment as well as the impact of management on the sustainability of ecotourism activities. In viewing ecotourism and its management as a complex system, this work explored a novel numerical method that links an ecosite's management to environmental impact by using water quality as the environmental indicator.

## 9.2 Findings and Conclusions

### 9.2.1 Chapter 4

- The sustainability of ecotourism activities in the Caribbean was found to be assessable across 15 indicators among the 3 core pillars of sustainability: environmental, societal and economic. For final selection, indicators had to pass the Pressure-State-Response (PSR) framework for a sustainable business.
- Indicators were placed onto a target plot to create an assessment tool that can be utilized numerically to represent the impacts of each indicator. Each indicator was analyzed for impact (on a scale of 0, no impact, to 3, high intensity impact) by the use of a created pool of questions the answers to which can suggest severity of impact. The information required to assign a value was obtained through the use of social data collection techniques (i.e. surveying, interviews, observation and checklists) while visiting the sites.
- By applying 5 scenarios to the assessment tool created it was found to respond to social and demographic changes for both study sites utilized.
- Through scenario development the assessment tool showed that it can highlight which internal aspects of the ecotourism activities enhance the overall sustainability of the activities.

### 9.2.2 Chapter 5

- This work showed that the assessment of the sustainable management of ecotourism in the Caribbean can be assessed among 5 pillars of sustainability: environmental, economic, societal, cultural and political at both the national and site specific levels.

- At the national level assessment can be done across 15 indicators while it can be done across 12 indicators for the site level assessment. The chosen indicators, at each level, were fitted to the PSR framework for final selection.
- Assessment tools were created by the use of target plots, one at each level of assessment considered. The indicators selected were used to create target plots to visualize the results of the assessment. Similar to target plot development done in Chapter 4, a set of questions were developed for each indicator that allowed for the assignment of a value for each parameter (on a scale of 0, no impact, to 3, high intensity impact) for a created scenario. Social data collection techniques (as listed above) were employed to attain information to assign impact. The scenario only tested the site specific management tool created since relevant data for the national assessment are not considered public. From the target plot for the scenario created and sensitivity analyses done it was shown that the tool created responded to managerial changes at the site level.
- A modified approach to Social Network Analysis (SNA) was taken to create a scheme by which management of ecotourism can be quantified at the site level. The conventional SNA concept of network density was modified to determine the strength of ecotourism's management structure. This management density, a single number between 0 (worst strength) and 1 (best strength), was developed to be:

  $$\text{Management density}\left(\rho_{Mgt}\right) = \frac{T_{two-way}}{N(N-1)/2} \qquad (5.3)$$

  where $T_{two\text{-}way}$ is the number of two-way ties in the management network; N is the number of actors (or nodes) in the network.

### 9.2.3 Chapter 6

- By visiting each site water sampling was done together with monitoring and *ex situ* laboratory analyses to create a background data base upon which a longitudinal study can be built. The sampling visit was also used to begin training of the ecotourism staff and management at each site on the importance of water quality management and sampling and monitoring techniques.
- The data obtained at each site was compared to the United States Environmental Protection Agency's (USEPA) water quality guidelines for aquatic life, recreational waters and drinking water. The Guyana and Jamaica sites were out of compliance with some parameters.
- There is a need to engage in proper water quality management within the ecotourism industry in the Caribbean and so a conceptual model was proposed that should include partnership building by ecosites (i.e. local, regional and/or international), staff training for improved water quality monitoring and the ecosite's management.

### 9.2.4 Chapter 7

- The 3 key steps in understanding the dynamics of ecotourism activities, onsite management and water quality were found to be partnerships for water monitoring and training; application of the ecotourism activities and management reductionist tools; and the use of correlation over 3 calendar years.
- Once the data collated is tightly controlled for quality then it can be used to model the impacts of the ecotourism industry on surface water quality.
- Monthly analyses are suggested for water quality monitoring during the 3 year period which can be costly and rationalized the need for partners. Local partners

should be first preference with regional and international partnerships for additional data analysis and two way knowledge sharing.

### 9.2.5 Chapter 8

- Based on an audit of current curricula and textbooks [47 secondary school book audited (across 24 curricula) and the 49 primary school books audited (across 6 curricula)] in use in Trinidad and Tobago, and the Caribbean by extension, it was determined that sustainability is, virtually, not addressed in the formal primary and secondary school system.
- In an attempt to set the Caribbean on a path of attaining the goal of the United Nations Educational, Scientific and Cultural Organization (UNESCO) Decade of Education in Sustainability (2005-2014), a conceptual guide was suggested in a Pre-2014 immersion-based model based on the Kolb training cycle.
- A Post-2014 model was suggested and focuses on effective teaching of sustainability, as necessitated by Kolb (1984) and other educational theorists after curricula changes, for the years of formal sustainability education infancy in the Caribbean.

## 9.3 Future Work

Overall the future studies that build on this work should, as a starting point, utilize the tools created as a means of database building and baseline creation. The relatively simple tools created can be diffused through academia and other routes to ecotourism managers, planners and governmental regulatory agencies in the Caribbean for application. Some more specific areas recommended for study, arranged by related chapter, are:

- Chapter 4: Application of the Yunis (2004) scheme to choose indicators of ecotourism activities at sites through longitudinal observations. This longitudinal study should include the community survey to get response of a much larger section of villagers than utilized in this work to assist in choosing the new indicators. These new indicators can then be compared against the ones suggested here to determine whether the method of choosing indicators based on suggested indicators and the PSR framework are justifiable for application to other sites and or regions where ecotourism exists. Once longitudinal observation of indicators are entered into this allows for scenarios to be run and sensitivity analyses to be done on a time basis which is of particular importance to compare the results of the scenario in times of high versus low visitation as well as wet versus dry season. This type of analysis inherently incorporates management as the direct influence of management should be able to affect scenario outcomes and so this type of timed analysis can correlate 'present' outcomes to changes in management.
- Chapter 5: For the method utilized in this work, the management network should be expanded to include micromanagement for all nodes and the management density calculated at each site. This will give a truer representation of managerial strength. The management network for the 2 sites that incorporate workers' perception of managerial influence on them along with formal management structure should be obtained to calculate a more correct management density. This would necessitate the interviewing and/or surveying of every node in the network to be able to draw 'informal' managerial links.
- Chapter 6: There is a need to continue water quality monitoring based on the list of suggested water quality parameters for the Caribbean's ecotourism industry. If done this will assist in developing data across both wet and dry seasons for input

into the numerical model. Once monitoring is done on a regular schedule results will allow for understanding site specific dynamics among parameters upon which a more stringent model can be proposed. More so the data collected can be shared through a public database to start promoting a culture of data sharing in the Caribbean.

- Chapter 7: After prolonged monitoring on a regular schedule (suggested to have monthly monitoring over 3 calendar years) site specific water quality indicators can be chosen for a multi-parameter water quality numerical model that links to the ecosite's management. To make the model more stringent some other water quality variables that could be monitored (besides those suggested in Chapter 6) are: sodium, potassium, chloride, sulfate, nitrite, reactive silica and chlorophyll A. Also to further add a social component to the model, and making it a more true sustainability model, the population dynamics of locals living in the watershed should be incorporated.
- Chapter 8: If the models proposed are implemented, studies would be needed to assess level of learning and whether the UNESCO goal for the Decade of Education for Sustainable Development is being met. In the event that they are not then new models can be proposed based on experiential learning.

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# APPENDICES

**Appendix A: Survey, Semi-structured Interview, Scoping Checklist and Impact/Screening Questions.**

**Survey**

**Script for Verbal Consent to Participate in Research Survey**

Upon approaching a study subject, please read the following statement. For words in parentheses separated by slashes, choose the word appropriate to the situation.
*"I am a (student/researcher) from the University of South Florida in Tampa, Florida. We are conducting a research study about tourism/ecotourism in conjunction with Greencastle Tropical Study Center. We would like to ask you some questions about tourism/ecotourism for this study. If you are willing to participate, we will ask questions and document your responses. We expect the survey will take about 10 minutes. No payment will be provided. Your participation is voluntary and you may decline to answer or decide to end the survey at any time. Are you willing to participate in our survey?"*

If the subject answers "No" just say thank you.
If the subject answers "Yes" then check here __________.

Turn to page 2 and conduct the survey. If the subject declines to answer a question, go on to the next question. If the subject asks to stop, STOP. Do no continue if you feel, at any time that the subject is no longer willing or able to fully participate.

After you completed the survey (or the subject has asked to stop), fill out your name and the date on the attached Study Information Sheet and give it to the subject. Read the following statement:

*"The survey is now complete. Thank you for your participation. We will be using the information provided in all the surveys we do to learn how people fell about the tourism/ecotourism industry in their community. If you have any questions, concerns or complaints about this study, contact Dr. Trotz or the research oversight board at the numbers on the sheet. If you decide that you want your information excluded from this research study, please contact Dr. Trotz via phone or email as given on the Information Sheet and provide her with your survey number (on the top right corner of the information sheet)."*

If the subject has consented to participate in the research study, sign the statement below, if true:

**Statement of Person Obtaining Verbal Consent**

I have carefully followed the procedures above. I hereby certify that, to the best of my knowledge, the subject understands the purpose of the study and gave the verbal consent to participate in this research study. I also certify that s/he does not have any apparent problems or impairments that could cloud their judgment or make it hard to understand what it means to take part in this research. The subject was able to hear and understand the verbal consent process and questionnaire. This person speaks the language that was used to explain this research.

_______________________________________ ________

Signature of Person Conducting Survey Date

_______________________________________

Printed Name of Person Conducting Survey

**Appendix A (Continued)**

**Questionnaire**

Date: ____________
GPS Location: _________________
Unknown

Site Name: _________________
Sex of Respondent: Male, Female,

Observer notes on interview, subject, and/or location
________________________________________________________________
________________________________________________________________

**Demographic Information**
Q1. What is your age? Less than 18 yrs, 18 to 25, 26 to 35, 36 to 50, 51 to 65, over 65, Other:________________

If the subject answers < 18 yrs, indicate that the survey is for subjects > 18 yrs and end the survey as discussed on Page 1.

Q2. Do you live in this area? Yes, No

Q3. Do you work in this area? Yes, No

Q4. What is your occupation?
___________________________________________________

Q5. How many people live in your household (including yourself)? _________________

Q6. How many people in your household are in the following age groups?
Adults > 18 yrs (___); Children 10-18 (___); below 10 (___); Infants (___)

Q7. What is the highest level of formal education in your household?
Some elementary, through 8th grade, some high school, high school graduate (CXC), high school graduate (A Level or CAPE), some university, university graduate, post-graduate degree, other (please specify)
_______________________________________________

Q8. What is your annual household income in Jamaican dollars?
_______________________

**Water and Sanitation**
Q9. What is (are) the source(s) of all the 'potable' water in your home?
_________________
________________________________________________________________
Q10. Do you pre-treat this water in any way before consumption? Yes, No
Q10a. If yes: What pre-treatment step(s) do you do?
________________________________________________________________
________________________________________________________________
Q11. How is your sewage disposed of? Sewerage network, on-lot septic tank, out-house/latrine, other: ______________________________________________________

**Appendix A (Continued)**

Q12. How is your grey water (eg. laundry water, bath water, kitchen water) disposed of? Let out onto soil, sent to septic tank, sent to sewerage network, other: ______________________________

**Tourism and Ecotourism**

Q13. Do you or any member(s) of your household work within the tourism industry? Yes, No

Q13a. If yes: How many? ____________

Q13-2. What are their occupations within the industry and how long have then been employed in this industry?

____________________________________________________________

____________________________________________________________

____________________________________________________________

Q13-3. What are their highest levels of formal education?

____________________________________________________________

____________________________________________________________

____________________________________________________________

Q14. Do you or any members of your household utilize available tourism or ecotourism products and services within Jamaica? Yes, No

Q14-1. If yes: Which products and service are typically utilized?

____________________________________________________________

___________________________________________________________

____________________________________________________________

Q14-2. Where in Jamaica are these activities typically undertaken?

____________________________________________________________

Q14-3. What influences the choice of location? ___________________________

Q14-4. How often are these activities undertaken? ________________________

Q14-5. If no: Why not?___________________________________________________

____________________________________________________________

Q15. Will you support the development of more tourism/ecotourism activities within your community? Yes, No

Q15-1. If yes or no: Why are you of that view?______________________________________

____________________________________________________________

____________________________________________________________

Q15-2. If yes: What types of activities do you think is best suited for your community?

____________________________________________________________

____________________________________________________________

Q15-3. Do you think your community is equipped with all the necessary amenities and/or infrastructure to allow for further development of the industry in your community? Yes, No

Q15-4. If no: What do you think is first needed?

____________________________________________________

____________________________________________________

The Survey is complete. Go back to page 1 and follow the instructions.

**Appendix A (Continued)**

**Study Information Sheet for Survey Participants**

Name of person conducting survey: ___________________ Date: __________

You have taken part in a survey for a research study described here.

STUDY TITLE: Ecotourism and Water Quality: Linking activities, management and indicators.

PERSON IN CHARGE: Maya Trotz, PhD PHONE NUMBER: (813)974-3172
EMAIL: matrotz@eng.usf.edu

RISKS, BENEFITS, AND ALTERNATIVES: There are no risks or benefits to participation in this study. You have the alternative to choose not to participate. Your participation is voluntary. You may withdraw at any time without penalty.

CONFIDENTIALITY: We have not collected any information about you that could identify you. The information we have collected will be combined with that from other sources to meet study goals. Results may be published, but will not contain any personally identifiable information about you.

CONSENT: A verbal consent process was used for your participation in this study. If you decide at any time that you want your information to be excluded from this research study, please contact Dr. Trotz and provide her with your survey number (on the top right corner of this information sheet).

QUESTIONS OR COMPLAINTS:
If you have concerns, do not hesitate to call or email Dr. Trotz.

If you have questions about your rights, general questions, complaints, or issues as a person taking part in the study, call the Division of Research Integrity and Compliance of the University of South Florida at (813)974-9343.

## Appendix A (Continued)

## Internal Review Boards (IRB) Exemption Certification

USF
UNIVERSITY OF
SOUTH FLORIDA

DIVISION OF RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd., MDC035 • Tampa, FL 33612-4799
(813) 974-5638 • FAX (813) 974-5618

August 28, 2009

Ken Thomas
Engineering
ENB 118

RE: **Exempt Certification** for IRB#: 108295 G
Title: *Ecotourism and Water Quality: Linking Management, Activities and Indicators in the Caribbean*

Dear Mr. Thomas:

On August 25, 2009, the Institutional Review Board (IRB) determined that your research **meets USF requirements and Federal Exemption criteria two (2).** It is your responsibility to ensure that this research is conducted in a manner reported in your application and consistent with the ethical principles outlined in the Belmont Report and with USF IRB policies and procedures.

Please note that changes to this protocol may disqualify it from exempt status. It is your responsibility to notify the IRB prior to implementing any changes.

The Division of Research Integrity and Compliance will hold your exemption application for a period of five years from the date of this letter or for three years after a Final Progress Report is received. If you wish to continue this protocol beyond those periods, you will need to submit an Exemption Certification Request form at least 30 days before this exempt certification ends. If a Final Progress Report has not been received, the IRB will send you a reminder notice prior to end of the five year period; therefore, it is important that you keep your contact information current with the IRB Office. Should you complete this study prior to the end of the five-year period, you must submit a Final IRB Progress Report for review.

**Please reference the above IRB protocol number in all correspondence** regarding this protocol with the IRB or the Division of Research Integrity and Compliance. In addition, you can find the Institutional Review Board (IRB) Quick Reference Guide providing guidelines and resources to assist you in meeting your responsibilities in the conduction of human participant research on our website. Please read this guide carefully. It is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-2036.

Sincerely,

Krista Kutash, Ph.D., Chairperson
USF Institutional Review Board

Cc: Anna Davis/cd, USF IRB Professional Staff
Maya Trotz PhD

**Appendix A (Continued)**

**Semi-structured Interview**

**For management:**

What's the current per room rate? What are the seasonal high and low rates?

When are the arrivals typically low?

Are there any plans to further market the tourism product?

Has the ecotourism activities been profitable for owners?

Is there any type of collaboration or partnership with the surrounding communities?

Are there any plans to increase staff? Will members of the surrounding communities be considered for any of these prospective positions?

**For staff and community members:**

Do you think the ecotourism operations have brought benefit to you community?

How do you think the managers of the facility can better incorporate the community into their business model?

Is the community aware of the current and planned activities at the ecotourism facility?

How is information communicated to the community?

Since the ongoing tourism in the area, has business activity grown throughout the community?

## Appendix A (Continued)

## Checklist

### ENVIRONMENTAL CHECKLIST FOR PAST, PRESENT AND FUTURE PROJECTS ONSITE: SCREENING AND SCOPING

### PART 1: PROJECT DESCRIPTION

Name of Concerned Project:

Project Elements:

Project Phase:

Project Location:

List Raw Material, Chemicals and Fuel stored on site:
During Construction:

During Operation:

**Appendix A (Continued)**

## PART 2: CHECKLIST OF POTENTIAL IMPACTS

| No. | QUESTION | RESPONSE |
|---|---|---|
| **A. PHYSICAL ENVIRONMENT** | | |
| **A.1 Air Quality** | | |
| A.1.1 | Will the project produce air emissions (directly or indirectly)? | Yes<br>No<br>Unknown |
| A.1.2 | During what phase of the project? Construction Operation | |
| A.1.3 | Indicate the type of emissions: Particulate Volatile Organic<br>Nitrogen Oxides Sulphur Oxides<br>Other | |
| A.1.4 | Are there national or other air emission or ambient air quality standards in force in this area? | Yes<br>No |
| A.1.5 | Will the project comply with these standards? | Yes No |
| A.1.6 | Is Wind Speed and Direction Data available for the Project Vicinity? | Yes<br>No |
| A.1.7 | List significant environmental components downwind of the project site.<br>…………………………………………………………………………………………<br>…………………………………………………………………………………………<br>………………………………………………………………… | |
| **A.2 Noise and Vibrations** | | |
| A.2.1 | Will the project increase ambient noise levels in the vicinity, or produce significant vibrations which will adversely affect adjacent areas? | Yes<br>No<br>Unknown |
| A.2.2 | During what phase of the project? Construction . Operation | |
| A.2.3 | Are there national or other noise standards in force in this area? | Yes<br>No |
| A.2.4 | Will the project comply with these standards? | Yes No |
| A.2.5 | Describe the nature of the noise or vibrations: | |

## Appendix A (Continued)

| No. | QUESTION | | RESPONSE |
|---|---|---|---|
| A.2.6 | List environmental components in the vicinity which are particularly sensitive to adverse impacts of noise and/or vibrations: | | |
| | **A.3 Water Quality** | | |
| A.3.1 | Does/did the project discharge waste water or effluents (including used cooling water) to the environment? | | Yes<br>No<br>Unknown |
| A.3.2 | During what phase of the project? Construction | | Operation |
| A.3.3 | Describe the major contaminants (including heat) in the waste water: | | |
| A.3.4 | Are there national or other effluent or ambient water quality standards in force in this area? | | Yes<br>No |
| A.3.5 | Did (and will) the project comply with these standards? | | Yes No |
| A.3.6 | Will there be any on-site treatment of waste water? | | Yes<br>No |
| A.3.7 | Describe the Treatment: | | |
| A.3.8 | From the site, discharge will be to: | River, Stream or other Surface Fresh Water Body<br>The Sea<br>Ground Water | |
| A.3.9 | Describe the baseline (before project) quality of water in the receiving fresh water body:<br>Relatively Uncontaminated Contaminated<br>Polluted Naturally Poor Quality<br>…………………………………………………………………………….... | | |
| A.3.10 | List present or potential uses of the receiving fresh water body:<br>Public Water Supply Village Water Supply<br>Fishing Transportation<br>Recreation Other | | |

**Appendix A (Continued)**

| No. | QUESTION | RESPONSE |
|---|---|---|
| A.3.11 | Describe the baseline (before project) quality of sea water:<br>Relatively Uncontaminated Contaminated<br>Polluted Naturally Poor Quality | |
| A.3.12 | List present or potential sea water uses: Transportation<br>Recreation Fishing<br>Desalination Cooling<br>Other | |
| A.3.13 | Indicate the nature of the ground water: fresh, brackish, saline | |
| A.3.14 | Describe baseline (before project) ground water quality:<br>Relatively Uncontaminated Contaminated<br>Polluted Naturally Poor Quality | |
| A.3.15 | Is ground water presently extracted for water supply or other use?<br>Yes No Potential for Future Use | |
| A.3.16 | Does/did the project restrict water use? | Yes<br>No |
| A.3.17 | Describe the ways in which the use was/will be restricted: | |
| | **A.4 Flooding** | |
| A.4.1 | Will the project discharge waste water and/or increased runoff into the area drainage system, or in any way alter this drainage system? | Yes<br>No<br>Unknown |
| A.4.2 | During what phase of the project? Construction | Operation |
| A.4.3 | Describe the nature of the increased flow or the changes to the drainage system: | |
| A.4.4 | Is the project site (or its environs) prone to flooding? | Yes No |
| A.4.5 | Are there regulations or design guidelines governing increased discharges to the drainage system, or changes to the system? | Yes<br>No |
| A.4.6 | Will the project comply with these regulations/guidelines? | Yes No |
| | **A.5 Slope Instability and Erosion** | |
| A.5.1 | Will the project involve clearing or earthwork that has the potential to induce slope instability or increase erosion? | Yes<br>No<br>Unknown |
| A.5.2 | Describe the clearing and/or earthwork, and indicate whether temporary or permanent in nature: | |
| A.5.3 | Is the soil/geology of the project site susceptible to land slippage or erosion?<br>Yes No Unknown | |
| A.5.4 | Are there regulations or guidelines governing land clearance or earthwork *viz-a-viz* slope instability or erosion? | Yes<br>No |

**Appendix A (Continued)**

| No. | QUESTION | RESPONSE |
|---|---|---|
| A.5.5 | Will the project comply with these regulations/guidelines? | Yes No |
| | **A.6 Solid Waste** | |
| A.6.1 | Will the project generate solid waste? | Yes<br>No<br>Unknown |
| A.6.2 | During what phase of the project? Construction Operation | |
| A.6.3 | Are there national or other policies or regulations pertaining to the collection and disposal of solid waste (including recycling)? | Yes<br>No |
| A.6.4 | Will the project comply with the policy/regulations? Yes | No |
| A.6.5 | Will there be any on-site processing of solid waste? | Yes No |
| A.6.6 | Describe the processing and final disposal of solid waste or residue: | |
| A.7.1 | Is the project vicinity prone to any natural hazards other than Flooding (see A.4) or Land Slippage (see A.5)? | Yes<br>No<br>Unknown |
| A.7.2 | Indicate the types of hazards: Hurricanes Earthquakes Volcanos<br>Other……………………………………………………… | |
| A.7.3 | Are there zoning or setback standards or other design regulations or guidelines, governing construction in areas subject to these hazards? | Yes<br>No |
| A.7.4 | Will the project comply with the policy/regulations? Yes No | |

| No. | QUESTION | RESPONSE |
|---|---|---|
| | **B. ECOLOGY** | |
| | **B.1 Ecosystems in the Project Vicinity** | |
| B.1.1 | Indicate below the types of ecosystems which are found in the vicinity of the project, and their baseline (before project) condition: | |

## Appendix A (Continued)

| No. | QUESTION | RESPONSE |
|---|---|---|
| | Pristine / Moderate Human Influence / Severe Human Influence<br>Aquatic<br>Terrestrial<br>Wetland<br>Coastal<br>Marine | |
| B.1.2 | Will any areas of natural ecosystem or established ecological areas be cleared or otherwise damaged/destroyed as part of the project? | Yes<br>No |
| B.1.3 | List the ecosystems/areas to be changed, including acreage: | |
| B.1.4 | Are any of the ecosystems/areas listed in B.1.3 unique or of special significance/importance? | Yes<br>No |
| B.1.5 | List the unique/significant ecosystems/areas: | |
| B.2.1 | Are there any Rare or Endangered Species known or reasonably inferred to inhabit the areas to be affected by the project? | Yes<br>No<br>Unknown |
| B.2.2 | List the Rare/Endangered Species: | |
| B.2.3 | Are there national or other policies or regulations governing protection of Rare/Endangered Species? | Yes<br>No |
| B.2.4 | Will the project comply with these instruments? Yes No | |
| B.3.1 | Are there any Migratory Species known or reasonably inferred to visit the areas to be affected by the project? | Yes<br>No<br>Unknown |
| B.3.2 | List the Migratory Species: | |
| B.3.3 | Are there any policies, regulations or practices governing maintenance of migratory routes or protection of Migratory Species? | Yes<br>No |
| B.3.4 | Will the project comply with these instruments? Yes No | |
| B.4.1 | Will the project involve the direct introduction of new species, or the importation of material through which new | Yes, direct<br>Yes, indirect |

**Appendix A (Continued)**

| No. | QUESTION | RESPONSE |
|---|---|---|
| | species may be inadvertently introduced? | No |
| B.4.2 | During what phase of the project? Construction | Operation |
| B.4.3 | List the species to be introduced directly: | |
| B.4.4 | Is there a national or other policy or regulation pertaining to the direct introduction of new species? | Yes<br>No |
| B.4.5 | Will the project comply with the policy/regulation? Yes | No |
| B.4.6 | List the types of species for which concerns about inadvertent introduction arise: | |
| B.4.7 | Will there be any processing of the material in question to minimize the possibility of inadvertent introduction of new species? | Yes<br>No |
| B.4.8 | Describe the proposed processing: | |
| B.5.1 | Are there Pest Plants or Animals or Disease Vectors in the project site and vicinity? | Yes<br>No<br>Unknown |
| B.5.2 | List the Pest Species or Disease Vectors: | |
| B.5.3 | Is there a program to control or eradicate these Pests or Vectors? | Yes<br>No |
| B.5.4 | Will the project affect this program? Enhance Retard | |
| B.5.5 | Will the project create conditions which would increase the incidence of existing Pests/Vectors, or encourage new Pests/Vectors? | Yes<br>No<br>Unknown |
| B.5.6 | Will any steps be taken under the project to control/eradicate these Pests or Vectors? | Yes<br>No |
| B.5.7 | Describe the proposed steps: | |
| B.6.1 | Are there any present or proposed Parks or Protected Areas in the project site and vicinity? | Yes<br>No<br>Unknown |
| B.6.2 | Name the Park(s) or Protected Area(s): | |
| B.6.3 | Does the project involve any intrusion into or use of the Park/Protected Area? | Yes<br>No |

**Appendix A (Continued)**

| No. | QUESTION | RESPONSE |
|---|---|---|
| B.6.4 | Describe the intrusion/use, and state whether during construction or operation phase: | |
| B.6.5 | Are there policies and regulations governing activities in the parks/protected areas? | Yes<br>No |
| B.6.6 | Does the project conform to the policies/regulations? Yes | No |
| B.6.7 | Will the project create/facilitate unauthorized access into the Park/Protected Area? | Yes<br>No<br>Unknown |
| B.6.8 | Will any steps be taken under the project to minimize unauthorized access to the Park Protected Area? | Yes<br>No |
| B.6.9 | Describe the proposed steps: | |

| | QUESTION | RESPONSE |
|---|---|---|
| | **C. HUMAN ENVIRONMENT** | |
| | **C.1 Land Use Zoning** | |
| C.1.1 | Is there a system of Land Use Zoning or other Designation of Land Use in force in this Country? | Yes<br>No |
| C.1.2 | Does the proposed project conform to the present Land Use Zoning/Designation? | Yes<br>No |
| C.1.3 | Has Rezoning/Redesignation been obtained? Yes | No |
| | **C.2 Relocation of Residents** | |
| C.2.1 | Will the implementation of the project result in the Displacement of Residents? | Yes<br>No |
| C.2.2 | Are there national or other policies or regulations governing the Acquisition of Land and the Displacement of Residents? | Yes<br>No |
| C.2.3 | Will the project comply with these instruments? Yes | No |
| | **C.3 Agriculture** | |
| C.3.1 | Is the site now used for agriculture, or is it abandoned agricultural land? | Yes<br>No |
| C.3.2 | Describe the site in terms of soil capability and crops presently grown: | |
| C.3.3 | Is there a national or other policy or practice relevant to the conversion of agricultural land to other use, or the acquisition of agricultural land? | Yes<br>No |
| C.3.4 | Will the project comply with this policy/practice? Yes | No |

**Appendix A (Continued)**

| | QUESTION | RESPONSE |
|---|---|---|
| **C.4 Conflict with Other Users** | | |
| C.4.1 | Will this project conflict with any existing land use in the general area? | Yes<br>No<br>Unknown |
| C.4.2 | Has the project been structured to minimize such conflict? | Yes<br>No |
| C.4.3 | Describe the relevant elements of the project structure: | |
| **C.5 Competition for Natural Resources** | | |
| C.5.1 | Are there exploitable Natural Resources in the general area? | Yes<br>No<br>Unknown |
| C.5.2 | List the Natural Resources: | |
| C.5.3 | Will the project restrict access by others (particularly traditional users) to these natural resources? | Yes<br>No |
| C.5.4 | During which phase? Construction Operation | |
| C.5.5 | Has the project been structured to minimize or compensate for the loss of access to resources? | Yes<br>No |
| C.5.6 | Describe the relevant elements of the project structure: | |
| **C.6 Employment: Jobs** | | |
| C.6.1 | Will the project result in the creation of any jobs? | Yes<br>No<br>Unknown |
| C.6.2 | Estimate/give the level of employment at each phase of the project:<br>Construction:____________ Operation____________ | |
| C.6.3 | Will local residents be re-trained to take up the new jobs? Yes No | |
| C.6.4 | Will the project result in the loss of any jobs? | Yes<br>No<br>Unknown |
| C.6.5 | Are there national or other policies or practices related to the compensation of displaced workers? | Yes<br>No |
| C.6.6 | Will displaced workers be compensated in accordance with these policies/practices? Yes No | |
| C.6.7 | Will displaced workers be re-trained to take up any new jobs mentioned in C.6.2, above? Yes No | |
| **C.7 Employment Biases** | | |
| C.7.1 | Will any particular group be ineligible for all or part of the New Jobs to be Created by the Project? | Yes<br>No<br>Unknown |

**Appendix A (Continued)**

| | QUESTION | RESPONSE |
|---|---|---|
| C.7.2 | Indicate groups who will be ineligible for employment?<br>Young Workers (age 15 to 24) Older Workers (over age 50)<br>Women The Handicapped<br>Other | |
| C.7.3 | Has the project been structured to minimize or compensate for such biases? | Yes<br>No |
| C.7.4 | Describe the relevant elements of the project structure: | |
| **C.8 Local Area Economy** | | |
| C.8.1 | Will the project cause significant changes in the distribution of income? | Yes<br>No<br>Unknown |
| C.8.2 | During what phase of the project? Construction Operation | |
| C.8.3 | List major changes of concern: | |
| C.8.4 | Will the project cause significant changes in property values? | Yes<br>No<br>Unknown |
| C.8.5 | During what phase of the project? Construction | Operation |
| C.8.6 | List major changes of concern: | |
| C.8.7 | Will workers and their families be moved into the area as a result of this project? | Yes<br>No<br>Unknown |
| C.8.8 | Estimate the number of new residents at each phase of the project:<br>Construction:____________ Operation____________ | |
| **C.9 Services and Utilities** | | |
| C.9.1 | Are there deficiencies in the Services or Utilities in this area? | Yes<br>No<br>Unknown |
| C.9.2 | Which Utility/Service? ☐ Water Supply ☐ Electricity<br>☐ Telephone ☐ Public Transport ☐ Health Service<br>☐ Police Service ☐ Fire Service<br>☐ Other…………………………………………………………………………… | |
| C.9.3 | Will this project's demand for Services and Utilities exceed their Local Area Capacity? | Yes<br>No<br>Unknown |

**Appendix A (Continued)**

| | QUESTION | RESPONSE |
|---|---|---|
| C.9.4 | Which Utility/Service? Water Supply Electricity<br>Telephone Public Transport Health Service<br>Police Service Fire Service<br>Other………………………………………………………………………………… | |
| C.9.5 | During what phase of the project? Construction | Operation |
| C.9.6 | Has the project been designed to minimize demand on scarce utilities or services? | Yes<br>No |
| C.9.7 | Describe the relevant elements of the project structure: | |
| C.9.8 | Will the project bring new services or utilities into the area?<br>Yes No Unknown | |
| | **C.10 Indigenous People and Special Groups** | |
| C.10.1 | Are there communities of Indigenous People or other Special Social Groups in the project vicinity? | Yes<br>No<br>Unknown |
| C.10.2 | List the Communities/Groups: | |
| C.10.3 | Will the project cause significant changes in the social patterns of these communities/groups? | Yes<br>No<br>Unknown |
| C.10.4 | List major changes of concern: | |
| C.10.5 | Has the project been structured to minimize or compensate for such changes? | Yes<br>No |
| C.10.6 | Describe the relevant elements of the project structure: | |
| C.10.7 | Have these groups been consulted in Project Planning and/or Decision-making? Yes No Unknown | |
| | **C.11 Sites of Special Interest** | |
| C.11.1 | Are there any Sites of Special Interest (Cultural, Religious, Aesthetic, etc) at the project site or in the vicinity? | Yes<br>No<br>Unknown |
| C.11.2 | List the Sites: | |
| C.11.3 | Does the project involve any intrusion into or other change to the Site? | Yes<br>No |

**Appendix A (Continued)**

| | QUESTION | RESPONSE |
|---|---|---|
| C.11.4 | Describe the intrusion/change, and state whether during construction or operation phase: | |
| C.11.5 | Are there policies and regulations governing use and protection of Sites of Special Interest? | Yes<br>No |
| C.11.6 | Does the project conform to the policies/regulations? Yes | No |
| C.11.7 | Has the project been structured to minimize or compensate for such intrusion/changes? | Yes<br>No |
| C.11.8 | Describe the relevant elements of the project structure: | |
| **C.12 Public Safety** | | |
| C.12.1 | Will the project increase the risk of Accidents, or otherwise affect Public Safety? | Yes<br>No<br>Unknown |
| C.12.2 | Describe the factors of increased risk to the public, and state whether during construction or operation phase: | |
| C.12.3 | Are there adequate medical/other facilities in the area to respond to accidents or emergencies related to this project? Yes No | |
| C.12.4 | Have any measures been included in the design of the Project to supplement existing medical/other emergency facilities? | Yes<br>No |
| C.12.5 | Describe these measures: | |
| C.12.6 | Is there an emergency response plan for this area? | Yes<br>No |
| C.12.7 | Describe any ways in which the project is incompatible or inconsistent with the Emergency Response Plan: | |
| **C.13 Hazardous Material and Waste** | | |
| C.13.1 | Will the project use hazardous material or generate hazardous waste? | Yes<br>No<br>Unknown |
| C.13.2 | During what phase of the project? Construction Operation | |
| C.13.3 | Indicate the type of Hazardous Waste: Corrosive Toxic Radioactive Flammable Other……………………………………………………………. ............................. | |

**Appendix A (Continued)**

| | QUESTION | RESPONSE |
|---|---|---|
| C.13.4 | Are there national or other policies or regulations pertaining to the handling of hazardous material or the collection and disposal of hazardous waste? | Yes<br>No |
| C.13.5 | Will the project comply with these policies/regulations? Yes No | |
| C.13.6 | Will there be on-site processing of hazardous substances or hazardous waste? Yes No | |
| C.13.7 | Describe any processing, on-site treatment and disposal of Hazardous Waste or Hazardous Material: | |
| **C.14 Risk Factors** | | |
| C.14.1 | Are there any project components which would contribute to Man-made Risk? | Yes<br>No<br>Unknown |
| C.14.2 | List Project Components which contribute to Man-made Risk:<br>Pressure Vessels/Lines Storage and Use of Toxics<br>Storage and use of Flammable and/or Explosive Substances<br>Other ........................................................................................................ | |
| C.14.3 | Are there national or other regulations or guidelines pertaining to the design, construction and/or operation of these components? | Yes<br>No |
| C.14.4 | Will the project comply with these policies/regulations? Yes No | |
| C.14.5 | Will any steps be taken to minimize the risk? Yes No | |
| C.14.6 | Describe the steps: | |

| D. OTHER ENVIRONMENTAL CONCERNS | |
|---|---|
| D.1 | List and describe any other environmental concerns, specific to this project, which were not covered by this Checklist: |

**Appendix A (Continued)**

**PART 3: REGULATORY FRAMEWORK**

***Note: Y = yes, N = no, and U = unknown***

| | QUESTION | Y | N | U | COMMENT |
|---|---|---|---|---|---|
| A | Does this Project conform to National or Local Plans or Policies? | | | | |
| B | Has the Project received any level of Planning Approval? | | | | |
| C | Are there Local Laws or Regulations which govern projects of this type? | | | | |
| D | Under these Laws/Regulations, is an Environmental Impact Assessment required for this Project? | | | | |
| E | Has any Environmental Study been done for this Project? | | | | |
| F | Are there Laboratory Facilities available Locally to undertake Testing for Environmental Parameters? | | | | |

**Appendix A (Continued)**

**Impact / screening questions**

| Impact Questions |
|---|
| 1. Will there be a large change in environmental conditions? |
| 2. Will new features be out-of-scale with the existing environment? |
| 3. Will the impact be unusual in the area, or particularly complex? |
| 4. Will the impact extend over a large area? |
| 5. Will there be any potential for transboundary impacts? |
| 6. Will many people be affected? |
| 7. Will many receptors of other types (e.g., flora and fauna, businesses, facilities) be affected? |
| 8. Will valuable or scarce features or resources be affected? |
| 9. Is there a risk that documented environmental standards or criteria will be exceeded? |
| 10. Is there a risk that protected sites, areas, features, or species will be affected? |
| 11. Is there a high probability of the impact occurring? |
| 12. Will the impact continue for a long time? |
| 13. Will the impact be permanent rather than temporary? |
| 14. Will the impact be continuous rather than intermittent? |
| 15. If the impact is intermittent, will it be more frequent than rare? |
| 16. Will the impact be irreversible? |
| 17. Will it be difficult to avoid, reduce, repair or compensate for the impact? |
| 18. Will the proportion of a biological population or community affected be so large that its viability may be compromised? |
| 19. Will the proportion of an ecosystem affected be so large that ecosystem function may be affected, particularly if the affected system is critical habitat? |
| 20. Will the capability of a protected natural ecosystem be compromised or put at unacceptable risk? |
| 21. Will there be considerable public concern over the impacts that will occur? |

**Appendix A (Continued)**

| Screening Questions |
|---|
| 1. Will construction, operation or decommissioning of the project involve actions that will cause physical changes in the locality (e.g., changes in topography, land use, water bodies, etc.)? |
| 2. Will construction or operation of the project use natural resources (e.g., land, water, construction materials, energy, etc.), especially any resources that are non-renewable and/or in short supply? |
| 3. Will the project involve use, storage, transport, handling or production of substances or materials which could be harmful to human health or the environment or raise concerns about actual or perceived risks to human health? |
| 4. Will the project produce solid wastes during construction, operation or decommissioning? |
| 5. Will the project release pollutants or any hazardous, toxic or noxious substances to air? |
| 6. Will the project cause noise and vibration or release of light, heat, energy or electromagnetic radiation? |
| 7. Will the project lead to risks of contamination of land or water from releases of pollutants into the environment (e.g., releases to the ground, surface waters, groundwater, coastal waters, the sea, etc.)? |
| 8. Will there be any risk of accidents during construction or operation of the project that could affect human health or the environment? |
| 9. Will the project result in social changes (e.g., demography, traditional lifestyles, employment)? |
| 10. Does the potential exist for cumulative impacts in combination with other existing, planned or consequential projects/activities in the locality? |
| 11. Are there any areas on or around the location that are protected under international or national or local legislation for their ecological, landscape, cultural or other value that could be affected by the project? |
| 12. Are there any other areas on or around the location that are important or sensitive for reasons of their ecology (e.g., wetlands, watercourses or water bodies, the coastal zone, mountains, forests or woodlands) that could be affected by the project? |
| 13. Are there areas on or around the location that are used by protected, important or sensitive species of fauna or flora (e.g., for breeding, nesting, foraging, resting, overwintering, migration) that could be affected by the project? |
| 14. Are there aquatic components (e.g., inland, coastal, marine or underground waters) on or around the location that could be affected by the project? |
| 15. Are there any areas or features of high landscape or scenic value on or around the location that could be affected by the project? |
| 16. Are there any routes or facilities on or around the location that are used by the public for access to recreation or other facilities that could be affected by the project? |
| 17. Are there any transport routes on or around the location that are susceptible to congestion or that cause environmental problems that could be affected by the project? |
| 18. Is the project in a location where it is likely to be highly visible to many people? |
| 19. Are there any areas or features of historic or cultural importance on or around the |

**Appendix A (Continued)**

| |
|---|
| location that could be affected by the project? |
| 20. Is the project located in a previously undeveloped area where there will be loss of greenfield land? |
| 21. Are there existing land uses on or around the location (e.g., homes, gardens, other private property, industry, commerce, recreation, public open space, community facilities, agriculture, forestry, tourism, mining or quarrying) that could be affected by the project? |
| 22. Are there any plans for future land uses on or around the location that could be affected by the project? |
| 23. Are there any areas on or around the location that are densely populated or built-up, which could be affected by the project? |
| 24. Are there any areas on or around the location that are occupied by sensitive land uses (e.g., hospitals, schools, places of worship, community facilities) that could be affected by the project? |
| 25. Are there any areas on or around the location that contain important, high quality or scarce resources (e.g., groundwater, surface waters, forestry, agriculture, fisheries, tourism, minerals) that could be affected by the project? |
| 26. Are there any areas on or around the location that are already subject to pollution or environmental damage (e.g., where existing legal environmental standards are exceeded) that could be affected by the project? |
| 27. Is the project location susceptible to earthquakes, subsidence, landslides, erosion, flooding or extreme adverse climatic conditions (e.g., temperature inversions, fog, severe winds) that could cause the project to present environmental problems? |
| 28. Will construction, operation or decommissioning of the project involve actions that will cause physical changes in the locality (e.g., changes in topography, land use, water bodies, etc.)? |

## Appendix B: Raw Results of Social Components by Location

### Iwokrama, Guyana

### Questionnaire Results

Date: **March 2009** Site Name: **Iwokrama, Guyana**

Sex of Respondent: **Female – 10 Male - 6**
**TOTAL RESPONDENTS = 16**

**Demographic Information**
Q1. What is your age?

**Table B1** Female responses to Q1 (Iwokrama).

| Age range | Frequency |
|---|---|
| 26-35 | 6 |
| 36-50 | 4 |

**Table B2** Male responses to Q1 (Iwokrama).

| Age range | Frequency |
|---|---|
| 36-50 | 5 |
| 51-65 | 1 |

**Table B3** Overall responses to Q1 (Iwokrama).

| Age range | Frequency |
|---|---|
| 26-35 | 6 |
| 36-50 | 9 |
| 51-65 | 1 |

Q2. Do you live in this area?
Female
Yes – 8 No – 2

Male
Yes – 2 No – 4

Overall
Yes – 10 No - 6

Q3. Do you work in this area?
Overall
Yes – 16 No - 0

**Appendix B (Continued)**

Q4. What is your occupation?

**Table B4** Female responses to Q4 (Iwokrama).

| Occupation | Frequency |
|---|---|
| Waitress | 1 |
| Kitchen staff | 5 |
| Tour guide | 2 |
| Housekeeper | 2 |

**Table B5** Male responses to Q4 (Iwokrama).

| Occupation | Frequency |
|---|---|
| Mechanic | 1 |
| Tour guide | 1 |
| Driver | 1 |
| Boat personnel | 2 |
| Handyman | 1 |

**Table B6** Overall responses to Q4 (Iwokrama).

| Occupation | Frequency |
|---|---|
| Waitress | 1 |
| Kitchen staff | 5 |
| Housekeeper | 2 |
| Mechanic | 1 |
| Tour guide | 3 |
| Driver | 1 |
| Boat personnel | 2 |
| Handyman | 1 |

Q5. How many people live in your household (including yourself)?
Female responses: 3, 7, 3, 5, 3, 6, 9, 5, 6, 4 Average = 5.1

Male responses: 4, 4, 5, 1, 4, 3 Average = 3.5

Overall average = 4.5

**Appendix B (Continued)**

Q6. How many people in your household are in the following age groups?

**Table B7** Female responses to Q6 (Iwokrama).

| No. of adults in household | Frequency |
|---|---|
| 2 | 3 |
| 3 | 3 |
| 4 | 2 |
| 5 | 2 |

**Table B8** Male responses to Q6 (Iwokrama).

| No. of adults in household | Frequency |
|---|---|
| 1 | 1 |
| 2 | 2 |
| 3 | 3 |

**Table B9** Overall responses to Q6 (Iwokrama).

| No. of adults in household | Frequency |
|---|---|
| 1 | 1 |
| 2 | 5 |
| 3 | 6 |
| 4 | 2 |
| 5 | 2 |

Q7. What is the highest level of formal education in your household?

**Table B10** Female responses to Q7 (Iwokrama).

| Highest formal education level | Frequency |
|---|---|
| Elementary/primary school | 3 |
| Some high school | 1 |
| High school grad (CXC) | 6 |

## Appendix B (Continued)

**Table B11** Male responses to Q7 (Iwokrama).

| Highest formal education level | Frequency |
|---|---|
| Elementary/primary school | 1 |
| Some high school | 1 |
| High school grad (CXC) | 3 |
| High school grad (CXC) with vocational studies (i.e. trade) | 1 |

**Table B12** Overall responses to Q7 (Iwokrama).

| Highest formal education level | Frequency |
|---|---|
| Elementary/primary school | 4 |
| Some high school | 2 |
| High school grad (CXC) | 9 |
| High school grad (CXC) with vocational studies (i.e. trade) | 1 |

Q8. What is your annual household income in Guyanese dollars?

**Table B13** Female responses to Q8 (Iwokrama).

| No. of adults in household | Responses (G$) | Average (G$) |
|---|---|---|
| 2 | 95000/50000/87000 | 77333 |
| 3 | 102000/120000/80000 | 100667 |
| 4 | 120000/155000 | 137500 |
| 5 | 200000/170000 | 185000 |
| | Female household avg.= | 125125 |

**Table B14** Male responses to Q8 (Iwokrama).

| No. of adults in household | Responses (G$) | Average (G$) |
|---|---|---|
| 1 | 40000 | 40000 |
| 2 | 175000/190000 | 182500 |
| 3 | 70000/87000/90000 | 82333 |
| | Male household avg.= | 101611 |

Overall household average = G$113368

(Exchange rate in March 2009: US$1=G$200)

**Appendix B (Continued)**

**Water and Sanitation**

Q9. What is (are) the source(s) of all the 'potable' water in your home?

**Table B15** Female responses to Q9 (Iwokrama).

| Source of potable water | Frequency |
|---|---|
| Rain | 4 |
| Rain and river water | 4 |
| Piped water | 2* |

*These both respondents do not live in the Iwokrama area.

**Table B16** Male responses to Q9 (Iwokrama).

| Source of potable water | Frequency |
|---|---|
| Rain | 1 |
| Rain and piped water | 2* |
| Rain and river water | 1 |
| Piped water | 2* |

*These four respondents do not live in the Iwokrama area.

**Table B17** Overall responses to Q9 (Iwokrama).

| Source of potable water | Frequency |
|---|---|
| Rain | 5 |
| Rain and piped water | 2* |
| Rain and river water | 5 |
| Piped water | 4* |

*These six respondents do not live in the Iwokrama area.

Q10. Do you pre-treat this water in any way before consumption?
Female
Yes – 2 No – 8

Male
Yes – 0 No – 6

Overall
Yes – 2 No – 14

Q10a. If yes: What pre-treatment step(s) do you do?
Female responses:

1. Boil river water if it is used for drinking.
2. Filtered with cloth of fine pore.

**Appendix B (Continued)**

Q11. How is your sewage disposed of?

**Table B18** Female responses to Q11 (Iwokrama).

| Sewage disposal method | Frequency |
|---|---|
| On-lot septic tank | 2* |
| Out house/latrine | 8 |

* These both respondents do not live in the Iwokrama area.

**Table B19** Male responses to Q12 (Iwokrama).

| Sewage disposal method | Frequency |
|---|---|
| On-lot septic tank | 4* |
| Out house/latrine | 2 |

* These four respondents do not live in the Iwokrama area.

**Table B20** Overall responses to Q11 (Iwokrama).

| Sewage disposal method | Frequency |
|---|---|
| On-lot septic tank | 6* |
| Out house/latrine | 10 |

*These six respondents do not live in the Iwokrama area.

Q12. How is your grey water (eg. laundry water, bath water, kitchen water) disposed of? All respondents (n=16; Female + Male) disposed of their grey water by letting it out on the soil.

**Tourism and Ecotourism**

Q13. Do you or any member(s) of your household work within the tourism industry?
Female
Yes – 9 No – 1

Male
Yes – 6 No – 0

Overall
Yes – 15 No – 1

Q13-1. If yes: How many?

**Table B21** Female responses to Q13-1 (Iwokrama).

| No. of household members in tourism | Frequency |
|---|---|
| 0 | 1 |
| 1 | 8 |
| 2 | 1 |

## Appendix B (Continued)

**Table B22** Male responses to Q13-1 (Iwokrama).

| No. of household members in tourism | Frequency |
|---|---|
| 1 | 6 |

**Table B23** Overall responses to Q13-1 (Iwokrama).

| No. of household members in tourism | Frequency |
|---|---|
| 0 | 1 |
| 1 | 14 |
| 2 | 1 |

Q13-2. What are their occupations within the industry and how long have they been employed in this industry?
Q13-3. What are their highest levels of formal education?

**Table B24** Female responses to Q13-2 and Q13-3 (Iwokrama)

| Occupation | Years in tourism | Highest level of education |
|---|---|---|
| Tour guide | 2 | High school grad (CXC) |
| Waitress | 4 | Some high school |
| Housekeeper | 3.5 | Elementary/primary |
| Kitchen staff | 5 | Elementary/primary |
| Kitchen staff | 5 | Elementary/primary |
| Kitchen staff | 3 | Elementary/primary |
| Kitchen staff | 4 | High school grad (CXC) |
| Tour guide | 2 | High school grad (CXC) |
| Housekeeper* | 10 | Elementary/primary |
| Boat personnel* | 10 | Elementary/primary |

*These two entries are from a single household.

## Appendix B (Continued)

**Table B25** Male responses to Q13-2 and Q13-3 (Iwokrama)

| Occupation | Years in tourism | Highest level of education |
|---|---|---|
| Mechanic | 4 | High school grad (CXC) with vocational studies |
| Tour guide | 8 | High school grad (CXC) |
| Boat personnel | 7 | Elementary/primary |
| Boat personnel | 6 | Elementary/primary |
| Handyman | 4 | Elementary/primary |
| Driver | 7 | Elementary/primary |

Q14. Do you or any members of your household utilize available tourism or ecotourism products and services within Guyana?
Female
Yes – 3 No – 7

Male
Yes – 0 No – 6

Overall
Yes – 3 No – 13

Q14-1. If yes: Which products and service are typically utilized?
Q14-2. Where in Guyana are these activities typically undertaken?
Q14-3. What influences the choice of location?
Q14-4. How often are these activities undertaken?

**Table B26** Female responses to Q14-1, -2, -3 and -4 (Iwokrama).

| | | |
|---|---|---|
| Q14-1 | River | River |
| Q14-2 | North Rupununi | Fairview area |
| Q14-3 | In place where they live | Fastest means of transport |
| Q14-4 | Weekly | Once or twice daily |
| Q14-1 | Forest | |
| Q14-2 | Fairview area | |
| Q14-3 | Variety of wildlife to hunt /close to house | |
| Q14-4 | Daily in hunting season | |

**Appendix B (Continued)**

Q14-5. If no: Why not?
Female responses:
1. Too expensive to do those activities.
2. These are expensive to utilize.
3. Lived in area most of life, done and seen it all while growing up.
4. Too busy working several jobs.
5. Expensive.
6. Very costly in Georgetown.
7. I get enough during work.

Male responses:
1. Too expensive.
2. Not really sure why.
3. Grew up in the area and enjoyed all the products and services in youth.
4. Cannot afford the luxury of tourism.
5. Family members are not interested in tourism for entertainment.
6. Too busy to enjoy the industry.

**Table B27** Overall responses to Q14-5 (Iwokrama).

| Common reason | Frequency |
|---|---|
| Expensive | 7 |
| Busy | 2 |
| Not interested | 3 |
| Uncertain | 1 |

Q15. Will you support the development of more tourism/ecotourism activities within your community?
Female
Yes – 9 No – 1

Male
Yes – 6 No – 0

Overall
Yes – 15 No – 1

Q15-1. If yes or no: Why are you of that view?
Female "Yes" responses:
1. This will help the development of the Lethem area.
2. To increase the revenue of the area.
3. Creation of more jobs and the opportunities for young women especially.
4. To give more [job] opportunities to young people.
5. That will bring more national attention to the Rupununi area.
6. To give more opportunities to villagers so that they don't feel they have to go to the capital to look for work.
7. Good revenue earner for Fairview.

**Appendix B (Continued)**

8. Creation of more job opportunities.
9. To highlight the area nationally – more infrastructure eventually through government.

Female “No” response:

1. There is already a lot [of tourism related activities] in Georgetown that is not saturated.

Male “Yes” responses:

1. It will allow Guyana to be more marketable on a global perspective.
2. Provide more jobs.
3. Will provide more employment for young people – help them turn away from crime.
4. Hopefully will lead to development inclusive of better school and health facilities.
5. Good way to increase revenue in the area.
6. With my experience in the industry I may be able to find a job where I live.

**Table B28** Overall responses to Q15-1 (Iwokrama).

| "Yes" theme | Frequency |
|---|---|
| Development of area | 3 |
| Revenue | 3 |
| Job creation | 6 |
| Increased recognition of communities | 3 |

Q15-2.If yes: What types of activities do you think is best suited for your community?

**Table B29** Female responses to Q15-2 (Iwokrama).

| Area | Suggested activity |
|---|---|
| Lethem | Bird watching<br>Development of nature trails for bird watching |
| Georgetown | Sailing or kiting<br>Uncertain |
| Rupununi | Development of a butterfly farm like in Fairview |
| Fairview | Annual heritage festival |

## Appendix B (Continued)

**Table B30** Male responses to Q15-2 (Iwokrama).

| Area | Suggested activity |
|---|---|
| Lethem | Training persons to be bird watching guides |
| Fairview | Guided tours of ruins |
| | Rafting in rapids |
| | Boat trips |
| | Fishing experience - especially using traditional Indian methods |
| | Craft store to give more opportunities to young women |
| Rupununi | Organic farming to support IIC's growing food needs |
| | Craft with natural materials for sale |
| | Outdoor camping |

Q16. Do you think your community is equipped with all the necessary amenities and/or infrastructure to allow for further development of the industry in your community?
All respondents (n=16; Female + Male) agreed their communities had all the necessary amenities.
Q16-1. If no: What do you think is first needed?
Not applicable.

## Appendix B (Continued)

**ENVIRONMENTAL CHECKLIST FOR PAST, PRESENT AND FUTURE PROJECTS ONSITE: SCREENING AND SCOPING**

*Checklist completed during interview with the Director of Resource Management and Training at IIC (March 2009). The responses are* ***bolded*** *in the Checklist.*

**PART 1: PROJECT DESCRIPTION**

Name of Concerned Project: **Expansion of ecotourism researcher and staff accommodations at Iwokrama.**

Project Elements: On site dwelling for some ecotourism workers and researchers. One or two buildings are expected to be constructed to the exact specifications of the ones that currently exist.

Project Phase: The construction of one or two staff accommodation buildings (to house 20 persons each) are to be constructed within the next one to four years (2010-2013). This may require clearing of a strip of forest parallel to the planned accommodations area. Note that this includes expansion of bathroom and toilet facilities.

Project Location: Iwokrama International Centre for Rain Forest Conservation and Development (IIC), Iwokrama, Guyana, South America

List Raw Material, Chemicals and Fuel stored on site:
During Construction: Diesel for generator and equipment, gasoline for equipment, timber for wooden walls

During Operation: Diesel for generator

**Appendix B (Continued)**

## PART 2: CHECKLIST OF POTENTIAL IMPACTS

| No. | QUESTION | RESPONSE |
|---|---|---|
| **A. PHYSICAL ENVIRONMENT** | | |
| **A.1 Air Quality** | | |
| A.1.1 | Will the project produce air emissions (directly or indirectly)? | **Yes**<br>No<br>Unknown |
| A.1.2 | During what phase of the project? **Construction** **Operation** | |
| A.1.3 | Indicate the type of emissions: Particulate **Volatile Organic** **Nitrogen Oxides** **Sulphur Oxides**<br>Other: **Burning of fossil fuels.** | |
| A.1.4 | Are there national or other air emission or ambient air quality standards in force in this area? | **Yes**<br>No |
| A.1.5 | Will the project comply with these standards? **Yes** No | |
| A.1.6 | Is Wind Speed and Direction Data available for the Project Vicinity? | **Yes**<br>No |
| A.1.7 | List significant environmental components downwind of the project site.<br>**Esequibo river** | |
| **A.2 Noise and Vibrations** | | |
| A.2.1 | Will the project increase ambient noise levels in the vicinity, or produce significant vibrations which will adversely affect adjacent areas? | Yes<br>**No**<br>Unknown |
| A.2.2 | During what phase of the project? **N/A** Construction Operation | |
| A.2.3 | Are there national or other noise standards in force in this area? | Yes<br>**No** |
| A.2.4 | Will the project comply with these standards? **N/A** Yes No | |
| A.2.5 | Describe the nature of the noise or vibrations: **Generator use and power tools** | |
| A.2.6 | List environmental components in the vicinity which are particularly sensitive to adverse impacts of noise and/or vibrations: **None** | |
| **A.3 Water Quality** | | |

**Appendix B (Continued)**

| | | |
|---|---|---|
| A.3.1 | Does/will the project discharge waste water or effluents (including used cooling water) to the environment? | Yes<br>**No**<br>Unknown |
| A.3.2 | During what phase of the project? **N/A** Construction Operation | |
| A.3.3 | Describe the major contaminants (including heat) in the waste water: **Grey water from bathrooms and black water from toilets are sent to septic system.** | |
| A.3.4 | Are there national or other effluent or ambient water quality standards in force in this area? | **Yes**<br>No |
| A.3.5 | Did (and will) the project comply with these standards? **Yes** No | |
| A.3.6 | Will there be any on-site treatment of waste water? | Yes<br>**No** |
| A.3.7 | Describe the Treatment: **N/A** | |
| A.3.8 | From the site, discharge will be to: **N/A** | River, Stream or other Surface Fresh Water Body<br>The Sea<br>Ground Water |
| A.3.9 | Describe the baseline (before project) quality of water in the receiving fresh water body:<br>**Relatively Uncontaminated** Contaminated<br>Polluted Naturally Poor Quality | |
| A.3.10 | List present or potential uses of the receiving fresh water body:<br>Public Water Supply **Village Water Supply**<br>**Fishing** **Transportation** **Recreation**<br>Other ........................................................................................................ | |
| A.3.11 | Describe the baseline (before project) quality of sea water: **N/A**<br>Relatively Uncontaminated Contaminated<br>Polluted Naturally Poor Quality | |
| A.3.12 | List present or potential sea water uses: Transportation<br>Recreation Fishing Desalination Cooling<br>Other: **N/A** | |
| A.3.13 | Indicate the nature of the ground water: **fresh** brackish saline | |
| A.3.14 | Describe baseline (before project) ground water quality:<br>**Relatively Uncontaminated** Contaminated<br>Polluted Naturally Poor Quality | |
| A.3.15 | Is ground water presently extracted for water supply or other use?<br>Yes **No** Potential for Future Use | |
| A.3.16 | Does/did the project restrict water use? | Yes<br>**No** |
| A.3.17 | Describe the ways in which the use was/will be restricted: **N/A** | |
| | **A.4 Flooding** | |
| A.4.1 | Will the project discharge waste water and/or increased runoff into the area drainage system, or in any way alter this drainage system? | Yes<br>**No**<br>Unknown |

**Appendix B (Continued)**

| | | |
|---|---|---|
| | | Yes |
| A.4.2 | During what phase of the project? **N/A** Construction Operation | |
| A.4.3 | Describe the nature of the increased flow or the changes to the drainage system: **Increased flows are not anticipated as all rain will be harvested and the buildings will be put on stilts so that the footprint is not made impervious due to this project.** | |
| A.4.4 | Is the project site (or its environs) prone to flooding? Yes **No** | |
| A.4.5 | Are there regulations or design guidelines governing increased discharges to the drainage system, or changes to the system? | **Yes**<br>No |
| A.4.6 | Will the project comply with these regulations/guidelines? **Yes** No | |
| **A.5 Slope Instability and Erosion** | | |
| A.5.1 | Will the project involve clearing or earthwork that has the potential to induce slope instability or increase erosion? | Yes<br>**No**<br>Unknown |
| A.5.2 | Describe the clearing and/or earthwork, and indicate whether temporary or permanent in nature: **The clearing will be a narrow strip of 'forest' which will remain permanent. This land is flat and does not present slope issues.** | |
| A.5.3 | Is the soil/geology of the project site susceptible to land slippage or erosion? Yes **No** Unknown | |
| A.5.4 | Are there regulations or guidelines governing land clearance or earthwork *viz-a-viz* slope instability or erosion? | **Yes**<br>No |
| A.5.5 | Will the project comply with these regulations/guidelines? **Yes** No | |
| **A.6 Solid Waste** | | |
| A.6.1 | Will the project generate solid waste? | **Yes**<br>No<br>Unknown |
| A.6.2 | During what phase of the project? **Construction** **Operation** | |
| A.6.3 | Are there national or other policies or regulations pertaining to the collection and disposal of solid waste (including recycling)? | **Yes**<br>No |
| A.6.4 | Will the project comply with the policy/regulations? **Yes** No | |
| A.6.5 | Will there be any on-site processing of solid waste? **Yes** No | |
| A.6.6 | Describe the processing and final disposal of solid waste or residue: **All solid waste that cannot be composted on site or recycled will be taken to approved dump / landfill sites.** | |
| A.7.1 | Is the project vicinity prone to any natural hazards other than Flooding (see A.4) or Land Slippage (see A.5)? | Yes<br>**No**<br>Unknown |

## Appendix B (Continued)

| | | |
|---|---|---|
| | | Yes |
| A.7.2 | Indicate the types of hazards: Hurricanes Earthquakes Volcanoes<br>Other: **N/A** | |
| A.7.3 | Are there zoning or setback standards or other design regulations or guidelines, governing construction in areas subject to these hazards? **N/A** | Yes<br>No |
| A.7.4 | Will the project comply with the policy/regulations? **Yes** No | |

| No. | QUESTION | RESPONSE |
|---|---|---|
| | **B. ECOLOGY** | |
| | **B.1 Ecosystems in the Project Vicinity** | |
| B.1.1 | Indicate below the types of ecosystems which are found in the vicinity of the project, and their baseline (before project) condition: | |
| | Pristine / Moderate Human Influence / Severe Human Influence<br>Aquatic: X (Pristine)<br>Terrestrial: X (Moderate Human Influence)<br>Wetland – **N/A**<br>Coastal – **N/A**<br>Marine – **N/A** | |
| B.1.2 | Will any areas of natural ecosystem or established ecological areas be cleared or otherwise damaged/destroyed as part of the project? | **Yes**<br>No |
| B.1.3 | List the ecosystems/areas to be changed, including acreage: **Forest <1 acre** | |
| B.1.4 | Are any of the ecosystems/areas listed in B.1.3 unique or of special significance/importance? | Yes<br>**No** |
| B.1.5 | List the unique/significant ecosystems/areas: **N/A** | |
| B.2.1 | Are there any Rare or Endangered Species known or reasonably inferred to inhabit the areas to be affected by the project? | Yes<br>**No**<br>Unknown |
| B.2.2 | List the Rare/Endangered Species: **N/A**<br>**Since the forested area is so close to the area that is currently inhabited, most of the forest is secondary growth there is not much unique fauna usually close to human development.** | |
| B.2.3 | Are there national or other policies or regulations governing protection of Rare/Endangered Species? | **Yes**<br>No |
| B.2.4 | Will the project comply with these instruments? **Yes** No | |
| B.3.1 | Are there any Migratory Species known or reasonably | Yes |

**Appendix B (Continued)**

| No. | QUESTION | RESPONSE |
|---|---|---|
| | | **No**<br>Unknown |
| B.3.2 | List the Migratory Species: **N/A** | |
| B.3.3 | Are there any policies, regulations or practices governing maintenance of migratory routes or protection of Migratory Species? | **Yes**<br>No |
| B.3.4 | Will the project comply with these instruments? **N/A** Yes No | |
| B.4.1 | Will the project involve the direct introduction of new species, or the importation of material through which new species may be inadvertently introduced? | Yes, direct<br>Yes, indirect<br>**No** |
| B.4.2 | During what phase of the project? **N/A** Construction Operation | |
| B.4.3 | List the species to be introduced directly: **N/A** | |
| B.4.4 | Is there a national or other policy or regulation pertaining to the direct introduction of new species? | Yes<br>**No** |
| B.4.5 | Will the project comply with the policy/regulation? **N/A** Yes No | |
| B.4.6 | List the types of species for which concerns about inadvertent introduction arise: **N/A** | |
| B.4.7 | Will there be any processing of the material in question to minimize the possibility of inadvertent introduction of new species? **N/A** | Yes<br>No |
| B.4.8 | Describe the proposed processing: **N/A** | |
| B.5.1 | Are there Pest Plants or Animals or Disease Vectors in the project site and vicinity? | **Yes**<br>No<br>Unknown |
| B.5.2 | List the Pest Species or Disease Vectors: **Mosquitoes** | |
| B.5.3 | Is there a program to control or eradicate these Pests or Vectors? | Yes<br>**No** |
| B.5.4 | Will the project affect this program? **N/A** Enhance Retard | |
| B.5.5 | Will the project create conditions which would increase the incidence of existing Pests/Vectors, or encourage new Pests/Vectors? | Yes<br>**No**<br>Unknown |
| B.5.6 | Will any steps be taken under the project to control/eradicate these Pests or Vectors? | **Yes**<br>No |
| B.5.7 | Describe the proposed steps: **During operation personnel will be encouraged to use mosquito nets while asleep. Also all entry ways will have screened doors and all windows will be screened also.** | |
| B.6.1 | Are there any present or proposed Parks or Protected Areas in the project site and vicinity? | **Yes**<br>No<br>Unknown |

**Appendix B (Continued)**

| No. | QUESTION | RESPONSE |
|---|---|---|
| B.6.2 | Name the Park(s) or Protected Area(s): **Iwokrama Preserve (where the actual project will be undertaken)** | |
| B.6.3 | Does the project involve any intrusion into or use of the Park/Protected Area? | **Yes**<br>No |
| B.6.4 | Describe the intrusion/use, and state whether during construction or operation phase: **During both phases as the project lies in the protected area. Entire project description applies here.** | |
| B.6.5 | Are there policies and regulations governing activities in the parks/protected areas? | **Yes**<br>No |
| B.6.6 | Does the project conform to the policies/regulations? **Yes** | No |
| B.6.7 | Will the project create/facilitate unauthorized access into the Park/Protected Area? | Yes<br>**No**<br>Unknown |
| B.6.8 | Will any steps be taken under the project to minimize unauthorized access to the Park Protected Area? | Yes<br>**No** |
| B.6.9 | Describe the proposed steps: **N/A** | |

| No. | QUESTION | RESPONSE |
|---|---|---|
| | **C. HUMAN ENVIRONMENT** | |
| | **C.1 Land Use Zoning** | |
| C.1.1 | Is there a system of Land Use Zoning or other Designation of Land Use in force in this Country? | **Yes**<br>No |
| C.1.2 | Does the proposed project conform to the present Land Use Zoning/Designation? | **Yes**<br>No |
| C.1.3 | Has Rezoning/Redesignation been obtained? **N/A** Yes | No |
| | **C.2 Relocation of Residents** | |
| C.2.1 | Will the implementation of the project result in the Displacement of Residents? | Yes<br>**No** |
| C.2.2 | Are there national or other policies or regulations governing the Acquisition of Land and the Displacement of Residents? | **Yes**<br>No |
| C.2.3 | Will the project comply with these instruments? **Yes** | No |
| | **C.3 Agriculture** | |
| C.3.1 | Is the site now used for agriculture, or is it abandoned agricultural land? | **Yes**<br>No |
| C.3.2 | Describe the site in terms of soil capability and crops presently grown: **Trees for timber** | |

**Appendix B (Continued)**

| No. | QUESTION | RESPONSE |
|---|---|---|
| C.3.3 | Is there a national or other policy or practice relevant to the conversion of agricultural land to other use, or the acquisition of agricultural land? | **Yes**<br>No |
| C.3.4 | Will the project comply with this policy/practice? **Yes** No | |
| | **C.4 Conflict with Other Users** | |
| C.4.1 | Will this project conflict with any existing land use in the general area? | Yes<br>**No**<br>Unknown |
| C.4.2 | Has the project been structured to minimize such conflict? **N/A** | Yes<br>No |
| C.4.3 | Describe the relevant elements of the project structure: **N/A** | |
| | **C.5 Competition for Natural Resources** | |
| C.5.1 | Are there exploitable Natural Resources in the general area? | **Yes**<br>No<br>Unknown |
| C.5.2 | List the Natural Resources: **Forest with biodiversity: Timber, fauna** | |
| C.5.3 | Will the project restrict access by others (particularly traditional users) to these natural resources? | Yes<br>**No** |
| C.5.4 | During which phase? **N/A** Construction Operation | |
| C.5.5 | Has the project been structured to minimize or compensate for the loss of access to resources? **N/A** | Yes<br>No |
| C.5.6 | Describe the relevant elements of the project structure: **N/A** | |
| | **C.6 Employment: Jobs** | |
| C.6.1 | Will the project result in the creation of any jobs? | **Yes**<br>No<br>Unknown |
| C.6.2 | Estimate/give the level of employment at each phase of the project:<br>Construction: **5** Operation: **10** | |
| C.6.3 | Will local residents be re-trained to take up the new jobs? **Yes** No | |
| C.6.4 | Will the project result in the loss of any jobs? | Yes<br>**No**<br>Unknown |
| C.6.5 | Are there national or other policies or practices related to the compensation of displaced workers? | **Yes**<br>No |
| C.6.6 | Will displaced workers be compensated in accordance with these policies/practices? **N/A** Yes No | |
| C.6.7 | Will displaced workers be re-trained to take up any new jobs mentioned in C.6.2, above? **N/A** Yes No | |
| | **C.7 Employment Biases** | |
| C.7.1 | Will any particular group be ineligible for all or part of the New Jobs to be Created by the Project? | Yes<br>No<br>Unknown |

**Appendix B (Continued)**

| No. | QUESTION | RESPONSE |
|---|---|---|
| C.7.2 | Indicate groups who will be ineligible for employment?<br>Young Workers (age 15 to 24) Older Workers (over age 50)<br>Women The Handicapped<br>Other: **Young worker below 18 and older workers above 65.** | |
| C.7.3 | Has the project been structured to minimize or compensate for such biases? | Yes<br>**No** |
| C.7.4 | Describe the relevant elements of the project structure: **The operations of Iwokrama have to stick within these stipulations to ensure that the laws of Guyana are adhered to.** | |
| | **C.8 Local Area Economy** | |
| C.8.1 | Will the project cause significant changes in the distribution of income? | Yes<br>**No**<br>Unknown |
| C.8.2 | During what phase of the project? **N/A** Construction Operation | |
| C.8.3 | List major changes of concern: **N/A** | |
| C.8.4 | Will the project cause significant changes in property values? | Yes<br>**No**<br>Unknown |
| C.8.5 | During what phase of the project? **N/A** Construction Operation | |
| C.8.6 | List major changes of concern: **N/A** | |
| C.8.7 | Will workers and their families be moved into the area as a result of this project? | Yes<br>**No**<br>Unknown |
| C.8.8 | Estimate the number of new residents at each phase of the project:<br>Construction: **0** Operation: 0 | |
| | **C.9 Services and Utilities** | |
| C.9.1 | Are there deficiencies in the Services or Utilities in this area? | **Yes**<br>No<br>Unknown |
| C.9.2 | Which Utility/Service? **Water Supply** **Electricity**<br>Telephone **Public Transport** **Health Service**<br>**Police Service** **Fire Service**<br>Other: **IIC has to be self sufficient to run its day to day operations.** | |
| C.9.3 | Will this project's demand for Services and Utilities exceed their Local Area Capacity? | Yes<br>**No**<br>Unknown |
| C.9.4 | Which Utility/Service? Water Supply Electricity<br>Telephone Public Transport Health Service<br>Police Service Fire Service<br>Other: **N/A** | |

**Appendix B (Continued)**

| No. | QUESTION | RESPONSE |
|---|---|---|
| C.9.5 | During what phase of the project? **N/A** Construction | Operation |
| C.9.6 | Has the project been designed to minimize demand on scarce utilities or services? | **Yes**<br>No |
| C.9.7 | Describe the relevant elements of the project structure: **Solar energy will be harnessed to provide some of the energy for the running of the electrical needs during construction and operation.** | |
| C.9.8 | Will the project bring new services or utilities into the area?<br>Yes **No** Unknown | |
| | **C.10 Indigenous People and Special Groups** | |
| C.10.1 | Are there communities of Indigenous People or other Special Social Groups in the project vicinity? | **Yes**<br>No<br>Unknown |
| C.10.2 | List the Communities/Groups: **Fair View Village – Makushi native Indian (Amerindian)** | |
| C.10.3 | Will the project cause significant changes in the social patterns of these communities/groups? | Yes<br>**No**<br>Unknown |
| C.10.4 | List major changes of concern: **N/A** | |
| C.10.5 | Has the project been structured to minimize or compensate for such changes? **N/A** | Yes<br>No |
| C.10.6 | Describe the relevant elements of the project structure:<br>**N/A** | |
| C.10.7 | Have these groups been consulted in Project Planning and/or Decision-making? **Yes** No Unknown | |
| | **C.11 Sites of Special Interest** | |
| C.11.1 | Are there any Sites of Special Interest (Cultural, Religious, Aesthetic, etc) at the project site or in the vicinity? | **Yes**<br>No<br>Unknown |
| C.11.2 | List the Sites: **Esequibo river** | |
| C.11.3 | Does the project involve any intrusion into or other change to the Site? | Yes<br>**No** |
| C.11.4 | Describe the intrusion/change, and state whether during construction or operation phase: **N/A** | |
| C.11.5 | Are there policies and regulations governing use and protection of Sites of Special Interest? | **Yes**<br>No |
| C.11.6 | Does the project conform to the policies/regulations? **Yes** | No |
| C.11.7 | Has the project been structured to minimize or compensate for such intrusion/changes? | **Yes**<br>No |
| C.11.8 | Describe the relevant elements of the project structure: **N/A** | |

**Appendix B (Continued)**

| No. | QUESTION | RESPONSE |
|---|---|---|
| **C.12 Public Safety** | | |
| C.12.1 | Will the project increase the risk of Accidents, or otherwise affect Public Safety? | Yes<br>**No**<br>Unknown |
| C.12.2 | Describe the factors of increased risk to the public, and state whether during construction or operation phase: **N/A** | |
| C.12.3 | Are there adequate medical/other facilities in the area to respond to accidents or emergencies related to this project? Yes **No** | |
| C.12.4 | Have any measures been included in the design of the Project to supplement existing medical/other emergency facilities? | **Yes**<br>No |
| C.12.5 | Describe these measures: **Some on site personnel/staff are trained in first aid and will be present during the construction phase.** | |
| C.12.6 | Is there an emergency response plan for this area? | **Yes**<br>No |
| C.12.7 | Describe any ways in which the project is incompatible or inconsistent with the Emergency Response Plan: **N/A** | |
| **C.13 Hazardous Material and Waste** | | |
| C.13.1 | Will the project use hazardous material or generate hazardous waste? | Yes<br>**No**<br>Unknown |
| C.13.2 | During what phase of the project? **N/A** Construction Operation | |
| C.13.3 | Indicate the type of Hazardous Waste: Corrosive Toxic Radioactive Flammable<br>Other: **N/A** | |
| C.13.4 | Are there national or other policies or regulations pertaining to the handling of hazardous material or the collection and disposal of hazardous waste? | **Yes**<br>No |
| C.13.5 | Will the project comply with these policies/regulations? **Yes** No | |
| C.13.6 | Will there be on-site processing of hazardous substances or hazardous waste? Yes **No** | |
| C.13.7 | Describe any processing, on-site treatment and disposal of Hazardous Waste or Hazardous Material: **N/A** | |
| **C.14 Risk Factors** | | |
| C.14.1 | Are there any project components which would contribute to Man-made Risk? | Yes<br>**No**<br>Unknown |
| C.14.2 | List Project Components which contribute to Man-made Risk:<br>Pressure Vessels/Lines Storage and Use of Toxics<br>Storage and use of Flammable and/or Explosive Substances<br>Other: **N/A** | |
| C.14.3 | Are there national or other regulations or guidelines | Yes |

**Appendix B (Continued)**

| No. | QUESTION | RESPONSE |
|---|---|---|
| | | No |
| C.14.4 | Will the project comply with these policies/regulations? **N/A** Yes No | |
| C.14.5 | Will any steps be taken to minimize the risk? **Yes** No | |
| C.14.6 | Describe the steps: **Having only trained persons are allowed to undertake work and those doing so will only be allowed to enter into activity if they are properly equipped with protective gear.** | |

| D. OTHER ENVIRONMENTAL CONCERNS | |
|---|---|
| D.1 | List and describe any other environmental concerns, specific to this project, which were not covered by this Checklist: **None** |

**PART 3: REGULATORY FRAMEWORK**

***Note: Y = yes, N = no, and U = unknown***

| | QUESTION | Y | N | U | COMMENT |
|---|---|---|---|---|---|
| A | Does this Project conform to National or Local Plans or Policies? | X | | | |
| B | Has the Project received any level of Planning Approval | X | | | Internally from the Board of Trustees |
| C | Are there Local Laws or Regulations which govern projects of this type? | X | | | |
| D | Under these Laws/Regulations, is an Environmental Impact Assessment required for this Project? | | X | | Iwokrama Act gives autonomy to Board of Trustees for decision making. |
| E | Has any Environmental Study been done for this Project? | X | | | |
| F | Are there Laboratory Facilities available Locally to undertake Testing for Environmental Parameters? | X | | | |

**Appendix B (Continued)**

## EVALUATION OF POSSIBLE ENVIRONMENTAL IMPACT OF FUTURE PROPOSED PROJECT AT IWOKRAMA, GUYANA

| **Impact Questions** |
|---|
| 1. Will there be a large change in environmental conditions? **No** |
| 2. Will new features be out-of-scale with the existing environment? **No** |
| 3. Will the impact be unusual in the area, or particularly complex? **No** |
| 4. Will the impact extend over a large area? **No – 1 acre maximum** |
| 5. Will there be any potential for transboundary impacts? **No** |
| 6. Will many people be affected? **No** |
| 7. Will many receptors of other types (e.g., flora and fauna, businesses, facilities) be affected? **No** |
| 8. Will valuable or scarce features or resources be affected? **Yes – a bit of the adjacent forest may have to be cut** |
| 9. Is there a risk that documented environmental standards or criteria will be exceeded? **No** |
| 10. Is there a risk that protected sites, areas, features, or species will be affected? **No** |
| 11. Is there a high probability of the impact occurring? **No** |
| 12. Will the impact continue for a long time? **No** |
| 13. Will the impact be permanent rather than temporary? **No** |
| 14. Will the impact be continuous rather than intermittent? **Intermittent** |
| 15. If the impact is intermittent, will it be more frequent than rare? **No** |
| 16. Will the impact be irreversible? **No** |
| 17. Will it be difficult to avoid, reduce, repair or compensate for the impact? **No** |
| 18. Will the proportion of a biological population or community affected be so large that its viability may be compromised? **No** |
| 19. Will the proportion of an ecosystem affected be so large that ecosystem function may be affected, particularly if the affected system is critical habitat? **No** |
| 20. Will the capability of a protected natural ecosystem be compromised or put at unacceptable risk? **No** |
| 21. Will there be considerable public concern over the impacts that will occur? **No** |

**Appendix B (Continued)**

| Screening Questions |
|---|
| 29. Will construction, operation or decommissioning of the project involve actions that will cause physical changes in the locality (e.g., changes in topography, land use, water bodies, etc.)? **No – exact replica of buildings already on site to be placed in close proximity** |
| 30. Will construction or operation of the project use natural resources (e.g., land, water, construction materials, energy, etc.), especially any resources that are non-renewable and/or in short supply? **Yes – land area** |
| 31. Will the project involve use, storage, transport, handling or production of substances or materials which could be harmful to human health or the environment or raise concerns about actual or perceived risks to human health? **No** |
| 32. Will the project produce solid wastes during construction, operation or decommissioning? **Yes – during construction and operation** |
| 33. Will the project release pollutants or any hazardous, toxic or noxious substances to air? **No** |
| 34. Will the project cause noise and vibration or release of light, heat, energy or electromagnetic radiation? **Yes – during construction** |
| 35. Will the project lead to risks of contamination of land or water from releases of pollutants into the environment (e.g., releases to the ground, surface waters, groundwater, coastal waters, the sea, etc.)? **No** |
| 36. Will there be any risk of accidents during construction or operation of the project that could affect human health or the environment? **Yes** |
| 37. Will the project result in social changes (e.g., demography, traditional lifestyles, employment)? **Yes – project is due to increased promotion of the Ecotourism product and so there will be need for more staff** |
| 38. Does the potential exist for cumulative impacts in combination with other existing, planned or consequential projects/activities in the locality? **No** |
| 39. Are there any areas on or around the location that are protected under international or national or local legislation for their ecological, landscape, cultural or other value that could be affected by the project? **No** |
| 40. Are there any other areas on or around the location that are important or sensitive for reasons of their ecology (e.g., wetlands, watercourses or waterbodies, the coastal zone, mountains, forests or woodlands) that could be affected by the project? **Yes – forest** |
| 41. Are there areas on or around the location that are used by protected, important or sensitive species of fauna or flora (e.g., for breeding, nesting, foraging, resting, migration) that could be affected by the project? **Yes - forest** |
| 42. Are there aquatic components (e.g., inland, coastal, marine or underground waters) on or around the location that could be affected by the project? **No** |
| 43. Are there any areas or features of high landscape or scenic value on or around the location that could be affected by the project? **No** |
| 44. Are there any routes or facilities on or around the location that are used by the public for access to recreation or other facilities that could be affected by the project? **No** |

**Appendix B (Continued)**

| Screening Questions |
|---|
| 45. Are there any transport routes on or around the location that are susceptible to congestion or that cause environmental problems that could be affected by the project? **No** |
| 46. Is the project in a location where it is likely to be highly visible to many people? **No** |
| 47. Are there any areas or features of historic or cultural importance on or around the location that could be affected by the project? **No** |
| 48. Is the project located in a previously undeveloped area where there will be loss of greenfield land? **Potentially yes** |
| 49. Are there existing land uses on or around the location (e.g., homes, gardens, other private property, industry, commerce, recreation, public open space, community facilities, agriculture, forestry, tourism, mining or quarrying) that could be affected by the project? **No** |
| 50. Are there any plans for future land uses on or around the location that could be affected by the project? **No** |
| 51. Are there any areas on or around the location that are densely populated or built-up, which could be affected by the project? **No** |
| 52. Are there any areas on or around the location that are occupied by sensitive land uses (e.g., hospitals, schools, places of worship, community facilities) that could be affected by the project? **No** |
| 53. Are there any areas on or around the location that contain important, high quality or scarce resources (e.g., groundwater, surface waters, forestry, agriculture, fisheries, tourism, minerals) that could be affected by the project? **No** |
| 54. Are there any areas on or around the location that are already subject to pollution or environmental damage (e.g., where existing legal environmental standards are exceeded) that could be affected by the project? **No – none visible or recorded** |
| 55. Is the project location susceptible to earthquakes, subsidence, landslides, erosion, flooding or extreme adverse climatic conditions (e.g., temperature inversions, fog, severe winds) that could cause the project to present environmental problems? **No** |

**Appendix B (Continued)**

**Greencastle, Jamaica**

**Questionnaire Results**

Date: **August 2008** Site Name: **Greencastle, Jamaica**

Sex of Respondent: **Female – 5** **Male - 3**
**TOTAL RESPONDENTS = 8**

**Demographic Information**
Q1. What is your age?

**Table B31** Female responses to Q1 (Greencastle).

| Age range | Frequency |
|---|---|
| 36-50 | 3 |
| 51-65 | 2 |

**Table B32** Male responses to Q1 (Greencastle).

| Age range | Frequency |
|---|---|
| 36-50 | 2 |
| 51-65 | 1 |

**Table B33** Overall responses to Q1 (Greencastle).

| Age range | Frequency |
|---|---|
| 36-50 | 5 |
| 51-65 | 3 |

Q2. Do you live in this area?
All respondents (n=8, Female + Male) live in the area.

Q3. Do you work in this area?
All respondents (n=8, Female + Male) work in the area.

Q4. What is your occupation?

**Table B34** Female responses to Q4 (Greencastle).

| Occupation | Frequency |
|---|---|
| Maid/housekeeper | 4 |
| Office assistant/tour guide | 1 |

## Appendix B (Continued)

**Table B35** Male responses to Q4 (Greencastle).

| Occupation | Frequency |
|---|---|
| Driver/mechanic | 1 |
| Handyman | 2 |

**Table B36** Overall responses to Q4 (Greencastle).

| Occupation | Frequency |
|---|---|
| Maid/housekeeper | 4 |
| Office assistant/tour guide | 1 |
| Driver/mechanic | 1 |
| Handyman | 2 |

Q5. How many people live in your household (including yourself)?
Female responses: 4, 3, 4, 2, 3     Average = 3.8

Male responses: 5, 3, 1     Average = 3.0

Overall average = 3.125

Q6. How many people in your household are in the following age groups?

**Table B37** Female responses to Q6 (Greencastle).

| No. of adults in household | Frequency |
|---|---|
| 2 | 3 |
| 3 | 2 |

**Table B38** Male responses to Q6 (Greencastle).

| No. of adults in household | Frequency |
|---|---|
| 3 | 2 |
| 1 | 1 |

**Table B39** Overall responses to Q6 (Greencastle).

| No. of adults in household | Frequency |
|---|---|
| 1 | 1 |
| 2 | 3 |
| 3 | 4 |

**Appendix B (Continued)**

Q7. What is the highest level of formal education in your household?

**Table B40** Female responses to Q7 (Greencastle).

| Highest formal education level | Frequency |
|---|---|
| Some high school | 2 |
| High school grad (CXC) | 2 |
| High school grad (CXC) with vocational studies (i.e. trade) | 1 |

**Table B41** Male responses to Q7 (Greencastle).

| Highest formal education level | Frequency |
|---|---|
| Elementary/primary school | 1 |
| Some high school | 1 |
| High school grad (A level) | 1 |

**Table B42** Overall responses to Q7 (Greencastle).

| Highest formal education level | Frequency |
|---|---|
| Elementary/primary school | 3 |
| Some high school | 1 |
| High school grad (CXC) | 2 |
| High school grad (CXC) with vocational studies (i.e. trade) | 1 |
| High school grad (A level) | 1 |

Q8. What is your annual household income in Jamaican dollars?

**Table B43** Female responses to Q8 (Greencastle).

| No. of adults in household | Responses (J$) | Average (J$) |
|---|---|---|
| 2 | 60000/55000/70000 | 61666 |
| 3 | 60000/95000 | 77500 |
| | Female household avg.= | 69583 |

**Table B44**: Male responses to Q8 (Greencastle).

| No. of adults in household | Responses (G$) | Average (G$) |
|---|---|---|
| 1 | 26000 | 26000 |
| 3 | 140000/85000 | 112500 |
| | Male household avg.= | 69250 |

Overall household average = G$69417

(Exchange rate in August 2008: US$1=J$65)

**Appendix B (Continued)**

**Water and Sanitation**

Q9. What is (are) the source(s) of all the 'potable' water in your home?

**Table B45** Female responses to Q9 (Greencastle).

| Source of potable water | Frequency |
|---|---|
| Piped water | 5 |

**Table B46** Male responses to Q9 (Greencastle).

| Source of potable water | Frequency |
|---|---|
| Rain and piped water | 1 |
| Piped water | 2 |

**Table B47** Overall responses to Q9 (Greencastle).

| Source of potable water | Frequency |
|---|---|
| Rain and piped water | 1 |
| Piped water | 7 |

Q10. Do you pre-treat this water in any way before consumption?
No respondent (n=8, Female + Male) does any pre-treatment.

Q10a. If yes: What pre-treatment step(s) do you do?
Not applicable

Q11. How is your sewage disposed of?

**Table B48** Female responses to Q11 (Greencastle).

| Sewage disposal method | Frequency |
|---|---|
| On-lot septic tank | 3 |
| Out house/latrine | 2 |

**Table B49** Male responses to Q11 (Greencastle).

| Sewage disposal method | Frequency |
|---|---|
| On-lot septic tank | 3 |

**Table B50** Overall responses to Q11 (Greencastle).

| Sewage disposal method | Frequency |
|---|---|
| On-lot septic tank | 6 |
| Out house/latrine | 2 |

Q12. How is your grey water (eg. laundry water, bath water, kitchen water) disposed of?
All respondents (n=8; Female + Male) disposed of their grey water by letting it out on the soil.

**Appendix B (Continued)**

**Tourism and Ecotourism**

Q13. Do you or any member(s) of your household work within the tourism industry?
Female
Yes – 3 No – 2

Male
Yes – 2 No – 1

Overall
Yes – 5 No – 3

Q13a. If yes: How many?

**Table B51** Female responses to Q13a (Greencastle).

| No. of household members in tourism | Frequency |
|---|---|
| 0 | 2 |
| 1 | 3 |

**Table B52** Male responses to Q13a (Greencastle).

| No. of household members in tourism | Frequency |
|---|---|
| 0 | 1 |
| 1 | 2 |

**Table B53** Overall responses to Q13a (Greencastle).

| No. of household members in tourism | Frequency |
|---|---|
| 0 | 3 |
| 1 | 5 |

Q13-2. What are their occupations within the industry and how long have then been employed in this industry?
Q13-3. What are their highest levels of formal education?

**Table B54** Female responses to Q13-3 (Greencastle).

| Occupation | Years in tourism | Highest level of education |
|---|---|---|
| Office assistant/tour guide | 5 | Some high school |
| Maid/housekeeper | 3 | High school grad (CXC) |
| Maid/housekeeper | 5 | Elementary/primary |

## Appendix B (Continued)

**Table B55** Male responses to Q13-3 (Greencastle).

| Occupation | Years in tourism | Highest level of education |
|---|---|---|
| Driver/mechanic | 8 | High school grad (A level) |
| Handyman | 7 | Some elementary/primary |

Q14. Do you or any members of your household utilize available tourism or ecotourism products and services within Guyana?
Female
Yes – 2 No – 3

Male
Yes – 0 No – 3

Overall
Yes – 2 No – 6

Q14-1. If yes: Which products and service are typically utilized?
Q14-2. Where in Guyana are these activities typically undertaken?
Q14-3. What influences the choice of location?
Q14-4. How often are these activities undertaken?

**Table B56** Female responses to Q14-1, -2, -3 and -4 (Greencastle).

| | | |
|---|---|---|
| Q14-1 | Beach | Beach |
| Q14-2 | Jack's bay and Fisherman's beach | Fisherman's beach |
| Q14-3 | [No response] | Free to use unlike Jack's bay |
| Q14-4 | Once weekly | Every week |

Q14-5. If no: Why not?
Female responses:
1. Too busy.
2. Too old for such activities.
3. No time for those activities – too busy.

Male responses:
1. Does not have time for those activities.
2. No time between jobs.
3. Busy with work, etc.

**Table B57** Overall responses to Q14-1, -2, -3 and -4 (Greencastle).

| Common reason | Frequency |
|---|---|
| Busy | 5 |
| Old age | 1 |

**Appendix B (Continued)**

Q15. Will you support the development of more tourism/ecotourism activities within your community?
All respondents (n=8; Female + Male) said they will support the development of tourism/ecotourism activities in their communities.

Q15-1. If yes or no: Why are you of that view?
Female "Yes" responses:

1. More development of the area – better schools, etc. eventually.
2. So younger people can find jobs in the area and not have to go to capital in search of work.
3. It will bring more business to the area.
4. Better/more competitive job opportunities.
5. To give job opportunities to locals.

Male "Yes" responses:

1. To give more opportunities to younger people to find employment in the area.
2. If it begins to thrive, the government might fix the roads.
3. It will bring more development to the area.

**Table B58** Overall responses to Q15-1 (Greencastle).

| "Yes" theme | Frequency |
|---|---|
| Development of area | 2 |
| Job creation | 5 |
| Business diversity in the area | 1 |

Q15-2.If yes: What types of activities do you think is best suited for your community?
Female suggested activities:

1. Water sports for the sea.
2. Kayaking.
3. Anything that utilizes the sea around Robin's Bay.
4. Yearly community festival.
5. Opening a craft store with handicrafts made by the local community.

Male suggested activities:

1. Night time beach bar.
2. Coastal water sports.
3. Not sure.

Q16. Do you think your community is equipped with all the necessary amenities and/or infrastructure to allow for further development of the industry in your community?
All respondents (n=8; Female + Male) agreed their communities had all the necessary amenities.

Q16-1. If no: What do you think is first needed?
Not applicable.

**Appendix B (Continued)**

**ENVIRONMENTAL CHECKLIST FOR PAST, PRESENT AND FUTURE PROJECTS ONSITE: SCREENING AND SCOPING**

**PART 1: PROJECT DESCRIPTION**

*Checklist completed during interview with the Managing Director of GCTSC in collaboration with Manager of Greencastle Estate (August 2008). Their responses are* ***bolded*** *in the Checklist.*

Name of Concerned Project: **Expansion of Low Impact Ecotourism on Greencastle's 1600 acres.**

Project Elements: Construction of 5-10 boutique suites to add to the Greencastle ecotourism product. This is expected to take place alongside current agricultural production (orchids, cattle, coconut oil) by lessees, ecotourism and on site dwelling for some workers.

Project Phase: The construction of the boutique suites are expected to take place within the next 5 years (2010-2014).

Project Location: Greencastle Estate, St. Mary, Jamaica, West Indies

List Raw Material, Chemicals and Fuel stored on site:

During Construction: Sand, gravel, welding fuel, gasoline for equipment, cement, timber, vehicle oil

During Operation: Cooking gas

**Appendix B (Continued)**

**PART 2: CHECKLIST OF POTENTIAL IMPACTS**

| No. | QUESTION | RESPONSE |
|---|---|---|
| **A. PHYSICAL ENVIRONMENT** | | |
| **A.1 Air Quality** | | |
| A.1.1 | Will the project produce air emissions (directly or indirectly)? | **Yes**<br>No<br>Unknown |
| A.1.2 | During what phase of the project? Construction | Operation |
| A.1.3 | Indicate the type of emissions: **Particulate** Volatile Organic<br>Nitrogen Oxides Sulphur Oxides<br>Other **Dust from aggregate and wood work**. | |
| A.1.4 | Are there national or other air emission or ambient air quality standards in force in this area? | **Yes**<br>No |
| A.1.5 | Will the project comply with these standards? | **Yes** No |
| A.1.6 | Is Wind Speed and Direction Data available for the Project Vicinity? | **Yes**<br>No |
| A.1.7 | List significant environmental components downwind of the project site:<br>**Forested area, river network and sea.** | |
| **A.2 Noise and Vibrations** | | |
| A.2.1 | Will the project increase ambient noise levels in the vicinity, or produce significant vibrations which will adversely affect adjacent areas? | **Yes**<br>No<br>Unknown |
| A.2.2 | During what phase of the project? **Construction** | Operation |
| A.2.3 | Are there national or other noise standards in force in this area? | Yes<br>**No** |
| A.2.4 | Will the project comply with these standards? **N/A** Yes | No |
| A.2.5 | Describe the nature of the noise or vibrations: **Since the suites are going to be placed on the mountain side they would require some degree of piling to compensate for gradient.** | |
| A.2.6 | List environmental components in the vicinity which are particularly sensitive to adverse impacts of noise and/or vibrations:<br>**The forested area does have unique fauna but we are uncertain if vibrations will affect them.** | |
| **A.3 Water Quality** | | |
| A.3.1 | Does/will the project discharge waste water or effluents | Yes |

**Appendix B (Continued)**

| No. | QUESTION | RESPONSE |
|---|---|---|
| | | **No**<br>Unknown |
| A.3.2 | During what phase of the project? Construction Operation **N/A** | |
| A.3.3 | Describe the major contaminants (including heat) in the waste water: **N/A** | |
| A.3.4 | Are there national or other effluent or ambient water quality standards in force in this area? | **Yes**<br>No |
| A.3.5 | Did (and will) the project comply with these standards? **Yes** | No |
| A.3.6 | Will there be any on-site treatment of waste water? | Yes<br>**No** |
| A.3.7 | Describe the Treatment: **N/A** | |
| A.3.8 | From the site, discharge will be to: **N/A** | River, Stream or other Surface Fresh Water Body<br>The Sea<br>Ground Water |
| A.3.9 | Describe the baseline (before project) quality of water in the receiving fresh water body:<br>**Relatively Uncontaminated** Contaminated<br>Polluted Naturally Poor Quality<br>Other ………………………………………………………………………………….... | |
| A.3.10 | List present or potential uses of the receiving fresh water body:<br>Public Water Supply **Village Water Supply**<br>Fishing Transportation<br>**Recreation**<br>Other: **It is part of a river network used by tourists and as water source for village in times of drought and no supply of water from the water authority.** | |
| A.3.11 | Describe the baseline (before project) quality of sea water:<br>**Relatively Uncontaminated** Contaminated<br>Polluted Naturally Poor Quality | |
| A.3.12 | List present or potential sea water uses: **Transportation**<br>**Recreation** **Fishing** Desalination Cooling<br>Other ........................................................................................................... | |
| A.3.13 | Indicate the nature of the ground water: **fresh** brackish saline | |
| A.3.14 | Describe baseline (before project) ground water quality:<br>**Relatively Uncontaminated** Contaminated<br>Polluted Naturally Poor Quality | |
| A.3.15 | Is ground water presently extracted for water supply or other use?<br>**Yes** No **Potential for Future Use** | |
| A.3.16 | Does/will the project restrict water use? | Yes<br>**No** |
| A.3.17 | Describe the ways in which the use was/will be restricted: **N/A** | |
| | **A.4 Flooding** | |
| A.4.1 | Will the project discharge waste water and/or increased | **Yes** |

**Appendix B (Continued)**

| No. | QUESTION | RESPONSE |
|---|---|---|
| | | No<br>Unknown |
| A.4.2 | During what phase of the project? **Construction** | **Operation** |
| A.4.3 | Describe the nature of the increased flow or the changes to the drainage system: **For this project, roads have to be constructed both as access roads during the construction phase and permanent ones during the operation phase. This inevitably means that there needs to be clearing of some vegetation/forested area leading to increased runoff into lower elevations in times of rainfall.** | |
| A.4.4 | Is the project site (or its environs) prone to flooding? | **Yes** No |
| A.4.5 | Are there regulations or design guidelines governing increased discharges to the drainage system, or changes to the system? | **Yes**<br>No |
| A.4.6 | Will the project comply with these regulations/guidelines? | **Yes** No |
| | **A.5 Slope Instability and Erosion** | |
| A.5.1 | Will the project involve clearing or earthwork that has the potential to induce slope instability or increase erosion? | **Yes**<br>No<br>Unknown |
| A.5.2 | Describe the clearing and/or earthwork, and indicate whether temporary or permanent in nature: **Approximately 20 acres need to be cleared permanently to allow for the suites and connecting roadways.** | |
| A.5.3 | Is the soil/geology of the project site susceptible to land slippage or erosion?<br>Yes No **Unknown** | |
| A.5.4 | Are there regulations or guidelines governing land clearance or earthwork *vis-à-vis* slope instability or erosion? | **Yes**<br>No |
| A.5.5 | Will the project comply with these regulations/guidelines? | **Yes** No |
| | **A.6 Solid Waste** | |
| A.6.1 | Will the project generate solid waste? | **Yes**<br>No<br>Unknown |
| A.6.2 | During what phase of the project? **Construction** | **Operation** |
| A.6.3 | Are there national or other policies or regulations pertaining to the collection and disposal of solid waste (including recycling)? | **Yes**<br>No |
| A.6.4 | Will the project comply with the policy/regulations? | **Yes** No |
| A.6.5 | Will there be any on-site processing of solid waste? | **Yes** No |
| A.6.6 | Describe the processing and final disposal of solid waste or residue: **They will be stored in impervious storage containers and removed when filled (by contractor) for safe disposal at legal landfill/dump sites.** | |
| A.7.1 | Is the project vicinity prone to any natural hazards other than Flooding (see A.4) or Land Slippage (see A.5)? | **Yes**<br>No |

**Appendix B (Continued)**

| No. | QUESTION | RESPONSE |
|---|---|---|
| | | Unknown |
| A.7.2 | Indicate the types of hazards: **Hurricane** **Earthquakes** Volcanoes Other…………………………………………………… | |
| A.7.3 | Are there zoning or setback standards or other design regulations or guidelines, governing construction in areas subject to these hazards? | Yes<br>**No** |
| A.7.4 | Will the project comply with the policy/regulations? **N/A** Yes No | |

| No. | QUESTION | RESPONSE |
|---|---|---|
| **B. ECOLOGY** | | |
| **B.1 Ecosystems in the Project Vicinity** | | |
| B.1.1 | Indicate below the types of ecosystems which are found in the vicinity of the project, and their baseline (before project) condition: | |
| | <table><tr><td></td><td>Pristine</td><td>Moderate Human Influence</td><td>Severe Human Influence</td></tr><tr><td>Aquatic</td><td>X</td><td></td><td></td></tr><tr><td>Terrestrial</td><td></td><td>X</td><td></td></tr><tr><td>Wetland</td><td>X</td><td></td><td></td></tr><tr><td>Coastal</td><td></td><td>X</td><td></td></tr><tr><td>Marine</td><td>X</td><td></td><td></td></tr></table> | |
| B.1.2 | Will any areas of natural ecosystem or established ecological areas be cleared or otherwise damaged/destroyed as part of the project? | **Yes**<br>No |
| B.1.3 | List the ecosystems/areas to be changed, including acreage:<br>**In total about 20 acres may have to be cleared for the suites and roads.** | |
| B.1.4 | Are any of the ecosystems/areas listed in B.1.3 unique or of special significance/importance? | **Yes**<br>No |
| B.1.5 | List the unique/significant ecosystems/areas:<br>**Mangrove swamp system** | |
| B.2.1 | Are there any Rare or Endangered Species known or reasonably inferred to inhabit the areas to be affected by the project? | Yes<br>No<br>**Unknown** |
| B.2.2 | List the Rare/Endangered Species:<br>**N/A** | |
| B.2.3 | Are there national or other policies or regulations governing protection of Rare/Endangered Species? | **Yes**<br>No |

**Appendix B (Continued)**

| No. | QUESTION | RESPONSE |
|---|---|---|
| B.2.4 | Will the project comply with these instruments? **Yes** No | |
| B.3.1 | Are there any Migratory Species known or reasonably inferred to visit the areas to be affected by the project? | Yes<br>No<br>**Unknown** |
| B.3.2 | List the Migratory Species:<br>**N/A** | |
| B.3.3 | Are there any policies, regulations or practices governing maintenance of migratory routes or protection of Migratory Species? | Yes<br>**No** |
| B.3.4 | Will the project comply with these instruments? **N/A** Yes No | |
| B.4.1 | Will the project involve the direct introduction of new species, or the importation of material through which new species may be inadvertently introduced? | Yes, direct<br>Yes, indirect<br>**No** |
| B.4.2 | During what phase of the project? **N/A** Construction Operation | |
| B.4.3 | List the species to be introduced directly: **N/A** | |
| B.4.4 | Is there a national or other policy or regulation pertaining to the direct introduction of new species? | Yes<br>**No** |
| B.4.5 | Will the project comply with the policy/regulation? **N/A** Yes No | |
| B.4.6 | List the types of species for which concerns about inadvertent introduction arise: **N/A** | |
| B.4.7 | Will there be any processing of the material in question to minimize the possibility of inadvertent introduction of new species? **N/A** | Yes<br>No |
| B.4.8 | Describe the proposed processing: **N/A** | |
| B.5.1 | Are there Pest Plants or Animals or Disease Vectors in the project site and vicinity? | **Yes**<br>No<br>Unknown |
| B.5.2 | List the Pest Species or Disease Vectors:<br>**Mosquitoes** | |
| B.5.3 | Is there a program to control or eradicate these Pests or Vectors? | **Yes**<br>No |
| B.5.4 | Will the project affect this program? **Enhance** Retard | |
| B.5.5 | Will the project create conditions which would increase the incidence of existing Pests/Vectors, or encourage new Pests/Vectors? | Yes<br>**No**<br>Unknown |
| B.5.6 | Will any steps be taken under the project to control/eradicate these Pests or Vectors? | **Yes**<br>No |

**Appendix B (Continued)**

| No. | QUESTION | RESPONSE |
|---|---|---|
| B.5.7 | Describe the proposed steps:<br>**Regular spraying for mosquitoes and the provision of nets for guests.** | |
| B.6.1 | Are there any present or proposed Parks or Protected Areas in the project site and vicinity? | Yes<br>**No**<br>Unknown |
| B.6.2 | Name the Park(s) or Protected Area(s):<br>**N/A** | |
| B.6.3 | Does the project involve any intrusion into or use of the Park/Protected Area? **N/A** | Yes<br>No |
| B.6.4 | Describe the intrusion/use, and state whether during construction or operation phase: **N/A** | |
| B.6.5 | Are there policies and regulations governing activities in the parks/protected areas? | **Yes**<br>No |
| B.6.6 | Does the project conform to the policies/regulations? **Yes** No | |
| B.6.7 | Will the project create/facilitate unauthorized access into the Park/Protected Area? **N/A** | Yes<br>No<br>Unknown |
| B.6.8 | Will any steps be taken under the project to minimize unauthorized access to the Park Protected Area? **N/A** | Yes<br>No |
| B.6.9 | Describe the proposed steps: **N/A** | |

| No. | QUESTION | RESPONSE |
|---|---|---|
| | **C. HUMAN ENVIRONMENT** | |
| | **C.1 Land Use Zoning** | |
| C.1.1 | Is there a system of Land Use Zoning or other Designation of Land Use in force in this Country? | **Yes**<br>No |
| C.1.2 | Does the proposed project conform to the present Land Use Zoning/Designation? | **Yes**<br>No |
| C.1.3 | Has Rezoning/Re-designation been obtained? **N/A** Yes No | |
| | **C.2 Relocation of Residents** | |
| C.2.1 | Will the implementation of the project result in the Displacement of Residents? | Yes<br>**No** |
| C.2.2 | Are there national or other policies or regulations governing the Acquisition of Land and the Displacement of Residents? | **Yes**<br>No |
| C.2.3 | Will the project comply with these instruments? **N/A** Yes | No |
| | **C.3 Agriculture** | |
| C.3.1 | Is the site now used for agriculture, or is it abandoned agricultural land? | **Yes**<br>No |

**Appendix B (Continued)**

| No. | QUESTION | RESPONSE |
|---|---|---|
| C.3.2 | Describe the site in terms of soil capability and crops presently grown:<br>**Pimento Coconuts Orchids Cocoa** | |
| C.3.3 | Is there a national or other policy or practice relevant to the conversion of agricultural land to other use, or the acquisition of agricultural land? | **Yes**<br>No |
| C.3.4 | Will the project comply with this policy/practice? | **Yes** No |
| **C.4 Conflict with Other Users** | | |
| C.4.1 | Will this project conflict with any existing land use in the general area? | **Yes**<br>No<br>Unknown |
| C.4.2 | Has the project been structured to minimize such conflict? | **Yes**<br>No |
| C.4.3 | Describe the relevant elements of the project structure:<br>**Community involvement in the project will be sought through the EIA process where the community will be informed of the benefits that the project can bring to them.** | |
| **C.5 Competition for Natural Resources** | | |
| C.5.1 | Are there exploitable Natural Resources in the general area? | **Yes**<br>No<br>Unknown |
| C.5.2 | List the Natural Resources: **Virgin forest** | |
| C.5.3 | Will the project restrict access by others (particularly traditional users) to these natural resources? | **Yes**<br>No |
| C.5.4 | During which phase? Construction **Operation** | |
| C.5.5 | Has the project been structured to minimize or compensate for the loss of access to resources? | Yes<br>**No** |
| C.5.6 | Describe the relevant elements of the project structure:<br>**All the forest that will be used for the project belongs to Greencastle. All other current users are unauthorized users.** | |
| **C.6 Employment: Jobs** | | |
| C.6.1 | Will the project result in the creation of any jobs? | **Yes**<br>No<br>Unknown |
| C.6.2 | Estimate/give the level of employment at each phase of the project:<br>Construction: **50** Operation: **10** | |
| C.6.3 | Will local residents be re-trained to take up the new jobs? | **Yes** No |
| C.6.4 | Will the project result in the loss of any jobs? | Yes<br>**No**<br>Unknown |
| C.6.5 | Are there national or other policies or practices related to the compensation of displaced workers? | **Yes**<br>No |

**Appendix B (Continued)**

| No. | QUESTION | RESPONSE |
|---|---|---|
| C.6.6 | Will displaced workers be compensated in accordance with these policies/practices? Yes No **N/A** | |
| C.6.7 | Will displaced workers be re-trained to take up any new jobs mentioned in C.6.2, above? Yes No **N/A** | |
| | **C.7 Employment Biases** | |
| C.7.1 | Will any particular group be ineligible for all or part of the New Jobs to be Created by the Project? | **Yes**<br>No<br>Unknown |
| C.7.2 | Indicate groups who will be ineligible for employment?<br>Young Workers (age 15 to 24) Older Workers (over age 50)<br>Women **The Handicapped**<br>Other: **Facilities simply do not allow for their employment at this time.** | |
| C.7.3 | Has the project been structured to minimize or compensate for such biases? | Yes<br>**No** |
| C.7.4 | Describe the relevant elements of the project structure: **N/A** | |
| | **C.8 Local Area Economy** | |
| C.8.1 | Will the project cause significant changes in the distribution of income? | Yes<br>**No**<br>Unknown |
| C.8.2 | During what phase of the project? **N/A** Construction Operation | |
| C.8.3 | List major changes of concern: **N/A** | |
| C.8.4 | Will the project cause significant changes in property values? | **Yes**<br>No<br>Unknown |
| C.8.5 | During what phase of the project? Construction **Operation** | |
| C.8.6 | List major changes of concern: **It is expected that the expansion when I operation will bring more business to the Robin's Bay / Rosend area hence raising land and building values.** | |
| C.8.7 | Will workers and their families be moved into the area as a result of this project? | **Yes**<br>No<br>Unknown |
| C.8.8 | Estimate the number of new residents at each phase of the project:<br>Construction: **10** Operation: **0** | |
| | **C.9 Services and Utilities** | |
| C.9.1 | Are there deficiencies in the Services or Utilities in this area? | **Yes**<br>No<br>Unknown |
| C.9.2 | Which Utility/Service? **Water Supply** Electricity<br>Telephone Public Transport Health Service<br>Police Service **Fire Service**<br>Other: **Irregular garbage collection; no fire hydrants in area; water supply bad at times.** | |

**Appendix B (Continued)**

| No. | QUESTION | RESPONSE |
|---|---|---|
| C.9.3 | Will this project's demand for Services and Utilities exceed their Local Area Capacity? | Yes<br>**No**<br>Unknown |
| C.9.4 | Which Utility/Service? Water Supply Electricity Telephone Public Transport Health Service Police Service Fire Service Other: **N/A** | |
| C.9.5 | During what phase of the project? **N/A** Construction Operation | |
| C.9.6 | Has the project been designed to minimize demand on scarce utilities or services? | **Yes**<br>No |
| C.9.7 | Describe the relevant elements of the project structure:<br>**Greencastle has its own well and catches rainwater for its daily uses.** | |
| C.9.8 | Will the project bring new services or utilities into the area?<br>Yes **No** Unknown | |
| | **C.10 Indigenous People and Special Groups** | |
| C.10.1 | Are there communities of Indigenous People or other Special Social Groups in the project vicinity? | Yes<br>**No**<br>Unknown |
| C.10.2 | List the Communities/Groups: **N/A** | |
| C.10.3 | Will the project cause significant changes in the social patterns of these communities/groups? | Yes<br>**No**<br>Unknown |
| C.10.4 | List major changes of concern: **N/A** | |
| C.10.5 | Has the project been structured to minimize or compensate for such changes? **N/A** | Yes<br>No |
| C.10.6 | Describe the relevant elements of the project structure: **N/A** | |
| C.10.7 | Have these groups been consulted in Project Planning and/or Decision-making? Yes No Unknown **N/A** | |
| | **C.11 Sites of Special Interest** | |
| C.11.1 | Are there any Sites of Special Interest (Cultural, Religious, Aesthetic, etc) at the project site or in the vicinity? | **Yes**<br>No<br>Unknown |
| C.11.2 | List the Sites: **Fisherman's beach; Jack's Bay** | |
| C.11.3 | Does the project involve any intrusion into or other change to the Site? | Yes<br>**No** |
| C.11.4 | Describe the intrusion/change, and state whether during construction or operation phase: **N/A** | |

**Appendix B (Continued)**

| No. | QUESTION | RESPONSE |
|---|---|---|
| C.11.5 | Are there policies and regulations governing use and protection of Sites of Special Interest? | **Yes**<br>No |
| C.11.6 | Does the project conform to the policies/regulations? **Yes** No | |
| C.11.7 | Has the project been structured to minimize or compensate for such intrusion/changes? | **Yes**<br>No |
| C.11.8 | Describe the relevant elements of the project structure:<br>**Activity is well away from these areas and all traffic during construction will stay clear of the main public road connecting those locations.** | |
| | **C.12 Public Safety** | |
| C.12.1 | Will the project increase the risk of Accidents, or otherwise affect Public Safety? | Yes<br>**No**<br>Unknown |
| C.12.2 | Describe the factors of increased risk to the public, and state whether during construction or operation phase: **N/A** | |
| C.12.3 | Are there adequate medical/other facilities in the area to respond to accidents or emergencies related to this project? Yes **No** | |
| C.12.4 | Have any measures been included in the design of the Project to supplement existing medical/other emergency facilities? | Yes<br>**No** |
| C.12.5 | Describe these measures: **N/A** | |
| C.12.6 | Is there an emergency response plan for this area? | Yes<br>**No** |
| C.12.7 | Describe any ways in which the project is incompatible or inconsistent with the Emergency Response Plan:<br>**One has to be developed for the project as it is expected that it will be mandated for the EIA process.** | |
| | **C.13 Hazardous Material and Waste** | |
| C.13.1 | Will the project use hazardous material or generate hazardous waste? | **Yes**<br>No<br>Unknown |
| C.13.2 | During what phase of the project? **Construction** Operation | |
| C.13.3 | Indicate the type of Hazardous Waste: **Corrosive** Toxic Radioactive Flammable Other ........................................... | |
| C.13.4 | Are there national or other policies or regulations pertaining to the handling of hazardous material or the collection and disposal of hazardous waste? | **Yes**<br>No |
| C.13.5 | Will the project comply with these policies/regulations? **Yes** No | |
| C.13.6 | Will there be on-site processing of hazardous substances or hazardous waste? **Yes** No | |

**Appendix B (Continued)**

| No. | QUESTION | | RESPONSE |
|---|---|---|---|
| C.13.7 | Describe any processing, on-site treatment and disposal of Hazardous Waste or Hazardous Material: **Not sure of the specifics but this will be dealt with by contractors that are capable of doing this.** | | |
| | **C.14 Risk Factors** | | |
| C.14.1 | Are there any project components which would contribute to Man-made Risk? | | **Yes**<br>No<br>Unknown |
| C.14.2 | List Project Components which contribute to Man-made Risk:<br>Pressure Vessels/Lines Storage and Use of Toxics<br>**Storage and use of Flammable and/or Explosive Substances**<br>Other ........................................................................................................ | | |
| C.14.3 | Are there national or other regulations or guidelines pertaining to the design, construction and/or operation of these components? | | **Yes**<br>No |
| C.14.4 | Will the project comply with these policies/regulations? | **Yes** | No |
| C.14.5 | Will any steps be taken to minimize the risk? | **Yes** | No |
| C.14.6 | Describe the steps: **Ensuring that the personnel undertaking these activities are properly trained and are equipped with the necessary PPE.** | | |

| | D. OTHER ENVIRONMENTAL CONCERNS |
|---|---|
| D.1 | List and describe any other environmental concerns, specific to this project, which were not covered by this Checklist: |

**PART 3: REGULATORY FRAMEWORK**

***Note: Y = yes, N = no, and U = unknown***

| | QUESTION | Y | N | U | COMMENT |
|---|---|---|---|---|---|
| A | Does this Project conform to National or Local Plans or Policies? | X | | | |
| B | Has the Project received any level of Planning Approval | | X | | |
| C | Are there Local Laws or Regulations which govern projects of this type? | X | | | |

**Appendix B (Continued)**

| | | | | | |
|---|---|---|---|---|---|
| D | Under these Laws/Regulations, is an Environmental Impact Assessment required for this Project? | | | X | |
| E | Has any Environmental Study been done for this Project? | X | | | Just personal preliminary studies. |
| F | Are there Laboratory Facilities available Locally to undertake Testing for Environmental Parameters? | X | | | Several certified laboratories are available privately in Kingston and through the UWI at Mona. |

**Appendix B (Continued)**

## EVALUATION OF POSSIBLE ENVIRONMENTAL IMPACT OF FUTURE PROPOSED PROJECT AT GREENCASTLE ESTATE, ST. MARY, JAMAICA, WEST INDIES

| **Impact Questions** |
|---|
| 1. Will there be a large change in environmental conditions? **Yes** |
| 2. Will new features be out-of-scale with the existing environment? **Yes** |
| 3. Will the impact be unusual in the area, or particularly complex? **No** |
| 4. Will the impact extend over a large area? **No** |
| 5. Will there be any potential for transboundary impacts? **Yes** |
| 6. Will many people be affected? **No** |
| 7. Will many receptors of other types (e.g., flora and fauna, businesses, facilities) be affected? **Yes – flora and fauna** |
| 8. Will valuable or scarce features or resources be affected? **Yes – forest and biodiversity** |
| 9. Is there a risk that documented environmental standards or criteria will be exceeded? **Yes** |
| 10. Is there a risk that protected sites, areas, features, or species will be affected? **Yes** |
| 11. Is there a high probability of the impact occurring? **Yes** |
| 12. Will the impact continue for a long time? **No** |
| 13. Will the impact be permanent rather than temporary? **Temporary** |
| 14. Will the impact be continuous rather than intermittent? **Intermittent** |
| 15. If the impact is intermittent, will it be more frequent than rare? **No** |
| 16. Will the impact be irreversible? **Possibly so** |
| 17. Will it be difficult to avoid, reduce, repair or compensate for the impact? **Yes** |
| 18. Will the proportion of a biological population or community affected be so large that its viability may be compromised? **Yes** |
| 19. Will the proportion of an ecosystem affected be so large that ecosystem function may be affected, particularly if the affected system is critical habitat? **Yes** |
| 20. Will the capability of a protected natural ecosystem be compromised or put at unacceptable risk? **Yes** |
| 21. Will there be considerable public concern over the impacts that will occur? **No** |

**Appendix B (Continued)**

| Screening Questions |
|---|
| 1. Will construction, operation or decommissioning of the project involve actions that will cause physical changes in the locality (e.g., changes in topography, land use, water bodies, etc.)? **Yes – land will be cleared (about 20 acres)** |
| 2. Will construction or operation of the project use natural resources (e.g., land, water, construction materials, energy, etc.), especially any resources that are non-renewable and/or in short supply? **Yes – construction uses currently forested land and would require timber for a cabin look** |
| 3. Will the project involve use, storage, transport, handling or production of substances or materials which could be harmful to human health or the environment or raise concerns about actual or perceived risks to human health? **Yes – During construction is where the greatest risk lies in this regard** |
| 4. Will the project produce solid wastes during construction, operation or decommissioning? **Yes – cleared trees, waste containers, workers' waste** |
| 5. Will the project release pollutants or any hazardous, toxic or noxious substances to air? **Yes – generator operation during construction, dust from construction** |
| 6. Will the project cause noise and vibration or release of light, heat, energy or electromagnetic radiation? **Yes – some piling will be needed** |
| 7. Will the project lead to risks of contamination of land or water from releases of pollutants into the environment (e.g., releases to the ground, surface waters, groundwater, coastal waters, the sea, etc.)? **Yes – especially since the project is on a slope during rain events lower elevations can be quickly polluted** |
| 8. Will there be any risk of accidents during construction or operation of the project that could affect human health or the environment? **Yes** |
| 9. Will the project result in social changes (e.g., demography, traditional lifestyles, employment)? **Yes – employment is expected to increase during construction and operation** |
| 10. Does the potential exist for cumulative impacts in combination with other existing, planned or consequential projects/activities in the locality? **Yes – the property is networked by rivers and this could cause a cumulative impact elsewhere** |
| 11. Are there any areas on or around the location that are protected under international or national or local legislation for their ecological, landscape, cultural or other value that could be affected by the project? **No** |
| 12. Are there any other areas on or around the location that are important or sensitive for reasons of their ecology (e.g., wetlands, watercourses or waterbodies, the coastal zone, mountains, forests or woodlands) that could be affected by the project? Yes **– Mangrove wetland, coastal bodies (Fisherman's Beach, Jack's Bay, Long Beach)** |
| 13. Are there areas on or around the location that are used by protected, important or sensitive species of fauna or flora (e.g., for breeding, nesting, foraging, resting, overwintering, migration) that could be affected by the project? **No** |
| 14. Are there aquatic components (e.g., inland, coastal, marine or underground waters) on or around the location that could be affected by the project? **Yes – coastal** |
| 15. Are there any areas or features of high landscape or scenic value on or around the location that could be affected by the project? **No** |

**Appendix B (Continued)**

| |
|---|
| 16. Are there any routes or facilities on or around the location that are used by the public for access to recreation or other facilities that could be affected by the project? **Yes** |
| 17. Are there any transport routes on or around the location that are susceptible to congestion or that cause environmental problems that could be affected by the project? **Yes – main public road is downwind of the construction which could be a problem during land clearing** |
| 18. Is the project in a location where it is likely to be highly visible to many people? **No** |
| 19. Are there any areas or features of historic or cultural importance on or around the location that could be affected by the project? **No** |
| 20. Is the project located in a previously undeveloped area where there will be loss of greenfield land? **Yes – site is currently virgin forest** |
| 21. Are there existing land uses on or around the location (e.g., homes, gardens, other private property, industry, commerce, recreation, public open space, community facilities, agriculture, forestry, tourism, mining or quarrying) that could be affected by the project? **Yes – piling can especially affect nearby Robin's Bay community** |

## Appendix C: Photos from Both Study Sites and Their Surroundings

### Iwokrama

**Figure C1** North Rupununi Savannah

**Figure C2** The five (5) guest suites in relation to each other (left) and close up of the last two (2) (right).

**Figure C3** The main building with offices, kitchen and training facilities.

## Appendix C (Continued)

**Figure C4** Photo showing main building in relation to guest accommodations.

**Figure C5** Views of the staff and researcher accommodations. Image on left shows rainwater harvesting technique from the roofs of the accommodations.

**Figure C6** Site Manager's accommodation in the background (with small solar panel on roof) and storage tanks for storing pumped river water for washing and toilet flushing purposes.

**Appendix C (Continued)**

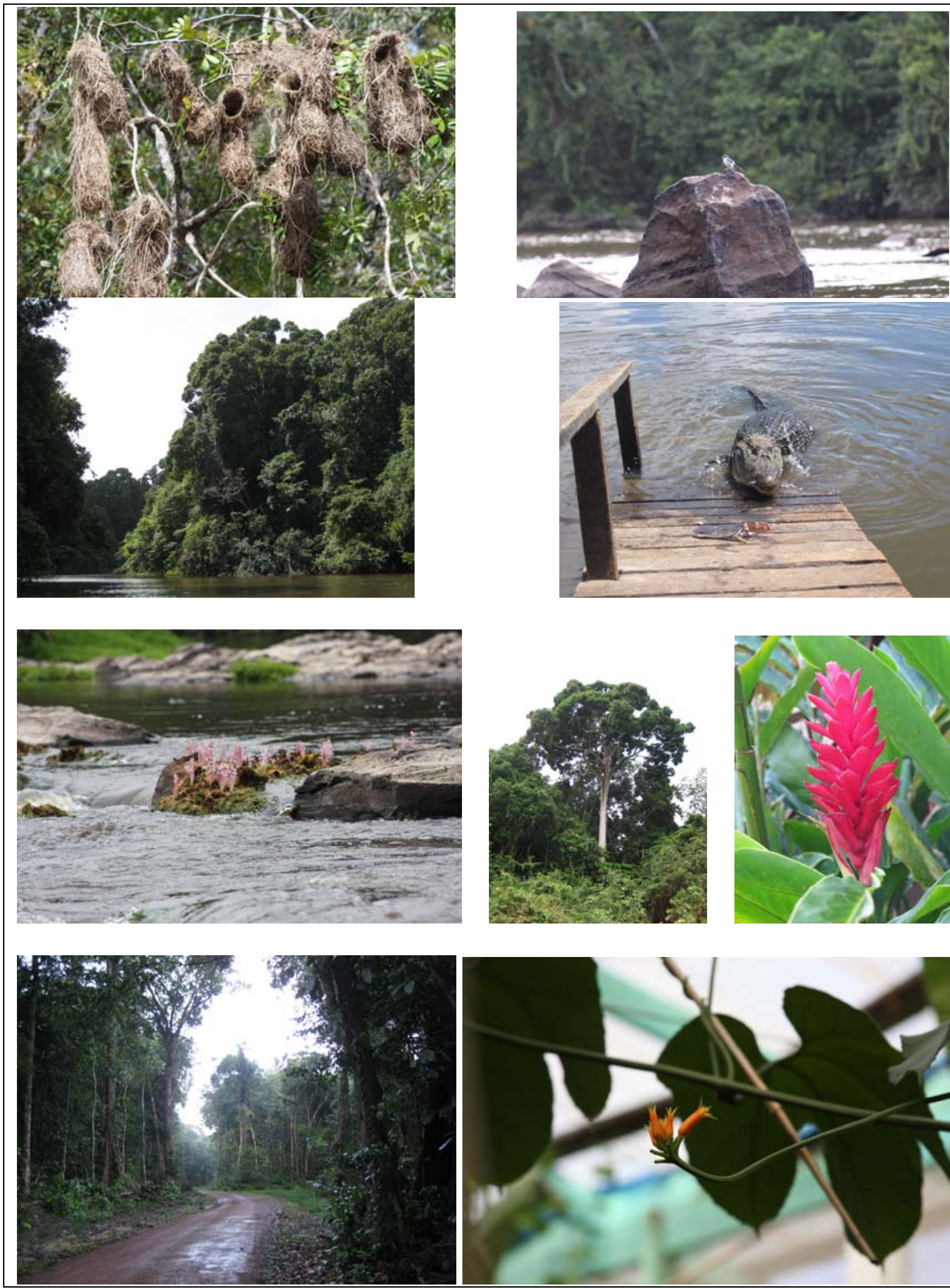


**Figure C7** Examples of the wide array of biodiversity at Iwokrama.

## Appendix C (Continued)

### Fairview Village

**Figure C8** Butterfly farm at Fairview Village.

**Figure C9** Two (2) of eleven (11) butterfly varieties at Fairview Village's Butterfly Farm.

**Figure C10** Harvesting of larvae at the Fairview Butterfly Farm which is sold and traded.

## Appendix C (Continued)

**Figure C11** Fairview Village Primary School (top left), Health Center (top right) and air field (bottom).

**Figure C12** Typical housing structure in Fairview Village.

**Figure C13** Fairview rapids and downstream (right).

## Appendix C (Continued)

### Views from Turtle Mountain

**Figure C14** Shots of Iwokrama rainforest from Turtle Mountain.

### Road Travel to Iwokrama

**Figure C15** Minibus (left) is often used for the 8hr trip from Georgetown along unpaved roads (right).

**Figure C16** Security checkpoint with local police at the entry into different Regions.

**Figure C17** Vehicles cross rivers by schedule via ferries (called pontoons).

## Appendix C (Continued)

### Onsite amenities at Iwokrama

**Figure C18** Weather station external (left) and internal (right).


**Figure C19** Generator shed.

**Figure C20** Views of solar panels at Iwokrama.

## Appendix C (Continued)

**Figure C21** Visible recycling initiatives outdoors (left) and indoors (right).


**Figure C22** Sign to encourage no littering and recycling.

**Figure 23** Filter used to treat rainwater for drinking purposes.

## Appendix C (Continued)

**Figure C24** Workshop of handymen and grounds keepers (left) and the fuel storage area.

**Figure C25** Area in river near guest accommodations where staff and guests were seen bathing.

## Greencastle

## Estate House & Estate Manager's Bungalow Views

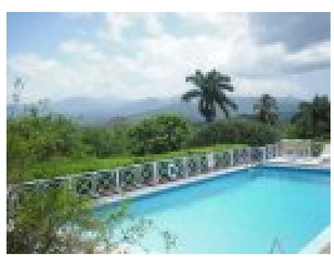


**Figure C26** Pool at the Estate House.

## Appendix C (Continued)

**Figure C27** Morning view from Estate House.

**Figure C28** Some views from the Estate Manager's Bungalow.

## Greencastle Orchid's operations

**Figure C29** Some of the varieties of orchids available at the Greencastle Orchids operations.

## Appendix C (Continued)

### JamOrganiX's operations

**Figure C30** Low lying area used for pepper planting.

**Figure C31** Stages of JamOrganiX's coconut oil production. Left through right: Drying of shredded coconut; pressing of dried coconut and filtering of oil; bottling of final product.

### Coastal images

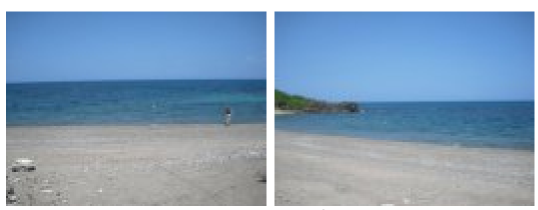


**Figure C32** Images of Jack's Bay.

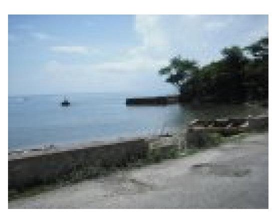


**Figure C33** Fisherman's Beach.

## Appendix C (Continued)

**Figure C34** Rocky coast near Blue Hole.

**Figure C35** Views of Blue Hole.

## Miscellaneous

**Figure C36** Part of the cattle heard at Greencastle.

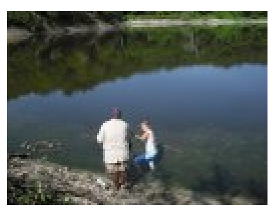


**Figure C37** Sampling at the reservoir (the largest water feature onsite).

## Appendix D: Raw Water Quality Data

### Greencastle

Sampling took place on 08/20/08 in the middle of the day.

**Table D1** Quanta Hydrolab™ water quality data at Greencastle with notes.

| Sample Point | Notes | Elevation (m) | Temp. (°C) | SpC (mS/cm) | DO (mg/L) | pH | Depth (ft) | Salinity (PSS) | DO (% sat) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|
| 001 | Bridge below the estate house | 88 | 25.61 | 0.975 | 4.51 | 5.99 | 0.0 | 0.31 | 52.0 | 0.6 |
| 002 | Waterfall | 101 | 25.81 | 0.740 | 7.84 | 7.03 | 0.0 | 4.10 | 89.5 | 1.2 |
| 003 | Calabash river upstream from bridge | 20 | 26.62 | 0.746 | 1.23 | 7.30 | 0.9 | 4.00 | 8.7 | 4.8 |
| 004 | Reservoir co-ordinates taken on hill | 37 | 30.55 | 0.514 | 6.61 | 7.82 | 0.9 | 3.90 | 81.9 | 15.0 |
| 005 | 1st bridge out of Greencastle | 11 | 26.91 | 0.751 | 2.23 | 7.59 | 0.0 | 3.80 | 27.3 | 3.3 |
| 006 | 2nd bridge downstream from bridge | - | 26.57 | 0.959 | 0.86 | 7.58 | 0.8 | 3.70 | 10.1 | 17.7 |
| 007 | 3rd bridge downstream | - | 28.22 | 0.864 | 2.56 | 7.66 | 0.8 | 3.90 | 21.2 | 7.4 |
| 008 | Haughton river at sea | 7 | 29.61 | 1.066 | 5.64 | 7.68 | 0.9 | 11.20 | 72.7 | 7.8 |
| 009 | Mangroves | 9 | 29.14 | - | 2.61 | 7.38 | 0.7 | 13.90 | 16.6 | 153.0 |
| 013 | Pond on lhs of Tower Road | - | 33.05 | 0.299 | 6.60 | 8.22 | 0.5 | 0.40 | 73.2 | 211.0 |
| 014 | Wag water (just below mining) | - | 28.15 | 0.239 | 8.64 | 8.30 | 0.8 | 0.20 | 108.5 | 118.0 |

## Appendix D (Continued)

**Table D2** Alkalinity, hardness and phosphorus concentration data for surface water at Greencastle, Jamaica with notes.

| Sample Point | Notes | Total alkalinity (mg/L $CaCO_3$) | Caustic alkalinity (mg/L $CaCO_3$) | Carbonate alkalinty (mg/L $CaCO_3$) | Total hardness (mg/L $CaCO_3$) | Ca (M) | Mg (M) | Total P (mg/L P) | Poly (mg/L P) | Ortho (mg/L P) |
|---|---|---|---|---|---|---|---|---|---|---|
| 001 | Bridge below the estate house | 542 | 0 | 542 | 232 | 0.0017 | 0.0007 | 0.8438 | 0.7132 | 0.1307 |
| 002 | Waterfall | 336 | 0 | 336 | 132 | 0.0006 | 0.0007 | 0.6107 | - | 1.1173 |
| 003 | Calabash river upstream from bridge | 360 | 16 | 344 | 148 | 0.0010 | 0.0005 | 0.7739 | 0.4299 | 0.3440 |
| 004 | Reservoir co-ordinates taken on hill | 220 | 12 | 208 | 80 | 0.0005 | 0.0003 | 0.7273 | 0.4633 | 0.2640 |
| 005 | 1st bridge out of Greencastle | 318 | 6 | 312 | 140 | 0.0010 | 0.0004 | 0.8205 | 0.5298 | 0.2907 |
| 006 | 2nd bridge downstream of bridge | 286 | 14 | 272 | 146 | 0.0007 | 0.0007 | 0.7040 | 0.4400 | 0.2640 |
| 007 | 3rd bridge downstream | 268 | 0 | 268 | 156 | 0.0006 | 0.0010 | 0.8438 | 0.6865 | 0.1573 |
| 008 | Haughton river at sea | 286 | 12 | 274 | 158 | 0.0010 | 0.0006 | 0.5408 | 0.4901 | 0.0507 |
| 009 | Mangroves | 244 | 22 | 222 | - | - | - | 2.5688 | 0.0914 | 2.4773 |
| 010 | Jack's bay | 138 | 0 | 138 | - | - | - | - | - | - |
| 011 | Fisherman's beach | 142 | 0 | 142 | - | - | - | - | - | - |
| 012 | Bay by Blue Hole | 136 | 0 | 136 | - | - | - | - | - | - |
| 013 | Pond on lhs of Tower Road | 100 | 0 | 100 | 40 | 0.0003 | 0.0001 | 0.7972 | 0.5065 | 0.2907 |
| 014 | Wag water (just below mining) | 102 | 0 | 102 | 56 | 0.0005 | 0.0001 | 0.7273 | 0.5966 | 0.1307 |
| 015 | Angie's well | - | - | - | 108 | 0.0006 | 0.0005 | 0.7273 | 0.2499 | 0.4773 |
| 016 | Greencastle well | - | - | - | 168 | 0.0010 | 0.0006 | 0.4242 | NA | 1.5173 |
| 010b | Jack's Bay PM | 126 | 10 | 116 | - | - | - | - | - | - |
| 008b | Sea where Haughton river meets | 146 | 0 | 146 | - | - | - | - | - | - |

## Appendix D (Continued)

**Table D3** Dissolved As, Pb, Cd and Se data for surface water at Greencastle, Jamaica.

| Sample Point | As (ppb) DL=5 ppb | Pb (ppb) DL=10 ppb | Cd (ppb) DL=5 ppb | Se (ppb) DL=5 ppb |
|---|---|---|---|---|
| 001 | <5 | <10 | <5 | <5 |
| 002 | <5 | <10 | <5 | <5 |
| 003 | <5 | <10 | <5 | <5 |
| 004 | <5 | <10 | <5 | <5 |
| 005 | <5 | <10 | <5 | <5 |
| 006 | <5 | <10 | <5 | <5 |
| 007 | <5 | <10 | <5 | <5 |
| 008 | <5 | <10 | <5 | <5 |
| 009 | <5 | <10 | <5 | <5 |
| 010 | <5 | <10 | <5 | <5 |
| 011 | <5 | <10 | <5 | <5 |
| 012 | <5 | <10 | <5 | <5 |
| 013 | <5 | <10 | <5 | <5 |
| 014 | <5 | <10 | <5 | <5 |
| 015 | <5 | <10 | <5 | <5 |
| 016 | <5 | <10 | <5 | <5 |
| 010b | <5 | <10 | <5 | <5 |
| 008b | <5 | <10 | <5 | <5 |

## Iwokrama

Sampling took place on 03/16/09 in the middle of the day.

**Table D4** Quanta Hydrolab$^{TM}$ water quality data at Iwokrama, Guyana with notes.

| Sample Point | UTM coordinates | | Notes | Temp (°C) | SpC (mS/cm) | DO (mg/L) | DO (%sat) | pH | TDS (g/L) | Turbidity (NTU) | Salinity (pss) | ORP (mV) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | N04.76196 | W58.762 | Middle of river | 27.41 | 0.014 | 7.69 | 95 | 5.63 | 0 | 13.4 | 0.02 | 109 |
| 2 | N04.84069 | W058.83415 | Middle of river | 27.36 | 0.022 | 7.04 | 83 | 5.39 | 0 | 17.3 | 0.02 | 105 |
| 3 | N04.78912 | W058.87139 | Point 1 | 26.63 | 0.022 | 6.91 | 81 | 5.42 | 18.5 | 19.1 | 0.02 | 104 |
| 4 | N04.75778 | W058.86938 | Middle of river | 26.2 | 0.022 | 7.87 | 82 | 5.7 | 0 | 12.4 | 0.02 | 74 |
| 5 | N04.74711 | W058.86625 | Middle of river | 26 | 0.023 | 7.35 | 87 | 5.94 | 0 | 12.6 | 0.02 | 69 |
| 6 | N04.73200 | W058.85048 | Point 2 | 26.1 | 0.024 | 6.85 | 83 | 5.6 | 0 | 13 | 0.02 | 93 |
| 7 | N04.76645 | W058.88126 | Point 3 | 27.4 | 0.022 | 7.62 | 87 | 5.7 | 0 | 32.2 | 0.02 | 89 |
| 8 | N04.74021 | W058.92834 | Point 4 | 27.1 | 0.022 | 10 | 98.4 | 5.95 | 0 | 28.8 | 0.02 | 73 |
| 9 | N04.67193 | W058.68386 | Dock at Iwokrama | 27.99 | 0.014 | 7.86 | 99.7 | 6.4 | 0 | 13.2 | 0.02 | - |
| 10 | N04.65584 | W058.68221 | Fairview rapids | 28.2 | 0.015 | 8.5 | 103 | 6.25 | 50 | 16.7 | 0.02 | - |
| 11 | N04.65575 | W058.68207 | Fairview rapids | 28.22 | 0.015 | 8.04 | 99.3 | 5.58 | 50 | 13.7 | 0.02 | 31 |
| 12 | N04.65500 | W058.68207 | Fairview rapids | 28.27 | 0.015 | 8.37 | 101.7 | 5.59 | 0 | 13.8 | 0.02 | 57 |
| 13 | N04.65508 | W058.68207 | Fairview rapids | 28.27 | 0.015 | 8.37 | 101.7 | 5.59 | 0 | 13.8 | 0.02 | 57 |
| 14 | N04.67193 | W058.68386 | Pontoon | 27.6 | 0.014 | 9.82 | 106 | 6.11 | 0 | 16.2 | 0.02 | - |

## Appendix D (Continued)

**Table D5** Alkalinity, hardness, phosphorus concentration and dissolved metal concentrations data for surface water at Iwokrama, Guyana with notes.

| Sample Point | Carbonate alkalinity (mg/L $CaCO_3$) | Total alkalinity (mg/L $CaCO_3$) | Total P (mg/L) | Poly P (mg/L) | Ortho P (mg/L) | Total hardness (mg/L $CaCO_3$) | Ca conc. (M) | Mg conc. (M) | As (ppb) DL=5 ppb | Pb (ppb) DL=10 ppb | Cd (ppb) DL=5 ppb | Se (ppb) DL=5 ppb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 20 | 20 | 0.417412 | 0.387597 | 0.029815 | 80 | 0.0006 | 0.0002 | <5 | <10 | <5 | <5 |
| 2 | 20 | 20 | 0.417412 | 0.387597 | 0.029815 | 80 | 0.0004 | 0.0004 | <5 | <10 | <5 | <5 |
| 3 | 40 | 40 | 0.387597 | 0.327967 | 0.05963 | 40 | 0.0002 | 0.0002 | <5 | <10 | <5 | <5 |
| 4 | 20 | 20 | 0.417412 | 0.357782 | 0.05963 | 100 | 0.0006 | 0.0004 | <5 | <10 | <5 | <5 |
| 5 | 20 | 20 | 0.357782 | 0.238521 | 0.119261 | 60 | 0.0004 | 0.0002 | <5 | <10 | <5 | <5 |
| 6 | 40 | 40 | 0.387597 | 0.268336 | 0.119261 | 60 | 0.0004 | 0.0002 | <5 | <10 | <5 | <5 |
| 7 | 20 | 20 | 0.447227 | 0.417412 | 0.029815 | 40 | 0.0002 | 0.0002 | <5 | <10 | <5 | <5 |
| 8 | 20 | 20 | 0.357782 | 0.327967 | 0.029815 | 60 | 0.0002 | 0.0004 | <5 | <10 | <5 | <5 |
| 9 | 60 | 60 | 0.417412 | 0.298151 | 0.119261 | 40 | 0.0002 | 0.0002 | <5 | <10 | <5 | <5 |
| 10 | 80 | 80 | 0.477042 | 0.357782 | 0.119261 | 60 | 0.0004 | 0.0002 | <5 | <10 | <5 | <5 |
| 11 | 60 | 60 | 0.327967 | 0.298151 | 0.029815 | 20 | 0.0002 | 0 | <5 | <10 | <5 | <5 |
| 12 | 60 | 60 | 0.298151 | 0.178891 | 0.119261 | 40 | 0.0002 | 0.0002 | <5 | <10 | <5 | <5 |
| 13 | 60 | 60 | 0.298151 | 0.178891 | 0.119261 | 40 | 0.0002 | 0.0002 | <5 | <10 | <5 | <5 |
| 14 | 80 | 80 | 0.477042 | 0.447227 | 0.029815 | 40 | 0.0002 | 0.0002 | <5 | <10 | <5 | <5 |

## Appendix E: Audit Results of 2009-2010 Recommended Textbooks for Primary and Secondary Schools for Sustainability Inclusion

**Table E1** Results of sustainability assessment of recommended 2009-2010 Primary School textbooks.

| Level | Books / Titles | Core Themes | Sustainability Incorporated? |
|---|---|---|---|
| Infants Year 1 | Reading Textbook Infants 1 - Jolly Reader RED | Friendship; love; kindness; family used for phonetics and syllable recognition lessons; spelling | No |
| | Reading Textbook Infants 1 - Jolly Reader YELLOW | | No |
| | Jolly Reader Workbook | | No |
| | Lets Learn Language Arts Textbook - Infants 1 | | No |
| | Active Mathematics - Infants 1 | Counting; addition; subtraction | No |
| | Integrated Mathematics for Primary Schools: A problem Solving Approach - Infants 1 | | No |
| | Lets Learn Mathematics - Infants 1 | | No |
| | Primary Maths for the Caribbean Bk. A 2nd Edition - Infants 1 | | |
| | Targeting Maths for Caribbean Primary Schools Grade K - Infants 1 | | No |
| | Trinidad and Tobago Primary Mathematics - Infants 1 | | No |
| | Thinking Mathematics - Infants 1 | | No |
| | Let's Learn Science Textbook and Workbook - Infants 1 | States of matter | |
| | Lets Learn Social Studies - Infants 1 | National emblems and significant holidays | No |
| Infants Year 2 | Reading Textbook Infants 2 - Jolly Readers GREEN | Friendship; love; kindness; family; respect used in verb and tense formulation; spelling | No |
| | Keskidee Integrated Language Arts for the Caribbean Pupil: Textbook and Workbook - Infants 2 | | No |
| | Lets Learn Language Arts Textbook and Workbook - Infants 2 | | No |
| | Active Mathematics - Infants 2 | Fractions; multiplication; division; review of addition and subtraction; introduction to time | No |
| | Integrated Mathematics for Primary Schools: A Problem Solving Approach - Infants 2 | | No |
| | Primary Maths for the Caribbean Bk. B 2nd Edition - Infants 2 | | No |
| | Targeting Maths for the Caribbean Primary Schools Grade 1 - Infants 2 | | No |
| | Trinidad and Tobago Primary Mathematics - Infants 2 | | No |
| | Thinking Mathematics - Infants 2 | | No |
| | Lets Learn Science Textbook and Workbook - Infants 2 | Animal classification; introduction to earth systems | No |

## Appendix E (Continued)

| | | | |
|---|---|---|---|
| Standard I | New Caribbean Junior Reader: An Integrated Approach to Reading Book 1- Revised Edition | Personality traits; tolerance of different religions; observance of national festivals. English comprehension skills introduction. | No |
| | Trinidad and Tobago New Republic Reader 1 - Revised Edition | | No |
| | Let's Learn Language Arts Textbook Book 1 | Sentence construction and basic essay writing. | No |
| | Let's Learn Mathematics - Book 1 | Decimals; percentage; approximations; money | No |
| | Let's Learn Science - Book 1 | Experimental variables; simple experimental design concepts | No |
| Standard II | New Caribbean Junior Reader: An Integrated Approach to Reading Book 2- Revised Edition | Conflict resolution. Essay writing based on situation resolution. | No |
| | Trinidad and Tobago New Republic Reader 2 - Revised Edition | | No |
| | Let's Learn Language Arts Textbook Book 2 | Comprehension skills development by use of synthesis and evaluation type questions. Sentence types and structure. | No |
| | Caribbean Primary Mathematics Bright Sparks - Book 2 | Area; volume; mass; time | |
| | Let's Learn Mathematics - Book 2 | | No |
| | Let's Learn Science - Book 2 | Ecosystems; earth and space | No |
| Standard III | New Caribbean Junior Reader : An Integrated Approach to Reading Book 3 - Revised Edition | Scientific fiction stories; vocabulary development - synonyms, antonyms. | No |
| | Trinidad and Tobago New Republic Reader 3 - Revised Edition | | |
| | Let's Learn Language Arts Textbook - Book 3 | Letter writing - personal (friendly, apology, sympathy, etc.) and business. | No |
| | Integrated Mathematics for Primary Schools: A Problem Solving Approach - Book 3 | Geometry: Solids and plane shapes; symmetry; slides, flips and turns | No |
| | Trinidad and Tobago Primary Mathematics - Book 3 | | No |
| | Let's Learn Science - Book 3 | Structure and mechanisms (eg. levers, pulleys, forces) | No |
| Standard IV | Trinidad and Tobago New Republic Reader 4 - Revised Edition | Similes and metaphors. Introduction to poetry. | No |
| | Let's Learn Language Arts Textbook - Book 4 | | No |
| | Exploring Mathematics - Upper Primary Level - Book 4 & 5 (Used in Std. 4 and Std.5) | Angles; introduction to statistics | No |
| | Integrated Mathematics for Primary Schools: A Problem Solving Approach - Book 4 & 5 (Used in Std. 4 and Std.5) | | No |
| | Trinidad and Tobago Primary Mathematics 5th Edition - Book 4 & 5 (Used in Std. 4 and Std.5) | | No |

## Appendix E (Continued)

| | | | |
|---|---|---|---|
| Standard V | Trinidad and Tobago New Republic Reader 5 - Revised Edition | Higher level spelling, vocabulary and grammar. Poetry comprehension. | No |
| | Let's Learn Language Arts Textbook - Book 5 | | No |
| | Let's Learn Science - Book 5 | Energy and magnetism | Yes - Conversation techniques; environmental impact of fossil fuel consumption |
| | Let's Learn Mathematics - Book 5 | Statistics; review of Standards III & IV topics | No |

**Table E2** Results of sustainability assessment of recommended 2009-2010 Form 1 School textbooks.

| Subject | Books / Titles | Core Themes | Sustainability Incorporated? |
|---|---|---|---|
| Mathematics | A Complete Mathematics Course for Secondary Schools Book 1 | Number operations and number theory; applying measurement in 2D; introduction to college algebra; equations to model mathematics; consumer arithmetics; basic geometry; relations and functions; statistics and probability; collecting and organization of statistical data | No |
| | New Secondary Mathematics for Caribbean Schools Book 1 | | No |
| | STP Caribbean Mathematics Book 1 | | No |
| | Trinidad and Tobago Maths Connect Book 1 | | No |
| Spanish | Que Hay - Libro Del Alumno Book 1 | Conjugation of regular verbs (present tense); family structure; days of the week; basic daily items used in the home | No |
| | The New World Spanish /English Dictionary | | No |
| | Collins Spanish Dictionary Express Edition | | No |
| | Chereve! Student Book 1 | | No |
| English | Lighthouse Book 1 | Aesthetic/appreciative listening; descriptions with explicit details; introduction to literary genres; character sketches and web development; media literacy (audio and visual classes); efferent listening; sequencing of events; literary elements; creation of setting or atmosphere; visual interpretation (sign and symbols); oracy; main idea; narration/plot structure; timelines and storyboards; interviewing skills | No |
| | Pocket Oxford English Dictionary | | No |
| Science | Hodder Science - A | Scientific measurement; solar | No |

## Appendix E (Continued)

| | | | |
|---|---|---|---|
| | New Lower Secondary Science Book 1 | | No |
| Physical Education | Caribbean Physical Education 1-2-3 | Nutrition and the body; benefits of exercise to growth and development; introduction to soccer, netball, cricket and basketball. | No |
| Visual & Performing Arts | Visual Arts for Secondary School | History of dance and performing arts; Caribbean dance and its ancestry; introduction to art and crafts. | No |
| | Steelpan Playing with Theory | | No |
| | Learning Can Be Fun | | No |
| Social Studies | Interactive Social Studies Form 1 Focus | Exploring self: esteem, socially acceptable behavior, conflicts and resolution; family in the Caribbean; diversity; consumerism and consumer rights; geographical location in the Caribbean; regional integration. | |
| | Phillip's Certificate Atlas for the Caribbean 5th Edition | | No |
| | Macmillan Caribbean Junior Atlas 3rd Edition | | No |
| | Macmillan Caribbean Certificate Atlas 3rd Edition | | No |
| | The Longman Atlas for the Caribbean Examinations 2nd Edition | | No |

**Table E3** Results of sustainability assessment of recommended 2009-2010 Form 2 School textbooks.

| Subject | Books / Titles | Core Themes | Sustainability Incorporated? |
|---|---|---|---|
| Mathematics | A Complete Mathematics Course for Secondary Schools Book 2 | Integers and number theory; application of measurements in 2D; basic algebra; equations to model mathematics; family consumption arithmetic; intermediary geometry; graphical representation of linear functions and relations; statistical data display; probability and decision making | No |
| | New Secondary Mathematics for Caribbean Schools Book 2 | | No |
| | STP Caribbean Mathematics Book 2 | | No |
| | Trinidad and Tobago Maths Connect Book 2 | | No |
| Spanish | Que Hay - Libro Del Alumno Book 2 | Introduction to past tense (two forms), past predicate and present continuous tense. All of these are used in the vocabulary contexts utilized in Form 1. | No |
| | The New World Spanish /English Dictionary | | No |
| | Collins Spanish Dictionary Express Edition | | No |
| | Chereve! Student Book 2 | | No |
| English | Lighthouse Book 2 | Critical listening; context clues; literary devices; elements of design; vocabulary development; enunciation; analysis of visual text; introduction of statistical reports; author's purpose and point of view; critical listening; fallacies in reasoning | No |
| | Pocket Oxford English Dictionary | | No |
| Science | Hodder Science - B | Organ systems and | No |

## Appendix E (Continued)

| | | | |
|---|---|---|---|
| | New Lower Secondary Science Book 2 | | No |
| Physical Education | Fundamentals of Health and Physical Education | Drugs; netball; football (soccer); basketball; the digestive system; the nervous system; educational gymnastics; formal gymnastics; hockey; badminton; cricket; volleyball; tennis; track and field; folk dance; contemporary/socail dance; outdoor education; swimming. | No |
| | Physical Education to 16 | | No |
| Visual & Performing Arts | Visual Arts for Secondary School | Pencil drawing/shading; water color painting; introduction to music theory | No |
| | Steelpan Playing with Theory | | No |
| | Learning Can Be Fun | | No |
| Social Studies | Interactive Social Studies Form 2 Focus | Globalization: benefits and impacts to the Caribbean; challenges to the Caribbean; technology and globalization; impacts of globalization on economy, environment and society; industrialization and trade. | Yes |
| | Phillip's Certificate Atlas for the Caribbean 5th Edition | | No |
| | Macmillan Caribbean Junior Atlas 3rd Edition | | No |
| | Macmillan Caribbean Certificate Atlas 3rd Edition | | No |
| | The Longman Atlas for the Caribbean Examinations 2nd Edition | | No |

**Table E4** Results of sustainability assessment of recommended 2009-2010 Form 3 School textbooks.

| Subject | Books / Titles | Core Themes | Sustainability Incorporated? |
|---|---|---|---|
| Mathematics | A Complete Mathematics Course for Secondary Schools Book 3 | Exploring real numbers; applying measurement in 2D and 3D; intermediary algebra; linear programming; consumer arithmetic: business/ financial institutions; intermediary geometry; inequalities; graphical solutions of inequalities (2 unknowns); statistical analysis of data: discrete and continuous | No |
| | New Secondary Mathematics for Caribbean Schools Book 3 | | No |
| | STP Caribbean Mathematics Book 3 | | No |
| | Success in Maths for the Caribbean Book 3 | | No |
| Spanish | Aventura Book 3 | Listening for comprehension of spoken narratives; speaking sentences in past and present tense; reading for comprehension (aloud and silently); writing sentences, paragraphs, dialogues, brochures, advertisements. All based on simple themes such as day to day situations, shopping, family, etc | No |
| | Dame Mucho Mas Book 3 | | No |
| | Listos! Book 2 | | No |
| | Viva! Book 3 | | No |
| English | Access English Book 3 | Critical/discriminative listening and speaking; inference; appealing to senses; descriptive writing; detecting stereotyping; | No |

## Appendix E (Continued)

| | | | |
|---|---|---|---|
| | Choices Book 3 | | No |
| Science | Caribbean Interactive Science Book 3 | Light; forces; pressure; man's effect on the environment; acids, bases and salts | Yes |
| Physical Education | Fundamentals of Health and Physical Education | Drugs; netball; football (soccer); basketball; the digestive system; the nervous system; educational gymnastics; formal gymnastics; hockey; badminton; cricket; volleyball; tennis; track and field; folk dance; contemporary/social dance; outdoor education; swimming. | No |
| | Physical Education to 16 | | No |
| Visual & Performing Arts | Visual Arts for Secondary School | Basic composition; music theory; steelpan practical; abstract art | No |
| | Steelpan Playing with Theory | | No |
| | Learning Can Be Fun | | No |
| Social Studies | Interactive Social Studies Form 3 Focus | Natural systems of the earth: weather and climate; riverine and coastal operations and landforms; global cycles; regional geography and eco-systems; mapping of patterns; relationships between natural systems and lifestyles, economics, settlement, transportation and communication; society's response to natural systems over time. Natural hazards and related environmental issues: natural disasters; environmental issues related to hazards; disaster preparedness; role of local and international organizations. Social systems: Authority/power; formal and informal groups; leadership and choice of leaders. Political systems in the English speaking Caribbean: structure of government; history of the Caribbean; judicial structure; regional co-operation. Globalization: global village; impacts of technology; impact of globalization on the individual and society. | |
| | Phillip's Certificate Atlas for the Caribbean 5th Edition | | No |
| | Macmillan Caribbean Junior Atlas 3rd Edition | | No |
| | Macmillan Caribbean Certificate Atlas 3rd Edition | | No |
| | The Longman Atlas for the Caribbean Examinations 2nd Edition | | No |

# Appendix F: Social Network Matrices for Iwokrama

**Table F1** Iwokrama's binary managerial grid for ecotourism.

| Management player (node designation) | Node | a | b | c | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w | x | y | z | aa | ab | ac | ad | ae | af | ag | ah |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Iwokrama Act (a) | a | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Board of Trustees (b) | b | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Stakeholders ( c) | c | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CEO (d) | d | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Finance & Operations Director (e) | e | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Director of Resource Mang't & Training (f) | f | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Finance Manager (g) | g | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HR Manager (h) | h | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Field Station Management Committee (i) | i | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Accounting Manger (j) | j | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HR staff (k) | k | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hospitality Co-ordinator (l) | l | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Maintenance Co-ordinator (m) | m | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tourism Co-ordinator (n) | n | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Accounting staff (o) | o | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Housekeeping & hospitality staff (p) | p | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Chefs (q) | q | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Maintenance staff (r) | r | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tourism staff (s) | s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Boat captains (t) | t | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Kitchen staff (u) | u | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bowmen (v) | v | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Training Co-ordinator (w) | w | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Community Outreach Manager (x) | x | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Conservation Monitoring Manager (y) | y | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Forest Manager (z) | z | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| Head Ranger (aa) | aa | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| GIS/IT Co-ordinator (ab) | ab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| Junior Forestor (ac) | ac | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Timber Operations Co-ordinator (ad) | ad | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| Rangers (ae) | ae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| IT support staff (af) | af | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Tourism Officer (ag) | ag | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Tourisn Admin. Staff (ah) | ah | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

**Table F2** Adjacency matrix for Iwokrama.

| Management player (node designation) | Node | a | b | c | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w | x | y | z | aa | ab | ac | ad | ae | af | ag | ah | Degree of actor | Standardized degree |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Iwokrama Act (a) | a | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1/11 |
| Board of Trustees (b) | b | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1/11 |
| Stakeholders ( c) | c | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1/11 |
| CEO (d) | d | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 13/33 |
| Finance & Operations Director (e) | e | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 7 | 7/33 |
| Director of Resource Mang't & Training (f) | f | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 8 | 8/33 |
| Finance Manager (g) | g | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 5/33 |
| HR Manager (h) | h | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 14/33 |
| Field Station Management Committee (i) | i | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4/33 |
| Accounting Manger (j) | j | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4/33 |
| HR staff (k) | k | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2/33 |
| Hospitality Co-ordinator (l) | l | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 2/11 |
| Maintenance Co-ordinator (m) | m | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 5/33 |
| Tourism Co-ordinator (n) | n | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 7 | 7/33 |
| Accounting staff (o) | o | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1/33 |
| Housekeeping & hospitality staff (p) | p | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1/33 |
| Chefs (q) | q | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1/33 |
| Maintenance staff (r) | r | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1/33 |
| Tourism staff (s) | s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1/33 |
| Boat captains (t) | t | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2/33 |
| Kitchen staff (u) | u | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1/33 |
| Bowmen (v) | v | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1/33 |
| Training Co-ordinator (w) | w | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1/11 |
| Community Outreach Manager (x) | x | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 5/33 |
| Conservation Monitoring Manager (y) | y | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 5/33 |
| Forest Manager (z) | z | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 6 | 2/11 |
| Head Ranger (aa) | aa | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 2/33 |
| GIS/IT Co-ordinator (ab) | ab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 2/33 |
| Junior Forestor (ac) | ac | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1/33 |
| Timber Operations Co-ordinator (ad) | ad | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1/33 |
| Rangers (ae) | ae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1/33 |
| IT support staff (af) | af | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1/33 |
| Tourism Officer (ag) | ag | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 5 | 5/33 |
| Tourisn Admin. Staff (ah) | ah | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1/33 |
| Degree of actor | | 2 | 4 | 2 | 10 | 5 | 7 | 5 | 14 | 6 | 5 | 2 | 5 | 3 | 6 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 4 | 5 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 4 | 2 | 126 | |

## Appendix F (Continued)

**Table F3** Reachability matrix for Iwokrama.

| Management player (node designation) | Node | a | b | c | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w | x | y | z | aa | ab | ac | ad | ae | af | ag | ah |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Iwokrama Act (a) | a | 2 | 3 | 0 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Board of Trustees (b) | b | 2 | 3 | 0 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Stakeholders ( c) | c | 1 | 2 | 2 | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CEO (d) | d | 1 | 2 | 1 | 8 | 4 | 7 | 5 | 11 | 4 | 5 | 1 | 4 | 2 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 4 | 4 | 1 | 1 | 1 | 1 | 0 | 0 | 2 | 0 |
| Finance & Operations Director (e) | e | 0 | 1 | 0 | 5 | 5 | 2 | 5 | 5 | 3 | 5 | 1 | 3 | 2 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 |
| Director of Resource Mang't & Training (f) | f | 0 | 1 | 1 | 6 | 3 | 7 | 2 | 7 | 1 | 2 | 1 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 4 | 4 | 1 | 1 | 1 | 1 | 0 | 0 | 2 | 1 |
| Finance Manager (g) | g | 0 | 1 | 0 | 4 | 4 | 2 | 5 | 5 | 2 | 5 | 1 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| HR Manager (h) | h | 0 | 1 | 1 | 7 | 4 | 7 | 5 | 14 | 5 | 5 | 2 | 4 | 2 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 4 | 4 | 4 | 4 | 1 | 1 | 1 | 1 | 0 | 0 | 3 | 0 |
| Field Station Management Committee (i) | i | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 4 | 0 | 0 | 3 | 2 | 4 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Accounting Manger (j) | j | 0 | 0 | 0 | 2 | 2 | 1 | 3 | 3 | 0 | 3 | 1 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HR staff (k) | k | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 0 | 1 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hospitality Co-ordinator (l) | l | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 3 | 3 | 1 | 1 | 4 | 2 | 4 | 0 | 2 | 2 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Maintenance Co-ordinator (m) | m | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 3 | 3 | 1 | 1 | 3 | 3 | 4 | 0 | 0 | 0 | 2 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Tourism Co-ordinator (n) | n | 0 | 0 | 0 | 2 | 2 | 1 | 1 | 3 | 3 | 1 | 1 | 4 | 2 | 5 | 0 | 1 | 1 | 0 | 2 | 2 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 |
| Accounting staff (o) | o | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Housekeeping & hospitality staff (p) | p | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Chefs (q) | q | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Maintenance staff (r) | r | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tourism staff (s) | s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Boat captains (t) | t | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Kitchen staff (u) | u | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bowmen (v) | v | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Training Co-ordinator (w) | w | 0 | 0 | 0 | 2 | 1 | 3 | 1 | 3 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Community Outreach Manager (x) | x | 0 | 2 | 2 | 4 | 2 | 4 | 2 | 4 | 1 | 2 | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 5 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Conservation Monitoring Manager (y) | y | 0 | 1 | 0 | 4 | 2 | 4 | 2 | 4 | 1 | 2 | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 4 | 3 | 2 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| Forest Manager (z) | z | 0 | 0 | 0 | 2 | 1 | 3 | 1 | 3 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 3 | 0 | 2 | 2 | 2 | 0 | 1 | 1 | 0 |
| Head Ranger (aa) | aa | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| GIS/IT Co-ordinator (ab) | ab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 |
| Junior Forestor (ac) | ac | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Timber Operations Co-ordinator (ad) | ad | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| Rangers (ae) | ae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| IT support staff (af) | af | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Tourism Officer (ag) | ag | 0 | 1 | 0 | 3 | 3 | 1 | 2 | 3 | 3 | 2 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 2 |
| Tourisn Admin. Staff (ah) | ah | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

**Table F4** Relationship matrix for Greencastle.

| Management player (node designation) | Node | a | b | c | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w | x | y | z | aa | ab | ac | ad | ae | af | ag | ah | Sum of frequencies |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Iwokrama Act (a) | a | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Board of Trustees (b) | b | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Stakeholders ( c) | c | 0 | 1 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| CEO (d) | d | 1 | 3 | 2 | 0 | 4 | 7 | 5 | 4 | 2 | 5 | 1 | 3 | 4 | 5 | 2 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 5 | 7 | 7 | 3 | 2 | 1 | 4 | 1 | 3 | 6 | 2 | 95 |
| Finance & Operations Director (e) | e | 0 | 2 | 1 | 4 | 0 | 5 | 5 | 5 | 2 | 5 | 1 | 1 | 1 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 38 |
| Director of Resource Mang't & Training (f) | f | 1 | 3 | 4 | 8 | 5 | 0 | 6 | 10 | 5 | 8 | 4 | 3 | 4 | 5 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 4 | 5 | 6 | 3 | 2 | 2 | 1 | 1 | 3 | 1 | 2 | 1 | 112 |
| Finance Manager (g) | g | 0 | 1 | 1 | 2 | 3 | 2 | 0 | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 |
| HR Manager (h) | h | 0 | 0 | 1 | 3 | 3 | 5 | 4 | 0 | 3 | 2 | 2 | 1 | 2 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 57 |
| Field Station Management Committee (i) | i | 0 | 0 | 0 | 2 | 1 | 2 | 1 | 3 | 0 | 0 | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 19 |
| Accounting Manger (j) | j | 0 | 0 | 1 | 3 | 1 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 |
| HR staff (k) | k | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Hospitality Co-ordinator (l) | l | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 2 | 2 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18 |
| Maintenance Co-ordinator (m) | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| Tourism Co-ordinator (n) | n | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 15 |
| Accounting staff (o) | o | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Housekeeping & hospitality staff (p) | p | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Chefs (q) | q | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Maintenance staff (r) | r | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Tourism staff (s) | s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Boat captains (t) | t | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Kitchen staff (u) | u | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bowmen (v) | v | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Training Co-ordinator (w) | w | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| Community Outreach Manager (x) | x | 0 | 0 | 3 | 4 | 0 | 3 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| Conservation Monitoring Manager (y) | y | 0 | 0 | 0 | 1 | 1 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 11 |
| Forest Manager (z) | z | 0 | 0 | 0 | 1 | 1 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 8 |
| Head Ranger (aa) | aa | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 3 |
| GIS/IT Co-ordinator (ab) | ab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 4 |
| Junior Forestor (ac) | ac | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Timber Operations Co-ordinator (ad) | ad | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Rangers (ae) | ae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| IT support staff (af) | af | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Tourism Officer (ag) | ag | 0 | 0 | 0 | 2 | 3 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 15 |
| Tourisn Admin. Staff (ah) | ah | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 |
| Sum of frequencies | | 3 | 11 | # | 37 | 24 | 37 | 30 | 45 | 13 | # | 9 | 13 | # | 28 | 13 | 9 | 5 | 5 | 9 | 5 | 6 | 5 | 9 | 18 | 18 | 18 | 11 | 6 | 3 | 7 | 10 | 6 | 14 | 8 | 489 |

## Appendix G: Modeling framework to link ecotourism activities in the Caribbean to management structure and water quality.

### Introduction

As was alluded to earlier in Chapter 1, ecotourism was born out of a need to marry tourism concepts with environmental preservation and conservation ideals. In order to attain this goal of marrying these 2 areas ecotourism has to be sustainable which can only be achieved through meticulous and calculated management (Carter and Lowman, 1994). Thus the management of the industry affects its sustainability across its 3 core pillars with environmental sustainability being of paramount importance in this work. One of the general key indicators of environmental sustainability is surface water quality (WTO, 1996; 2004; Ceballos-Lascurain, 1996). Literature suggests that management of tourism, inclusive of ecotourism, is a major determinant on the impact of the industry on the environment (Holden, 2000; Manson, 2008). However the measure of impacts of the tourism industry as well as the measure of success of management of tourism and ecotourism still remains qualitative. These qualitative measures are typically done by the use of environmental management auditing tools (Tribe, 1997; Denman, 2008). In the case of the Caribbean such audits and impacts are typical at the start up of the ecotourism business since they may be mandated by law (Stewart, 2006; CARICOM, 2009). The World Tourism Organization (WTO) recognizes the need for quantification of impacts and model development and has called on the scientific community to become involved in this type of work as the WTO thinks it is pivotal for true sustainability planning, especially in the case of ecotourism (WTO, WTTC & Earth Council, 1996; Shah, 2000). Thus this work was done to propose a first approach to modeling, through quantitative inputs, the impacts of ecotourism on water quality as a function of the ecotourism management.

**Objective and Subtasks**

The main goal of this chapter was to propose a systems thinking approach to numerical modeling of ecotourism, which in itself is a complex system. The objective of the numerical model development was to determine the impact, at a single point in the surface water, of all the ecotourism operations (i.e. the transient tourists and onsite activities that caters to running the business) on surface water quality as a function of how ecotourism, as a single complex entity, is run at the site level. The specific subtasks were:

- Use systems thinking to develop the dynamics of management and water quality,
- Determine the numerical model for the management-water quality dynamics,
- Run numerical model by use of scenario STELLA®.

**The Conceptual Link between Management and Surface Water Quality**

Management density is used as the numerical link between the impacts of ecotourism activities and surface water quality. Management density was developed in Chapter 5 from the use of Social Network Analysis (SNA). To recap, management density was created by modifying the concept of network density as it exists in SNA. Conventional network density can be calculated by:

$$\text{Network density} = \frac{T}{N(N-1)/2} \qquad (5.2)$$

where T is the number of ties present; N is the number of actors in the network. Conventional network density accounts for all ties among actors since all ties are usually two-way when measuring social/informal relations (e.g. friendship) for which SNA was developed. However in the case of a management relationship there may exist many one-way ties. In consideration of modern theories of management and organizational theory that promote two-way interactions among actors (Nohria and Eccles, 1992; Hu, 2009), all one-way ties were considered half of a tie and only two-way ties were considered a whole tie. Thus the modified Equation 5.2 utilized was:

$$\text{Management density}\left(\rho_{Mgt}\right) = \frac{T_{two-way}}{N(N-1)/2} \tag{5.3}$$

where $T_{two\text{-}way}$ is the number of two-way ties in the management network; N is the number of actors (or nodes) in the network.

Prior to the determination of the management density is the sociograph or network of all the relevant actors in consideration of management of the ecotourism product at the site. In keeping with the network density convention, management density too can be a theoretical minimum of 0 and a maximum of 1. Also a management density of 1 represents a management structure that is firmly rooted in sustainable business practice. As was stated in Chapter 5 the sustainable management of ecotourism at the site level requires proper management across the economic, environmental, societal, cultural and political spheres of sustainability. This refers to the management of both onsite/staff as well as guest activities, from an environmental standpoint, to minimize overall pollution inclusive of water pollution. Thus for this work we have:

Environmental sustainability = $f$(surface water quality) (G1)

and: environmental sustainability = $f$(management density) (G2)

which implies that: surface water quality = $f$(management density). (G3)

From the first principles of management density, poor water quality will be directly proportional to a low management density. That is for a given water quality variable (e.g. COD, BOD) low water quality is denoted by a high numerical value for the indicator variable. Thus:

Water quality variable value $\propto$ (management density)$^{-1}$ (G4)

Therefore: Water quality variable value = $k$ / management density (G5)

where $k$ is the proportionality constant.

Theoretically management density, as it follows from SNA's network density, can have a minimum of 0. However due to the definition of self management used in this study a management density of 0 is impossible. That is, this work assumes that every actor in an ecotourism network manages himself or herself so that accounts for a half tie.

**Description of Single Indicator Model and Parameters**

The concept described above is linked through a systems approach to determine the mathematical model for water quality contingent upon a single parameter as the indicator. COD was chosen for initial use as it is one of the key indicators suggested (in Chapter 6) for inclusion in any water quality monitoring program to be created.

Theoretically, COD is considered to be the amount of chemical oxidant required to completely oxidize a source of organic matter such as nitrogen, phosphorus, ammonia, nitrates and nitrites. The oxygen demand that is created by the presence of these chemicals is reduced when the chemicals are removed from or degraded in the system. Model assumptions used for development are:

1. COD as the only key water quality indicator;
2. Time step was taken as one day;
3. 2:1 tourist arrival to departure ratio;
4. Population growth rate within the watershed is negligible when compared to the transient tourist arrival rates; and
5. Natural degradation of COD in the environment was taken to be the theoretical half life.

The objective of the model is to determine the impact of management on COD outflow. Consider Figure G1 and Table G1 for descriptions of the model parameters.

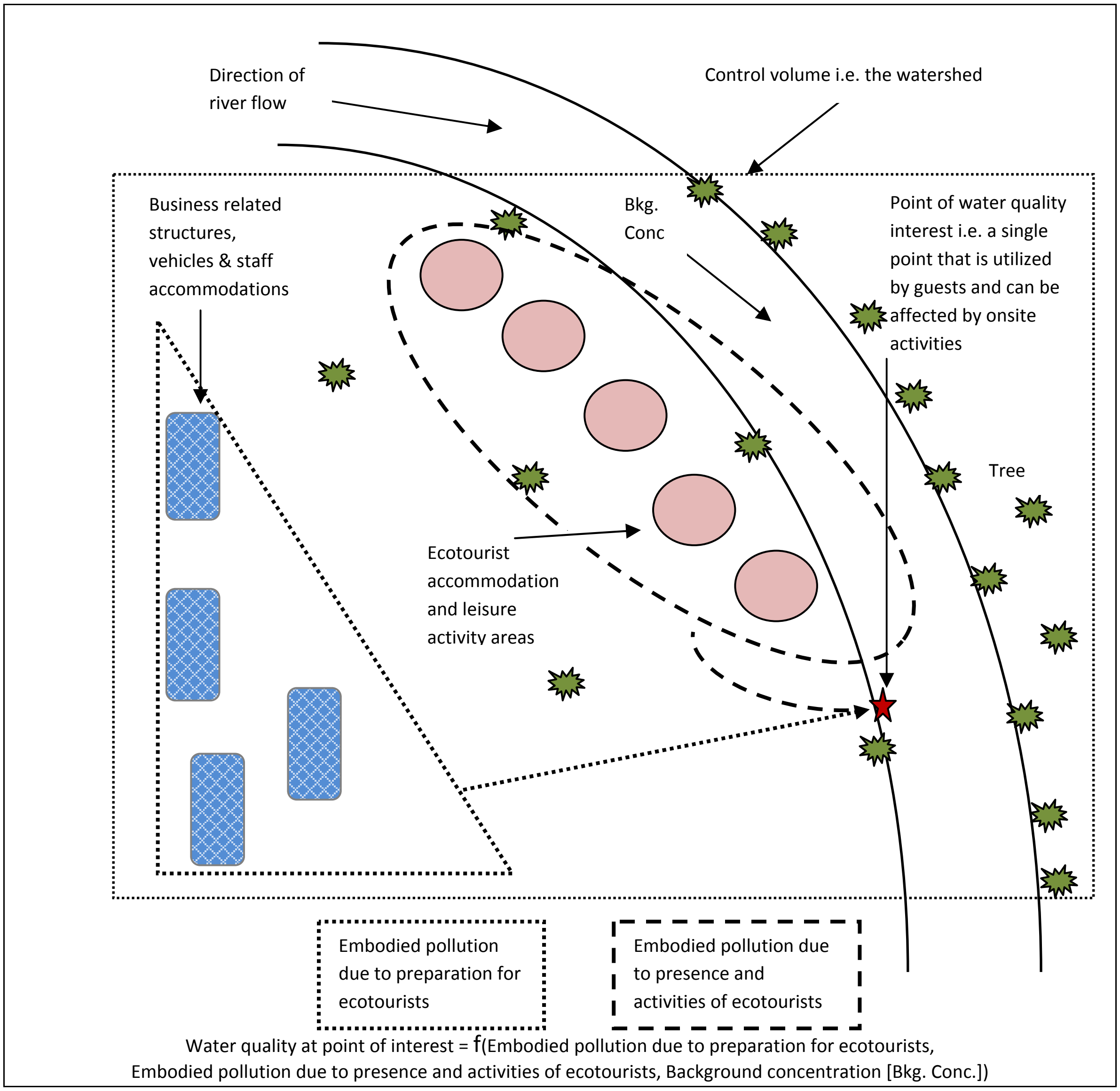



**Figure G1** General systems dynamics utilized in the model development.

**Table G1** Description of parameters in the COD-management model.

| Term | Description | Units |
|---|---|---|
| Monthly seasonal variability factor | In the Caribbean arrivals are greatest in the northern hemisphere's winter months. As such this factor accounts for a fluctuating arrival rate by month. | - |
| Population | Population refers to people living and working in the watershed that can potentially affect water quality. | persons |
| Arrivals ($T_A$) | Number of ecotourists arriving at an ecohotel daily. | persons/day |
| Departures | Number of ecotourists departing from ecohotel daily. | persons/day |
| Management density ( $\rho_{Mgt}$ ) | As developed in Chapter 5, this factor refers to the strength of relationships between employees and management as needed for meeting business objectives. This value is usually a fraction at a maximum of 1 and minimum of 0. | - |
| Embodied COD ($E_{COD}$) per person | This term is analogous to embodied energy (sum total of cradle to grave energy requirement of any product/activity) and was coined to incorporate all the onsite activities that take place in preparation for guests (directly and indirectly) that impacts the COD of surface water as well as the potential impacts of tourists (e.g. through use of personal care products, taxis driving them in the watershed, etc.) just being present in the watershed. | mg/L/person |
| Natural COD degradation rate ( $\lambda_{t_{1/2}}$ ) | In a natural system, water quality changes due to natural processes that are ongoing (e.g. sorption of chemicals, degradation or consumption, etc.) and these losses were lumped into a single degradation constant. | - |
| COD | This refers to the sum of the background COD of waters (i.e. unrelated to the ecotourism in the watershed) flowing into the watershed as well as COD inflows due to onsite activity. | mg/L |
| COD inflow | Amount of COD into surface water due to arrival of tourists (and the preparation for them onsite before, during and after arrival). | mg/L |
| COD outflow | Final COD of surface water which takes into account the background concentration as well as onsite activity/ecotourists inputs. | mg/L |

### Model Development

The number of ecotourists that arrive on any given day is influenced by the season in the northern hemisphere with arrival rates being greatest during the winter months. Therefore a seasonal variability factor was introduced to observe how COD concentrations will change over seasons in an entire year. Regardless of when the ecotourists visit the ecosites, their presence in the watershed has associated with it COD inputs into the surface water indirectly before they come when staff are preparing for their arrival, during their stay and involvement in leisurely activities while staff continue to exert COD to make guests comfortable, and even upon departure to take care of the impacts of the guests. These perturbations in COD are collectively lumped under embodied COD. Therefore each guest has associated with him or her some embodied COD value. So on any given day the total COD inflow due to guests' presence is given by:

Total theoretical COD due to tourists = Embodied COD per tourist * Arrivals (G6)

[Units: mg/L $day^{-1}$= mg/L / person * persons/day]

However from Equation G5 management density is inversely related to this theoretical COD due to the guests. That is management density can affect both the COD exerted by staff and guests through proper management inclusive of monitoring and policy. Thus from Equation G5 we have:

$$\text{Actual } E_{COD} \text{ exerted} = k * \text{Theoretical } E_{COD} \text{ per tourist} / \rho_{Mgt} \quad \text{(G7)}$$

where $k$ is a proportionality constant; $E_{COD}$ is embodied COD; $\rho_{Mgt}$ is management density.

Since the embodied COD is on a per tourist basis then the final embodied COD must include the number of arrivals on any given day. Thus:

$$\text{Actual } E_{COD} \text{ exerted} = \text{Arrivals} * \text{Theoretical } E_{COD} \text{ per tourist} / \rho_{Mgt} \quad \text{(G8)}$$

[Units: mg/L $day^{-1}$ = persons/day * {mg/L / person} / {-}]

where $k$ is a proportionality constant; $E_{COD}$ is embodied COD; $\rho_{Mgt}$ is management density.

In consideration of Figure G1 and a mass balance perspective, the total COD flowing into the point of interest must consider that there is some natural degradation of COD i.e. naturally occurring processes by which the stream attempts to 'restore' itself. Therefore the COD output from the ecotourism operations (i.e. the transient tourists and onsite activities that caters to running the business) can be given by:

Actual COD at point of interest = Actual $E_{COD}$ exerted – Degraded COD (G9)

[Units for all terms: mg/L day$^{-1}$]

In the Caribbean setting, the substances that are expected to be inputted into the ecosite's adjoining waterways (i.e. nitrogen, phosphorus, ammonia, nitrates and nitrites) have half lives of seconds up to 4 days. Thus for this model the natural degradation of COD is taken to follow a first order reaction under half life behavior kinetics. For a first order reaction:

$$\text{Half life } (t_{1/2}) = \frac{0.693}{\lambda_{t_{1/2}}} \qquad \text{(G10)}$$

where $t_{1/2}$ is half life in days; and $\lambda_{t_{1/2}}$ is the rate constant in day$^{-1}$.

Since the average half life of all the chemicals expected to contribute to COD are approximately 1 day, then the lumped half life is taken to be 1 day. By substituting in Equation G10:

Rate constant for COD degradation ( $\lambda_{t_{1/2}}$ ) = 0.693 $day^{-1}$ (G11)

At the point of interest the COD that can be possibly degraded is inclusive of the actual $E_{COD}$ exerted in addition to the background COD of the surface water. The sum of these both system inputs is hereunder referred to as the 'Overall COD input to point.' This implies that at the point of interest:

COD outflow = Actual $E_{COD}$ exerted – Degraded COD (G12)

where Degraded COD = ( $\lambda_{t_{1/2}}$ ) (Overall COD input to point) (G13)

COD outflow = Actual $E_{COD}$ exerted - ( $\lambda_{t_{1/2}}$ ) (Overall COD input to point) (G14)

[Units: mg/L $day^{-1}$ = mg/L $day^{-1}$ – {-}{ mg/L $day^{-1}$}]

where $E_{COD}$ is embodied COD; $\lambda_{t_{1/2}}$ is 0.693 $day^{-1}$.

Thus Equation G12 represents the impacts of management on ecotourism activities and level of COD in surface water. By substituting Equation G8 into Equation G14 we have:

COD outflow from point = Arrivals * $E_{CODth}$ / $\rho_{Mgt}$ - $\lambda_{t_{1/2}}$ * $C_{COD}$ (G15)

[Units: mg/L $day^{-1}$ = {persons/day * {mg/L / person} / {-}} – {-} {mg/L / day}] where $E_{CODth}$ is Theoretical $E_{COD}$ per tourist; $E_{COD}$ is embodied COD; $\lambda_{t_{1/2}}$ is the natural daily rate of COD degradation; $\rho_{Mgt}$ is management density; $C_{COD}$ is Overall COD input to point.

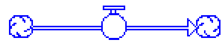
## Modeling in STELLA®

The water quality modeling described above was obtained by applying systems thinking to a complex system. The model developed (Equation G15) was attempted to be put into STELLA® to basically check if the systems thinking behind the model makes sense numerically and units-wise i.e. if it can be run to give a useful output.

STELLA® requires that models be created based on first order differential equations. It is for this reason the Equation G15 was developed in the way that is was as it is already in a first order differential form. To help see Equation G15 in the required form, it was rewritten as:

$$\frac{dC_{COD}}{dt} = T_A * \frac{1}{\rho_{Mgt}} * E_{COD} - C_{COD} * \lambda_{t_{1/2}} \qquad \text{(G16)}$$

where $\frac{dC_{COD}}{dt}$ is the rate of change of COD concentration at point of interest [mg/L day$^{-1}$]; $T_A$ is the number of arrivals [persons/day]; all other terms are as described for Equation G15.

With Equation G16 in the desired form, it then had to be decided what would be the stocks, flows and converters in order to construct the model in STELLA®. In STELLA®'s language a stock (shown as a blue rectangle) can be considered a reservoir i.e. it is a state variable as it tell of the condition in the system. Stocks are used to represent variables that the program uses to make all other calculations in the model (Hannon and Ruth, 2001). Flows (shown as ) on the other hand represent how the reservoirs (i.e. stocks) are filled (inflow) and emptied (outflow). The rates at which the stocks are filled or emptied depend on some translational variable or converter (shown as a lone blue circle). The informational arrow (pink) or connector simply relays information from a converter or stock information about the state, control or transformational variable to another converter, flow or stock (Hannon and Ruth, 2001). By application of this theory to Equation G16 a STELLA® representation of the system was created (see Figure G2).

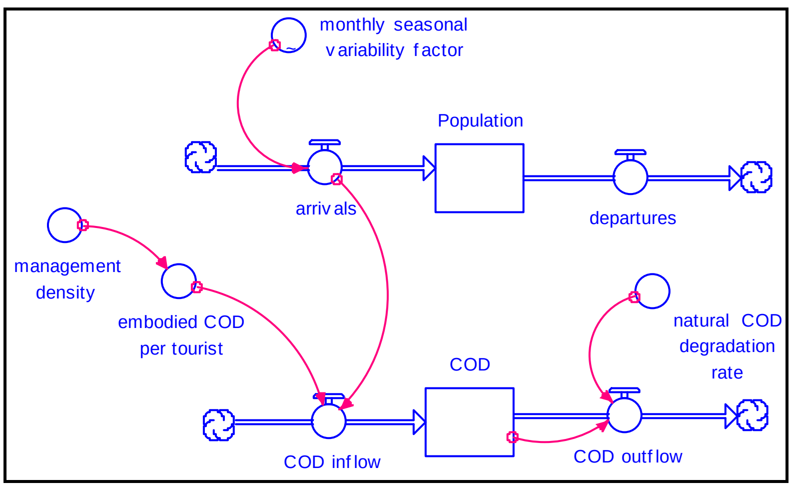



**Figure G2** Systems thinking linking of Chemical Oxygen Demand (COD), management and ecotourism activities according to Equation G16

### Scenario to Run Model

The overall objective of the model was to determine the impact of management on COD outflow and thus a sensitivity analysis using varied management densities was utilized.

Conservative numerical values were assigned for all other parameters highlighted in Figure G2. The assigned values are detailed in Table G2

**Table G2** Assigned parameter values to run model with COD as sole water quality indicator.

| Parameter | Value | Unit |
|---|---|---|
| Population | 150 | persons |
| Arrivals ($T_A$): departures ratio | 2:1 | persons/day |
| Management density ( $\rho_{Mgt}$ ) | Varied between 0.1 and 1 | - |
| Embodied COD per person i.e. theoretical ($E_{CODth}$) | 1000 * $T_A$ | mg/L/person |
| Actual embodied COD per person ($E_{COD}$) | 1000 * $T_A$ / $\rho_{Mgt}$ | mg/L/person |
| Natural COD degradation rate ( $\lambda_{t_{1/2}}$ ) | 0.693 | 1/day |
| Background COD ($Bkg_{COD}$) | 200 | mg/L |
| Output COD from point ($C_{COD}$) | Sum of $E_{COD}$ and ( $\lambda_{t_{1/2}}$ * $Bkg_{COD}$) | mg/L/day |
| Monthly seasonal variability factor | Varies from 0 - 1 | - |
| January | 1 | - |
| February | 1 | - |
| March | 0.9 | - |
| April | 0.8 | - |
| May | 0.7 | - |
| June | 0.5 | - |
| July | 0.25 | - |
| August | 0.5 | - |
| September | 0.6 | - |
| October | 0.7 | - |
| November | 0.8 | - |
| December | 1 | - |

**Model Output**

The model was able to be run successfully by using the following settings:

1. Incremental increase in management density,
2. Comparative graphical output, and
3. Time series with 5 grid segments.

The result of the run (Figure G3) shows that as management density increases the level of COD decreases i.e. a higher management density gets better surface water quality. Also, COD varies with month as a function of tourist arrival. Thus it appears that this proposed model is able to capture the impact of visitors and onsite activities as a function of the ecosite's management based on a single water quality parameter.

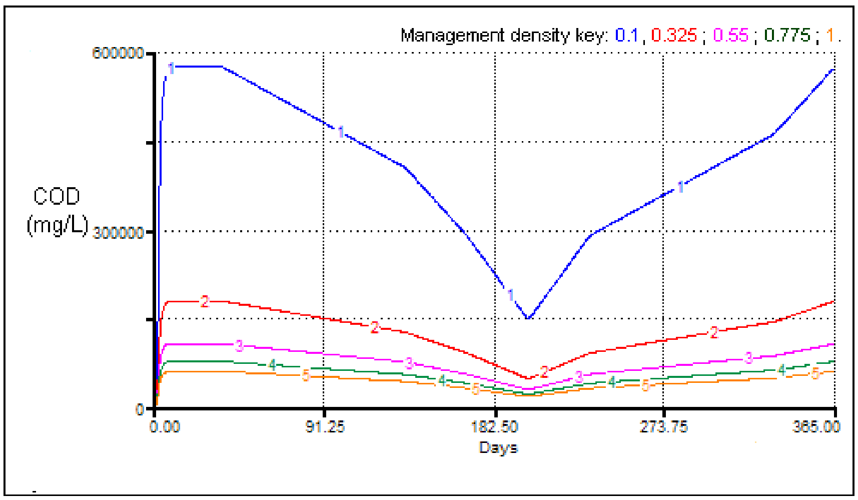



**Figure G3** Plot of COD output (mg/L) vs time (days) for varying management densities generated in STELLA®.

STELLA® automatically generates the equations of the model that is utilized to create the linkages. Table G3 shows the generated equations for this scenario.

**Table G3** Automatically generated model equations in STELLA® for COD-management interaction.

```
COD(t) = COD(t - dt) + (COD_inflow - COD_outflow) * dt
INIT COD = 200 {mg/L}
INFLOWS:
COD_inflow = arrivals * embodied_COD__per_tourist
OUTFLOWS:
COD_outflow = COD * natural__COD_degradation_rate
Population(t) = Population(t - dt) + (arrivals - departures) * dt
INIT Population = 150 {persons}
INFLOWS:
arrivals = monthly_seasonal_variability_factor * 40 {persons/day}
OUTFLOWS:
departures = 20 {persons/day}
embodied_COD__per_tourist = (1 / management__density) * 1000
management__density = 0.5
natural__COD_degradation_rate = 0.693
monthly_seasonal_variability_factor = GRAPH(TIME)
(0.00, 1.00), (33.2, 1.00), (66.4, 0.9), (99.5, 0.8), (133, 0.7), (166, 0.5), (199, 0.25), (232, 0.5), (265, 0.6),
(299, 0.7), (332, 0.8), (365, 1.00)
```

Based on the STELLA output in Table G3, the numerical model that links COD levels with management and ecotourism activities can be worked out. When this was done, it was found that it was exactly Equation G16 that was arrived at. This means that the proposed model (i.e. Equation G16) can be exactly modeled in systems thinking software such as STELLA®. However when it comes to water quality it is very likely that more than one parameter may be utilized as an indicator. As a result there is a need to ensure that the proposed model can include other water quality parameters and that they can be modeled simultaneously.

### Description of Bi-indicator Model and Parameters

The 2 indicators selected for inclusion were BOD and COD as BOD is also suggested as an indicator for inclusion in any water quality monitoring programs in Caribbean ecotourism areas. BOD is usually defined as the amount of oxygen consumed by microorganisms in performing oxidation on carbonaceous and nitrogenous organic matter. The rate of oxidation thus depends on, non-exhaustively, the type of microorganisms present and the sources of organic matter. Similarly the rate of degradation of BOD naturally in surface water would also be a function of these and therefore highly variable by location.

Very similar to those used in the aforementioned model, the assumptions used for this bi-indicator model development are:

1. COD and BOD are the only key water quality indicators;
2. Time step was taken as one day;
3. 2:1 tourist arrival to departure ratio;
4. Population growth rate within the watershed is negligible when compared to the transient tourist arrival rates;
5. Natural degradation of COD in the environment was taken to be the theoretical half life rate constant; and
6. The natural rate of degradation of BOD in the environment was assumed to be 0.35 $day^{-1}$. This was obtained from use of the theoretical reaeration coefficient of BOD in a natural system at $30^{o}C$, a temperature representative of the Caribbean.

The objective of the bi-indicator model is to determine the impact of management on both BOD and COD outflow at a single point of interest. Consider Figure G1, Table G1 and Table G4 for descriptions of the model parameters. Table G1 describes parameters of interest for COD modeling as well as general parameters that affect both BOD and COD outputs. The parameters described in Table G4 are specific to the BOD aspect of the model.

**Table G4** Description of BOD related parameters in the BOD-COD-management model.

| Term | Description | Units |
|---|---|---|
| Embodied BOD ($E_{BOD}$) per person | This term incorporated all the onsite activities that take place in preparation for guests (directly and indirectly) that impacts the BOD of surface water as well as the potential impacts of tourists (e.g. through use of onsite pit latrines/toilets in the watershed, etc.) just being present in the watershed. | mg/L/person |
| Natural BOD ($k_{BOD}$) degradation rate | In a natural system, water quality changes due to natural processes that are ongoing (e.g. equilibration with atmospheric oxygen, etc.) and these losses were lumped into a single degradation constant. | - |
| BOD | This refers to the sum of the background BOD of waters (i.e. unrelated to the ecotourism in the watershed) flowing into the watershed as well as BOD inflows due to onsite activity. | mg/L |
| BOD inflow | Amount of BOD into surface water due to arrival of tourists (and the preparation for them onsite before, during and after arrival). | mg/L |
| BOD outflow | Final BOD of surface water which takes into account the background concentration as well as onsite activity/ecotourist inputs. | mg/L |

### Bi-indicator Model Development

Numerically, the simplest approach to modeling a binary system is to develop separate models for each component and then combine the individual models based on the parameters that are common. This was the approach taken in this work. Thus the COD component of the model will be as developed earlier:

$$\frac{dC_{COD}}{dt} = T_A * \frac{1}{\rho_{Mgt}} * E_{COD} - C_{COD} * \lambda_{t_{1/2}} \tag{G16}$$

where $\frac{dC_{COD}}{dt}$ is the rate of change of COD concentration at point of interest [mg/L day$^{-1}$]; $T_A$ is the number of arrivals [persons/day]; $E_{COD}$ is embodied COD; $\lambda_{t_{1/2}}$ is the natural daily rate of COD degradation; $\rho_{Mgt}$ is management density; $C_{COD}$ is Overall COD input to point.

The dynamics by which BOD would enter, leave and degrade in the system are very much similar to the COD dynamics. Thus by going through the same process of model development done for the COD analysis, as highlighted above, the only difference would be in the rate of natural degradation of BOD when compared to COD. The natural degradation of BOD in a natural water is controlled by the critical concentration level of the Dissolved Oxygen (DO) Sag Curve. From Sag Curve theory, as oxygen levels drop due to BOD loading of the natural water, atmospheric oxygen enters the water to compensate for the oxygen deficit. Initially oxygen consumption in the water and to the sediment limits this reaeration process (Chapra, 1997). However, as the organic matter is assimilated as the oxygen levels drop, there will come a point at which the depletion and the reaeration will be in balance. At this the lowest or critical level of oxygen will be reached. Beyond this point reaeration dominates and oxygen levels begin to rise (Chapra, 1997). Note that in this model surface reaeration is considered as the dominant mechanism of reaeration.

So for the development of the BOD model the natural rate of degradation of BOD was symbolized by $k_{BOD}$ with units of day$^{-1}$. Therefore the BOD model can be expressed (in like form to the COD model) as:

$$\frac{dC_{BOD}}{dt} = T_A * \frac{1}{\rho_{Mgt}} * E_{BOD} - C_{BOD} * k_{BOD} \qquad \text{(G17)}$$

where $\frac{dC_{BOD}}{dt}$ is the rate of change of BOD concentration at point of interest [mg/L day$^{-1}$]; $T_A$ is the number of arrivals [persons/day]; $E_{BOD}$ is embodied BOD; $k_{BOD}$ is the natural daily rate of BOD degradation; $\rho_{Mgt}$ is management density; $C_{BOD}$ is Overall BOD input to point [mg/L].

Note that the term $T_A * \frac{1}{\rho_{Mgt}}$ (i.e. arrival * {1 / management density}) is common to both Equations 7.17 and 7.16. By rearranging Equation G17 we have:

$$T_A * \frac{1}{\rho_{Mgt}} = \frac{\frac{dC_{BOD}}{dt} + C_{BOD}k_{BOD}}{E_{BOD}} \tag{G18}$$

Substituting Equation G18 into Equation G16 obtains:

$$\frac{dC_{COD}}{dt} = [\frac{\frac{dC_{BOD}}{dt} + C_{BOD}k_{BOD}}{E_{BOD}}]E_{COD} - \lambda_{t_{1/2}}C_{COD} \tag{G19}$$

By rearranging Equation G19 the overall COD, BOD, management and onsite ecotourism activities can be expressed as:

$$E_{BOD}\frac{dC_{COD}}{dt} = \frac{dC_{BOD}}{dt} + C_{BOD}k_{BOD} - \lambda_{t_{1/2}}E_{COD}C_{COD} \tag{7.20}$$

**Bi-indicator Modeling in STELLA®**

As was done for the single parameter model, STELLA® was also used to attempt to validate the model by determining if the systems thinking behind the bi-indicator model are logical and possible. Again STELLA® requires first order differential equations to model any complex system. Though Equations G19 and G20 are in this form it makes for very complicated linking in STELLA® since the key modeling links (i.e. tourist arrival and management density) between the COD and BOD parameters are not explicitly stated. Thus the best way of linking the two indicators is through the individual models developed i.e. Equations G16 and G17. This basically means that the COD model's STELLA® representation (shown in Figure G2) served as the basis for the addition of the BOD model. The culmination of the two models is shown in Figure G4.

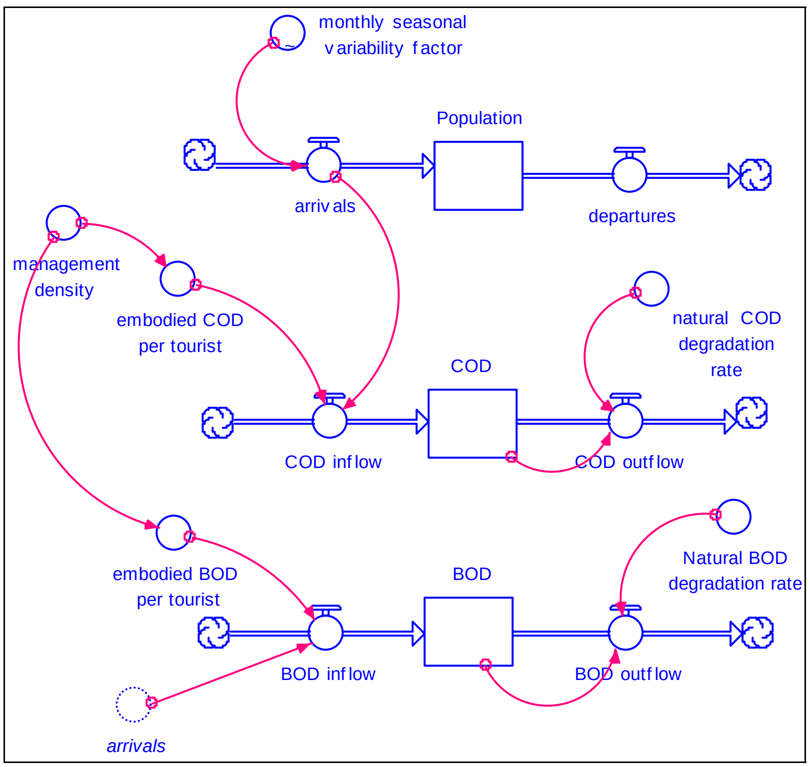



**Figure G4** Systems thinking linking of Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), management and ecotourism activities.

### Scenario to Run Bi-indicator Model

The STELLA® model created has the objective of determining the impact of management on both BOD and COD outflow. The same conservative COD model parameters' values were utilized so as to compare whether the output will be different due to the inclusion of the additional indicator. Some values for BOD parameters were also assigned with all the parameter inputs used shown in Table G5.

**Table G5** Assigned parameter values to run bi-indicator model with COD and BOD as water quality indicators.

| Parameter | Value | Unit |
|---|---|---|
| Population | 150 | persons |
| Arrivals ($T_A$): departures ratio | 2:1 | persons/day |
| Management density ( $\rho_{Mgt}$ ) | Varied between 0.1 and 1 | - |
| Embodied COD per person i.e. theoretical ($E_{CODth}$) | 1000 * $T_A$ | mg/L/person |
| Actual embodied COD per person ($E_{COD}$) | 1000 * $T_A$ / $\rho_{Mgt}$ | mg/L/day |
| Natural COD degradation rate ( $\lambda_{t_{1/2}}$ ) | 0.693 | 1/day |
| Background COD ($Bkg_{COD}$) | 200 | mg/L |
| Output COD from point ($C_{COD}$) | 1000 | mg/L |
| Embodied BOD per person i.e. theoretical ($E_{BOD}$) | 1000 * $T_A$ | mg/L/person |
| Actual embodied BOD per person ($E_{COD}$) | 100 * $T_A$ / $\rho_{Mgt}$ | mg/L/day |
| Natural BOD degradation rate ( $k_{BOD}$ ) | 0.35 | 1/day |
| Background BOD ($Bkg_{BOD}$) | 20 | mg/L |
| BOD ($C_{BOD}$) | 200 | mg/L |
| Monthly seasonal variability factor | Varies from 0 - 1 | - |
| January | 1 | - |
| February | 1 | - |
| March | 0.9 | - |
| April | 0.8 | - |
| May | 0.7 | - |
| June | 0.5 | - |
| July | 0.25 | - |
| August | 0.5 | - |
| September | 0.6 | - |
| October | 0.7 | - |
| November | 0.8 | - |
| December | 1 | - |

**Model Output**

The model was able to be run successfully by using the same settings listed above for the single variable model. Interesting to note is that the COD output was exactly that attained in running the single variable model (see Figure G3). The BOD output is shown in Figure G5

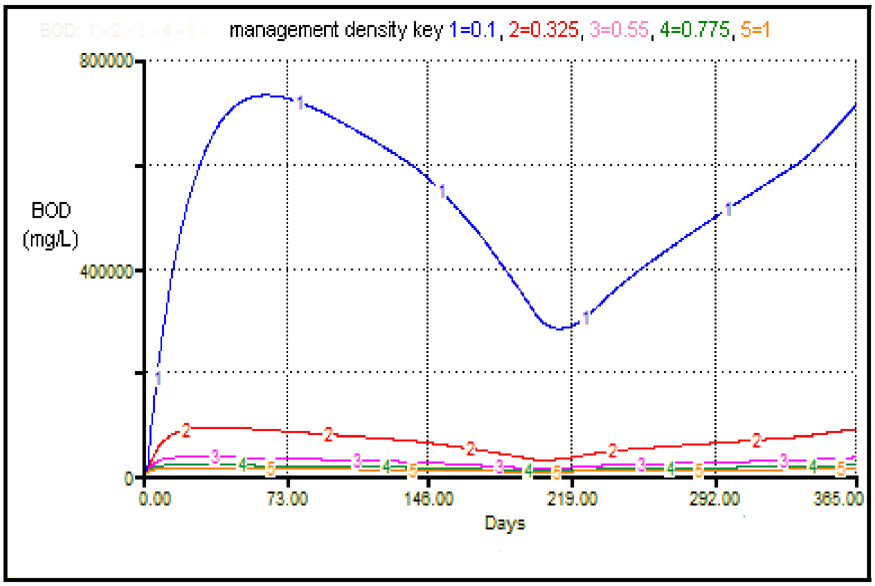



**Figure G5** Plot of BOD output (mg/L) vs time (days) for varying management densities generated in STELLA®.

The COD and BOD results of the run show that as management density increases as the level of both COD and BOD decrease. It was also determined that BOD and COD varies monthly as a function of tourist arrival. Therefore this proposed bi-indicator model is able to capture the impact of visitors and onsite activities as a function of the ecosite's management based on two water quality parameter. This also shows that multiple water quality indicator can be added to the numerical model and the STELLA® representation.

The automatically generated equations in STELLA® for the bi-indicator scenario developed are shown in Table G6.

**Table G6** Automatically generated model equations in STELLA® for BOD-COD-management interaction.

```
BOD(t) = BOD(t - dt) + (BOD_inflow - BOD_outflow) * dt
INIT BOD = 20 {mg/L}
INFLOWS:
BOD_inflow = arrivals * embodied_BOD__per_tourist
OUTFLOWS:
BOD_outflow = BOD * Natural_BOD__degradation_rate
COD(t) = COD(t - dt) + (COD_inflow - COD_outflow) * dt
INIT COD = 200 {mg/L}
INFLOWS:
COD_inflow = arrivals * embodied_COD__per_tourist
OUTFLOWS:
COD_outflow = COD * natural__COD_degradation_rate
Population(t) = Population(t - dt) + (arrivals - departures) * dt
INIT Population = 150 {persons}
INFLOWS:
arrivals = monthly_seasonal_variability_factor * 40 {persons/day}
OUTFLOWS:
departures = 20 {persons/day}
embodied_BOD__per_tourist = 1 / management__density * 100 {mg/L}
embodied_COD__per_tourist = (1 / management__density) * 1000
management__density = 0.1
Natural_BOD__degradation_rate = 0.35
natural__COD_degradation_rate = 0.693
monthly_seasonal_variability_factor = GRAPH(TIME)
(0.00, 1.00), (33.2, 1.00), (66.4, 0.9), (99.5, 0.8), (133, 0.7), (166, 0.5), (199, 0.25), (232, 0.5), (265, 0.6),
(299, 0.7), (332, 0.8), (365, 1.00)
```

From the STELLA® output equations in Table G6, the individual numerical models (i.e. Equations G17 and G19) that link BOD and COD levels with management and ecotourism activities can be worked out. It was determined that it was exactly Equations G16 and G17 that were arrived at. This means that the proposed model (i.e. Equation G20) can be exactly modeled in systems thinking software such as STELLA®.

## Conclusions

The first approach to linking ecotourism's onsite management with surface water quality was developed by the use of systems thinking. Numerical models were individually developed for both single and dual water quality indicator for a single point of interest i.e.

a point that guests utilize for bathing or the facility draws water from use onsite. The numerical models developed were then inputted into STELLA®'s system thinking software and it was determined that in each case that the thinking behind the numerical model development was true. Therefore from this work a general equation that links any given water quality parameter, say X for example, and an ecosite's management can be modeled by:

$$\frac{dC_X}{dt} = T_A * \frac{1}{\rho_{Mgt}} * E_X - C_X * \psi \qquad \text{(G21)}$$

where $\frac{dC_X}{dt}$ is the rate of change of concentration of X at point of interest [mg/L day$^{-1}$]; $T_A$ is the number of arrivals [persons/day]; $E_X$ is embodied X; $\psi$ is the natural daily rate of degradation of X; $\rho_{Mgt}$ is management density; $C_X$ is the overall input of X to point.

In the event that multiple indicators of water quality need to be looked at together then a similar equation can be applied per indicator of interest. Note that the term $T_A * \frac{1}{\rho_{Mgt}}$ (i.e. arrival * {1 / management density}) will be common to all the generated models and this term can then be used, through substitution, to develop a single numerical model for the all the indicators of concern. One of the key assumptions in the development of the model like that in Equation G21 is that the population growth rate within the watershed is negligible when compared to the transient tourist arrival rates. Should population growth rate be significant enough then the model can be tweaked to include the impacts of the persons living in the watershed. The STELLA® representations include a Population stock which could be easily linked to a water quality indicator's inflow when needed.

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# About the Author

Ken Darrie Thomas completed his BSc in Chemical and Process Engineering from the University of the West Indies, St. Augustine, Trinidad in 2004. Directly after completion of the BSc Ken then embarked upon the MSc in Environmental Engineering at the same institution which was completed in 2006. During the latter stage of the MSc he worked for the state agency the Environmental Management Authority of Trinidad and Tobago in the capacity of Environmental Protection Officer I up until commencing PhD studies at the University of South Florida, Tampa, Florida. The author began PhD studies at the aforementioned institution in May 2006 within the Department of Civil and Environmental Engineering. During PhD studies Ken engaged in teaching and research assistantships while being active in the school's chapter of Engineers for a Sustainable World.