

**Evaluating the Trade-Offs Between Users of  
Marine Protected Areas in the Caribbean**

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## Table of Contents

Contents	<i>i</i>
List of Tables, Figures and Boxes	<i>ii</i>
Acknowledgements	<i>iii</i>
Executive Summary	<i>1</i>
Background and previous research	<i>3</i>
Project Purpose	<i>4</i>
Research Activities	<i>4</i>
Outputs and Findings	<i>6</i>
Contribution of Outputs to Project Purpose	<i>16</i>
Publications Arising from the Project	<i>22</i>
References	<i>24</i>
Addendum (Response to comments by FTR reviewers, September 1999)	<i>25-A</i>
Appendix 1: Evaluating Trade-offs between Uses of Marine Protected Areas in the Caribbean (forthcoming in <i>Integrated Appraisal and Sustainable Development in a Developing World</i> . Edward Elgar).	<i>26</i>
Appendix 2: How Tobago Might Look in 2007? Four development scenarios for the area surrounding Buccoo Reef Marine Park	<i>48</i>
Appendix 3: Estimation of Economic Criteria under different development scenarios for the area surrounding Buccoo Reef Marine Park	<i>65</i>
Appendix 4: Estimation of Social Criteria, under different development scenarios in South West Tobago	<i>85</i>
Appendix 5: An ecological assessment of Buccoo Reef - Bon Accord lagoon complex	<i>105</i>
Appendix 6: Estimation of the Ecosystem Health Criteria under different development scenarios for the area surrounding Buccoo Reef Marine Park	<i>126</i>
Appendix 7: Report on the Consensus Building Workshop for primary	<i>139</i>

stakeholders of Buccoo Reef Marine Park, Tobago

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## List of Tables, Figures and Boxes

Table 1 Primary data collection for multi-criteria analysis (MCA) of development options for Buccoo Reef Marine Park	5
Table 2 Scenarios for Buccoo Reef Marine Park and the driving forces of change	7
Table 3 Criteria for assessing management options for Buccoo Reef Marine Park and method of estimation	9
Table 4 Estimated impact of four development scenarios for Buccoo Reef Marine Park area on the economic, social and ecological criteria	10
Table 5 Methods of eliciting weights for the MCA from the diverse stakeholder groups	14
Table 6 Results of stakeholder preference ordering of management issues based on second round focus group meetings	14
Figure 1 Estimated and projected total tourist supply in Tobago 1997 to 2007 and population of Buccoo Reef area 1980-2007.	8
Box 1 Summary of project outputs from the project logical framework	17
Box 2 Formal dissemination and presentations in Trinidad and Tobago	19

## **Evaluating the Trade-Offs Between Users of Marine Protected Areas in the Caribbean**

### **Executive Summary**

A critical development constraint, particularly for complex systems involving multiple uses, such as those found at the land water Interface, is the need to evaluate trade-offs between social, economic and environmental costs and benefits of different development options. Although extended cost-benefit analysis that includes the valuation of environmental externalities can support decision-making and policy formulation, it is still unable to deal effectively with some aspects of natural resource development. Such valuation cannot, for example, easily handle uncertainty of the linkages between different components of complex systems, vulnerability and lack of quantifiable indicators of ecological change. In addition policy may want to prioritise the needs of subsistence of 'traditional' resource users above other economic uses, contrary to the recommendation of cost-benefit analysis. This project has successfully developed an approach to trade off analysis in order to overcome this constraint.

This approach provides a decision-support tool involving multi-criteria analysis and participatory techniques to engage different stakeholders and resource users in policy formulation and decision-making. This has been developed and applied to a case study of a marine protected area, the Buccoo Reef Marine Park in Tobago, where uses and users have been in conflict for a number of years. In such cases, management has become conflictual and enforcement non-effective and sometimes almost non-existent. Suspicion and non-communication between stakeholders, who include resource managers, has dominated. The approach developed offers some mechanisms to overcome this stalemate, and has successfully created space for dialogue, negotiation, conflict resolution and eventually consensus building to manage vital natural resources.

Marine protected areas are critical coastal resources for the small island developing states of the Caribbean. The case study research of Buccoo Reef Marine Park in south-west Tobago demonstrates the magnitude of social, economic and ecological trade-offs inherent in future planning decisions. The application of multi-criteria analysis enabled these trade-offs to be made explicit and we believe this the first application for these land water interface resources. The project incorporated participatory techniques for the first time within such a framework, using the multi-criteria model in novel ways to seek enhanced decision-making in planning and managing such resources. Thus the project contributes to the objectives of identifying and promoting sustainable resource use strategies in the coastal zone.

The approach aims to develop and promote sustainable resource use strategies through an analysis of the conflicts and trade-offs between different uses and users of marine protected areas. Multi-criteria analysis (MCA) was used as the framework for assessing the resource use strategies and for quantifying the impacts of coastal zone management options on the urban and rural communities in the coastal zone. For the MCA, four development scenarios for south-west Tobago over a ten-year time frame were developed, and criteria to measure their impacts were identified and modelled. Sustainable management options were identified through an iterative process of including stakeholders' development preferences within the MCA; these options were prioritised at the final consensus building workshops.

The research included the collection of substantial primary and secondary, economic, social and ecological data. In terms of primary data collection, a contingent valuation survey (1000 respondents) was undertaken to estimate consumer surplus from recreational use of Buccoo

Reef Marine Park, a census of informal business vendors was undertaken, and a sample were included in a series of semi-structured interviews. Ecological data were also collected, including fish identification and fish counts, mangrove leaf fall to estimate productivity, water quality sampling and plankton tows. In developing scenarios, the Tobago tourism sector was modelled to determine the economic costs and benefits of various tourism development options. An environmental economic valuation of Buccoo Reef Marine Park (BRMP) was undertaken. Stakeholders were correctly identified and fully included. Sustainable management options were identified and prioritised, and the MCA framework was promoted within Tobago House of Assembly (THA) for decision making. All project outputs were achieved.

The research strategy required building trust among primary stakeholders and including them in decision making about the resource. The stakeholders were regularly provided with feedback from the project and benefited from useful information about the resources, and the implications of changing uses and management. Through a series of focus groups and workshops stakeholders were able to articulate their priorities, aspirations and concerns. The project worked closely with decision and policy-makers at all levels, including the Park Manager, reef patrol, and relevant Department Secretaries (equivalent to ministers in the Tobago system).

Thus local resource users and regulators have been directly engaged in developing future priorities and structures for implementation for management of Buccoo Reef Marine Park. During the research we have consulted widely and have received support and interest from other departments in Trinidad and Tobago, in the region, and indeed internationally. This leads us to believe that the approach is widely applicable to management of natural resources, including forestry, terrestrial protected areas, wetlands and even urban planning. The issue we now seek to address is how the participatory processes will be institutionalised. A new project 'Building Consensus at the Land Water Interface' funded through the Land Water Interface Programme from 1999 to 2000 will extend and build on our analysis.

## **Acknowledgements**

Many individuals and institutions have contributed in many different ways to the development and implementation of this project. We would like to thank DFID for funding this work and the support we have received from Programme Leaders in carrying out the research.

Various people within our own institutions have provided superb assistance. Administrative personnel in the ODG, University of West Indies and the Department of Fisheries and Marine Resources have made this research possible, and we sincerely thank them.

We have benefited intellectually from our interactions with other researchers in our institutions; we especially value the advice of colleagues in CSERGE, ODG and the School of Development Studies at UEA. We have also enjoyed feedback from academics, policy makers and others at various fora where we have presented parts of this research. We greatly value these inputs and they have helped us immensely in developing our ideas.

We are especially grateful to the many different people in Tobago who have contributed their time, energy, ideas and knowledge to our project over the past 26 months. We thank the community groups, local councils, different Buccoo users, and the local officials from THA who have provided such valuable assistance. We have learned a vast amount from our interactions and we are deeply indebted to each of them.

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## **BACKGROUND AND PREVIOUS RESEARCH**

This research project is a collaboration between the University of East Anglia, the University of the West Indies, and the Tobago House of Assembly (THA). Collaboration between these groups on the role of protected areas for natural resource management in Trinidad and Tobago stretches back to 1994 (Brown and Adger, 1994). The focus of the research on Buccoo Reef Marine Park in Tobago was initiated as a result of significant local demand from the THA and local resource users and managers. The Institute of Marine Affairs based in Trinidad had developed a management plan for Buccoo Reef Marine Park in 1995, but the explicit trade-off between the resource users and the enhanced participation of stakeholder groups remained problematic. The research project was perceived by the THA and local stakeholders to be an important contribution to implementing sustainable coastal resource use. Further the Land Water Interface Programme's consultation in the Caribbean (Barr et al., 1993) identified the need to assess impacts from tourism development on critical coastal resources.

This research develops 'trade-off analysis' a decision support tool involving participatory techniques. Specifically, the project has sought to assess the conflicts between different uses and users of fragile tropical coastal ecosystems and to identify likely trade-offs between those users. This information is utilised to devise sustainable management strategies that meet short term productive needs and conserve long term ecosystem health, meeting both international and local research demands. The research has been carried out in the context of the dilemmas facing small island developing states. These states attempt to manage their natural resource base in line with principles of integrated coastal zone management, recognising the needs of all resource users and integrity of the resource base. The research directly addresses the trade-offs inherent in the decisions that impact on poverty and economic growth in the local economy while attempting to maintain ecological integrity.

This approach is developed within the context of a multiple use marine protected area. Protected areas have been utilised as a management strategy in both terrestrial and marine environments, but with limited success, primarily because of the context by which uses and users are traditionally excluded from resources. The ecological arguments for the designation of marine protected areas in particular are twofold. First, the close environmental interactions in coastal zones between land-based activities and marine resource use ensure that there is resource dependence between the ecological and social systems. Land use change, for example, leads directly to changes in nutrient loadings which affects the quality and productivity of the marine environment (Rawlins et al., 1998), while the dependency of coastal communities on fisheries and other marine resources crucially affects their land based livelihood strategies (e.g. Andersson and Ngazi, 1998). Thus the ecological and socio-economic systems have inbuilt linkages often with direct and immediate feedbacks (Bailey and Pomeroy, 1996; Berkes and Folke, 1998). Secondly, marine protected areas have been used as a strategy for coastal and marine conservation because of the close interaction between economic and recreational use linkages, particularly within small island developing countries. The quality of coral reef resources, for example, in tropical marine protected areas is a major determinant of the long term viability of the tourism sector in such areas. The degradation of reef areas can lead both to a decline in overall tourist revenue with knock on consequences for local economies, and the consumer surplus associated with the recreational experience (Dixon and Sherman, 1990; Dixon et al., 1993; Ruitenbeek and Cartier, 1999).



Small island states exhibit critical dependence on their coastal resources and this issue is addressed by the approach developed in this project through quantification of the weights attached to social, economic and ecological criteria and the incorporation of these into development planning. In trade off analysis this is undertaken within a multi-criteria model. The results demonstrate that there are evident trade-offs between the different criteria, and that different stakeholders rank or weight these criteria differently. Involvement by stakeholders in the process of developing the model, and in discussing the recommendations derived from different weightings, provides an opportunity to explore and construct different development outcomes. This process of stakeholder involvement makes explicit the different perceptions and values of the different actors. The process creates opportunities for decision-making and management based on consensus rather than conflict.

## **PROJECT PURPOSE**

The project aims to identify and quantify the impacts of coastal zone management options on urban and rural communities in the coastal zone, and to develop and promote sustainable resource use strategies through an analysis of the conflicts and trade-offs between different uses and users of marine protected areas. A strategy for assessing conflicts and evaluating trade-offs between different uses and users has been developed in the case study area in Tobago. This provides information on development options to decision-makers regionally and the further opportunities for application of these methods in other small island developing states and coastal regions was explored.

The project contributed to all DFID's goals within the RNRSS Production System. In terms of land use planning, the project succeeded in encouraging land-use planners to take into consideration stakeholders' views when making plans for the case study site. This was achieved by meeting regularly with land-use planners to explain the stakeholder participatory approach and revealing to the planners the merging of stakeholders views over time, as the stakeholders became more informed and as the process became more inclusionary.

## **RESEARCH ACTIVITIES**

The objectives of the research were to develop a method to evaluate trade-offs and facilitate decision and policy making by incorporating stakeholder preferences into the multi-criteria framework. The research leading to the project outputs was based on a three stage strategy.

First, a stakeholder analysis revealed the critical groups and interests in the management of the Buccoo Reef Marine Park (BRMP) system. The stakeholder analysis identified stakeholders for participation in focus groups; identified key criteria for management of the resource; and assisted in the formulation of scenarios. Second, a multi-criteria analysis model was developed, involving the quantification of the major impacts of different development scenarios. The process of developing this modelling approach involves:

1. Generating scenarios of future development options, in consultation with stakeholders.
2. Defining key criteria, in this case nine economic, social and ecological criteria, by which the scenarios are to be judged
3. Quantifying the impact of the scenarios on the criteria

4. Deriving weights from each stakeholder group and using the model as the basis for stakeholder participation in decision-making.

The first year of the project involved the stakeholder analysis, the development of the framework, and the collection of data to model the potential impacts. The MCA model utilised user-friendly, off-the-shelf software so that stakeholder groups in the THA could utilise this tool. The data collection and analysis formed a significant effort, as detailed in Table 1.

The project adhered to the original timetable and achieved its goals through good working relationships with collaborators and stakeholders. Substantial technical support and expertise was provided by the Marine Park Manager (Mr David Shim) and his office in the Department of Fisheries and Marine Resources, within the Division of Agriculture, Lands and Marketing, Tobago House of Assembly. The ecological data was collected by the researcher from the University of the West Indies (UWI), with full co-operation and assistance from the Tobago House of Assembly Reef Patrol.

**Table 1 Primary data collection for multi-criteria analysis (MCA) of development options for Buccoo Reef Marine Park**

MCA criteria	Data collection
Economic criteria	1 modelling of tourism demand 2 sample survey of recreational users – 1000 respondents
Social criteria	3 informal business survey – 70 percent sample of sector using semi-structured survey 4 key informant interviews on access and employment issues as well as use of secondary data on job creation levels
Ecological criteria	5 water sampling 6 coral quality and seagrass assessment 7 aerial photographs for mangrove estimates

Indicators were selected and evaluated for ecological, social and economic aspects (Table 2) and these were presented to stakeholder groups in a series of focus group meetings. This third stage of the research involved most of the second year of the project. This involved iterations of MCA using focus groups and stakeholder workshops, as well as dissemination to policy and decision-makers. The stakeholder groups included fishers, local communities, local businesses and entrepreneurs, reef tour and water sports operators, recreational users, and technical personnel from various departments of the Tobago House of Assembly. The research involved intensive focus group meetings with stakeholder groups and consensus building workshops, as discussed in the section below and outlined in Appendix 7.

**OUTPUTS AND FINDINGS**

*Scenarios and criteria estimation for Buccoo Reef Marine Park*

The Buccoo Reef Marine Park (BRMP) consists of the habitats of Buccoo Reef and Bon Accord Lagoon Complex located in south west Tobago in the eastern Caribbean. This protected area is a large reef system which protects an extensive shallow reef lagoon bordered by a fringing mangrove wetland and covers an area of 150 ha with a terrestrial area of 300 ha (described in DRDE, 1996, and outlined in Appendix 5). The economy of Tobago is less diverse than that of Trinidad and more dependent on tourism and agriculture than the national economy in general. A key issue in the maintenance of livelihoods is the growing evidence of Tobago as a peripheral economy (or the so-called 'second island' problem) in the development of the service sectors in the two island state of Trinidad and Tobago (Weaver, 1998). Being a smaller island (62 km<sup>2</sup>) the management of the coastal margins are interconnected with all its coastal and marine resources. The intensive use of its marine and coastal resources for both the tourism industry and for commercial and subsistence use ensure that the major resource conflicts in Tobago are played out in the land water interface.

Developing a series of future scenarios for South West Tobago involved identifying the key drivers and likely outcomes of those drivers in consultation with the park regulators and various government agencies. The scenarios are named A, B, C, and D for the sake of neutrality of language (see for example, O'Hara, 1996) such that they do not represent 'inevitable' development options that particular stakeholder groups and vested interests may oppose. These scenarios are outlined in Table 2 and represent feasible situations in 2007 (a ten year time frame from 1997), based on permutations of expansive or limited tourism development, with or without enhanced environmental management. These descriptors are relevant to park management, they encompass broad development priorities in Tobago, and they take into account the scale and type of tourism development and environmental management plans which affect Buccoo Reef Marine Park (BRMP).

Permutations of the scenario descriptors are used to create specific scenarios. These four scenarios, outlined in Table 2, encapsulate very different development paths. A review of the developments in South West Tobago, for example in strategic planning documents for the island (DRDE, 1996), highlights the driving forces of change. These are the number of new tourism developments in South West Tobago; sub-regional population growth; and waste treatment. The specific scenario drivers (number of new tourism beds, population growth, and percentage of waste treated to tertiary level) are selected on the basis of measurability and likely impact on the criteria. Numerical measures of these 'drivers' are used to describe each scenario in detail (see Table 2). Figure 1 shows the projections of resident population and of changes in the supply of tourist arrivals (available tourist beds) for the area draining into BRMP for the ten year projected time period.

**Table 2 Scenarios for Buccoo Reef Marine Park and the driving forces of change**

Scenario	New tourist beds in BRMP area*	Population in BRMP area*	Percentage waste treated
A: Limited tourism development without complementary environmental management	240	6900	9
B: Limited tourism development with complementary environmental management	240	6900	49
C: Expansive tourism development without complementary environmental management	1580	7400	18
D: Expansive tourism development with complementary environmental management	1580	7400	69

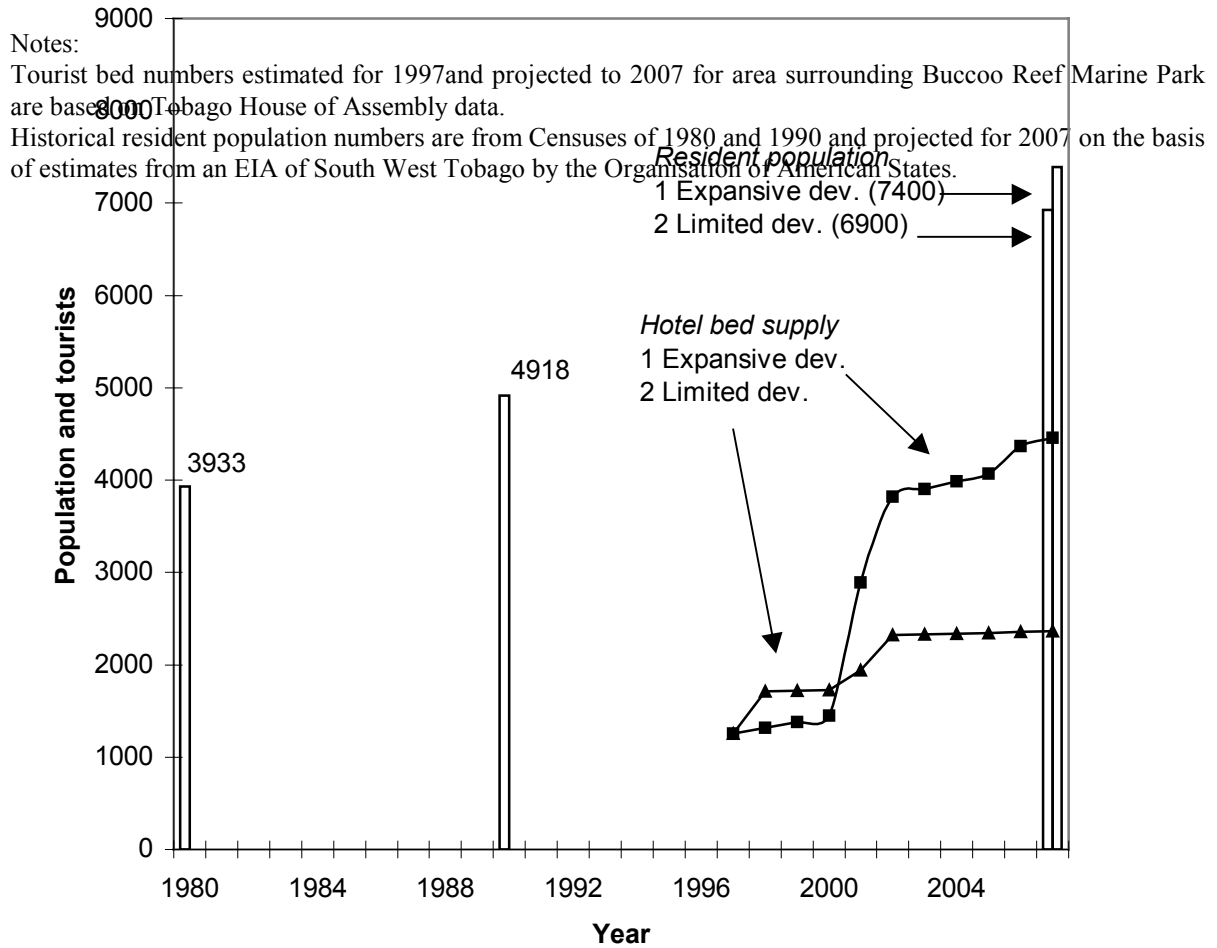
Note: \* 'BRMP area' refers to the watershed draining into Buccoo Reef Marine Park.

Economic, social and ecological criteria are also developed within the multi-criteria model, representing the potential multiple impacts of the development. In the case of BRMP, these criteria are predominantly related to national and local economic growth, community, social and cultural development, and environmental conservation (referred to here as economic, social and ecological criteria). As with the scenarios, these concepts are broad to enable discussion of their importance, but are complemented by more specific sub-criteria. The sub-criteria do not describe the entire system under consideration, as in a comprehensive ecosystem model developed by Bockstael et al. (1995) for the Patuxent River basin for example. Rather they are indicators of change which can be immediately understood by different stakeholders and which will enable stakeholders to perceive the broader changes occurring throughout the system.

For BRMP, selection of the sub-criteria has been undertaken by the research team and by representatives of the THA. Sub-criteria are only considered for inclusion in the MCA if they were measurable and if they varied under the different scenarios. 'Relevance' is determined through on-going stakeholder analysis as the project progressed, which served to highlight the important, but often implicit, preferences of the key stakeholders. Table 3 describes the criteria and the selected sub-criteria with a brief explanation of the means of calculating those data. Operationalising the MCA involves estimating the effects of the scenarios on each sub-criterion in quantitative or semi-quantitative form. The strategy for data collection involves diverse techniques across the ecological, social and economic criteria.

The results of the modelling are shown in Table 4. The data show the trade-offs for BRMP between expansive tourism development, which threatens the integrity particularly of the coral reef through eutrophication, compared to more limited tourism development which maintains fringing mangrove and seagrass areas. Details of each of the economic, social and ecological criteria estimation are now briefly outlined before discussing the stakeholder involvement in the process.

**Figure 1 Estimated and projected total tourist supply in Tobago 1997 to 2007 and population of Buccoo Reef area 1980-2007.**



**Table 3 Criteria for assessing management options for Buccoo Reef Marine Park and method of estimation**

<b>Criteria</b>	<b>Sub criteria</b>	<b>Measure/basis of calculation</b>	<b>Sources of data</b>
Economic criteria	1. Macro-economic benefits of tourism to Trinidad and Tobago	Tourism revenue * economic multiplier * (1-marginal propensity to import)	Secondary data from government statistical sources
	2. Tourist benefits	Consumer surplus of recreational users of BRMP	Contingent valuation survey of visitors and residents
Social criteria	3. Local employment in tourism	Additional full time 'quality' jobs * proportion of jobs to Tobagonians	Continuous Sample of Population (Trinidad and Tobago); UN Economic Commission for Latin America and the Caribbean; Tobago House of Assembly management report on BRMP
	4. Informal sector benefits	No. of additional persons with 50% of livelihoods coming from informal sector	Primary data collection - informal business survey
	5. Costs of local access to BRMP	Change in costs of accessing BRMP for recreation and subsistence extractive purposes	Private access costs, public access costs, expert judgement of BRMP manager
Ecosystem health criteria	6. Water quality	Nutrient concentration – nitrate loading and concentration	Secondary existing data and modelling using scenarios of tourist sector development
	7. Mangrove Habitat	Change in area of mangrove (ha) % change in area	Historical aerial photographs and projected tourist development
	8. Productivity – nursery function of sea grass	unit productivity; nos. of small fish, diversity of species per area	Surveys using rapid assessment techniques and modelling
	9. Coral reef health	% live coral cover	Surveys using rapid assessment techniques and modelling

**Table 4 Estimated impact of four development scenarios for Buccoo Reef Marine Park area on the economic, social and ecological criteria**

Criteria	Scenario			
	A	B	C	D
<b>Economic</b>				
<i>Economic revenues to Tobago (US\$ m)</i>	9	11	17	19
<i>Visitor enjoyment of BRMP (US\$ m)</i>	1.2	2.5	0.6	1.2
<b>Social</b>				
<i>Local employment (no. jobs)</i>	2,500	2,600	6,400	6,500
<i>Informal sector benefits (score)</i>	5	4	3	2
<i>Local access (score)</i>	6	5	6	7
<b>Ecological</b>				
<i>Mangrove health (ha)</i>	65	73	41	65
<i>Sea grass health (g dry weight/m<sup>2</sup>)</i>	18	19	12	15
<i>Coral reef viability (% live stony coral)</i>	19	20	17	18
<i>Water quality (µg N/l)</i>	1.5	1.4	2.2	1.9

Notes:

Scenarios (as outlined in Table 2):

A: Limited tourism development without complementary environmental management

B: Limited tourism development with complementary environmental management

C: Expansive tourism development without complementary environmental management

D: Expansive tourism development with complementary environmental management

### *Economic criteria*

The economic criteria focus on macro-economic benefits and recreational user benefits. The first of these is the domain of economic planners who may want to maximise revenues to the public and private sector (Economic sub-criterion 1). The recreational value of the tourist visitors and local recreational users (Economic sub-criterion 2) is, however, an important non-market benefit that captures aspects of the benefit to that stakeholder group. Further, this criterion represents an indirect indicator of the sustainability of tourism based in part on the quality of the marine and coastal environment.

The first economic sub-criterion (1), 'Macro-economic benefits', has been calculated by first estimating total annual visitor expenditure in the relevant unit of assessment, South West Tobago. This estimate of tourism revenue, derived from the THA's Division of Tourism, is the gross benefit to the immediate region from tourism. But the net figure is dependent on the rate of leakage from the economy, a critical issue for many small island and particularly 'second island' states (e.g. Weaver, 1998). Thus the net macroeconomic benefit is derived through estimating both the marginal propensity to import for Tobago

and the 'tourism multiplier' to reflect the benefits that accrue across the economy from the initial round of tourist expenditure, thereby showing the macro-economic benefits that accrue to South West Tobago. The results are estimates of Net Present Value ranging from US\$9.1 million to 18.7 million over a ten year period across the scenarios.

The second economic sub-criterion, 'Recreational user benefits', reflects visitor perception of BRMP. It has been estimated as the total willingness to pay of visitors through BRMP using a contingent valuation survey, based on a randomised survey of 1,000 visitors and residents (Tompkins et al., 1999). Consumer surplus has previously been estimated for coastal and marine resources in a variety of contexts, for example through revealed and expressed preference methods (e.g. Berg et al., 1998). The contingent valuation study is carried out for the purposes of estimating changes in total consumer surplus over the scenarios to 2007. The resulting estimates show a consumer surplus of between US\$0.6 million and US\$2.5 million in Net Present Value depending on the resulting environmental quality implied by the scenarios. Details of the economic criteria estimation are given in Appendix 3.

### *Social criteria*

The social criteria reflect the distribution and impact of some of the economic criteria. The social criteria describe costs and benefits affecting the local community in terms of human development impacts, or social change. The social criteria, developed in consultation with stakeholder groups, are local employment, contribution of the informal sector to local livelihoods, and local access to the resource. Tourism creates many social problems and challenges, from increased crime rates, changes in cultural values and health and other factors (Pattullo, 1996). The social criteria developed here reflect the overwhelming focus of the stakeholder groups of employment and socio-economic factors that they feel are often excluded from many economic analyses. The qualitative and quantitative sub-criteria (2,3,4) have been estimated using the methods outlined in Table 3. Further detail is given in Appendix 4

Not all criteria are best represented in quantitative terms. A qualitative survey of a sample of informal business vendors was undertaken to ascertain the employment impacts of development as a social factor important to many stakeholder groups. The informal sector vendors were asked their attitudes to the level of environmental control and informal sector control introduced by the government agencies; the size and nature of the hotels to be developed in South West Tobago; and the type of tourists who are likely to visit Tobago. Their qualitative responses are scored and transformed into ordinal data for the MCA through use of scales with single indicators. Similarly, access by Tobagonian residents to the BRMP for recreational activities is an important factor identified by local residents and is included in the MCA using a simple scaling device, which are scaled and converted to ordinal data (see for example, Bernard, 1994).



### *Ecological criteria*

Water quality is one of the major indicators of ecosystem health used, and is indicated by the projected ambient concentrations of total nitrates in the marine environment in 2007. It is estimated that approximately 80 percent of all marine pollution in the Caribbean courses from land based sources, primarily through run-off but also from atmospheric deposition, with agriculture and land use change being one important source (Rawlins et al. 1998). The impacts of increased sediment loading, nutrient loading and presence of other pollutants on coral reef and related systems is relatively well researched. In general coral reef systems thrive in low nutrient systems with low turbidity. Increasing nutrient levels decrease their competitive advantage over benthic algae and hence reduce coral reef integrity and diversity. In the Caribbean it has been shown that land use changes and subsequent increased sediment loadings often exacerbated by seasonal storms, have resulted in degradation of reef systems (e.g. in St. Lucia and Costa Rica: Cortes and Risk, 1985; Nowlis et al., 1997). In addition Rawlins et al. (1998), reviewing the impacts of agriculture nutrient loadings for the Caribbean island states, conclude that pressure on reef systems has been increasing from this source in the past thirty years. The impacts of all pollution loading are determined by biophysical parameters, including the underlying geological features of the coastal areas, the dispersal from the coastal zone and the mode of discharge, and the presence of related mangrove systems. Mangroves assimilate nitrogen and hence help prevent the effects of eutrophication on reefs and seagrass beds (Rawlins et al. 1998; Suing-Chang, 1997).

Given the complexity of related fringing mangrove, seagrass and reef systems in the BRMP, a meaningful water quality indicator is required that can be easily measured and projected across the scenarios. Nitrate concentration is the chosen indicator. Nitrates are important because of their impacts on enhanced algal growth as well as on human health, though at higher concentrations than usually found in coastal marine environments. Further, there is evidence in Buccoo Reef Marine Park of the correlation of nitrate loading with the other major pollutants. Kumersingh et al. (1998) estimate phosphorus concentrations using coral coring methods to examine phosphorous in sediments. They show that phosphorous levels in BRMP have been rising since the 1970s, and that a large proportion of this phosphorous is organic in origin, and hence is associated with sewage contamination and agricultural run-off, particularly from livestock. In addition, however, levels of phosphorous at BRMP, although rising, are lower than in the early 1970s when a sharp decline in loading occurred due to the introduction of enhanced waste water treatment facilities and decline in the livestock sector (Kumersingh et al, 1998). In a similar fashion, levels of hydrocarbons, probably associated with fugitive emissions from recreational and commercial boats, are also high in the lagoon area of BRMP (Rajikumar and Persad, 1994). These high concentrations are observed despite this area being largely protected from the other major sources of marine hydrocarbon contamination such as heavy oil tanker traffic to the east of the island.

Observations of present nitrate concentrations were taken at 20 sites (Appendix 5), and loading estimates based on present population and mean loadings of 3.3-4.4 kg N per person per year in line with the estimates of Howarth et al. (1996). The impact of development scenarios on nitrate concentrations is estimated in two stages. First, the observed present day mean concentrations across the 15 marine based sites are attributed to the terrestrial population contributing to this contamination such that there is a

concentration per person factor for the total resident plus tourist populations in the areas feeding into the five major outflows. Thus a person living in Buccoo Village contributes more to the observed outflow than from Bon Accord because of the lack of tertiary sewage treatment in that village. These ‘pollution-per-person’ factors are then multiplied by the extrapolated population projections to 2007 in the area to arrive at the projected ambient concentrations in Table 4 for the scenarios B + D, the situation without environmental management. Enhanced environmental management (Scenarios A and C) in this case refers to increased proportions of waste treated to tertiary level that strips nutrients from the waste water. As indicated in Table 4, the installation and adoption of tertiary level treatment by the major villages with a threshold per household cost of connection leads to projections of adoption of 49 and 69 percent respectively for scenarios B and D.

These projections are based on two assumptions. First, all human induced nitrate loadings are related to population levels. Second, ambient concentrations are equal across the marine park. The first of these may be limited by the contribution of other polluting sources, but non-point run-off from agriculture is declining in significance with the decline of agriculture in Tobago in the post oil-boom era (Kumersingh et al., 1998) since the 1970s. Since the estimates of pollution loadings include tourist contributions, the major projected driver of the economy over the next decade, this assumption of loading related to population may be realistic. The second assumption concerning equal mixing of the loading is outlined above – the nitrates reach the marine park both by seeping through limestone and direct outflow, so the concentrations are patchy across the park but no lower on the reef than inshore.

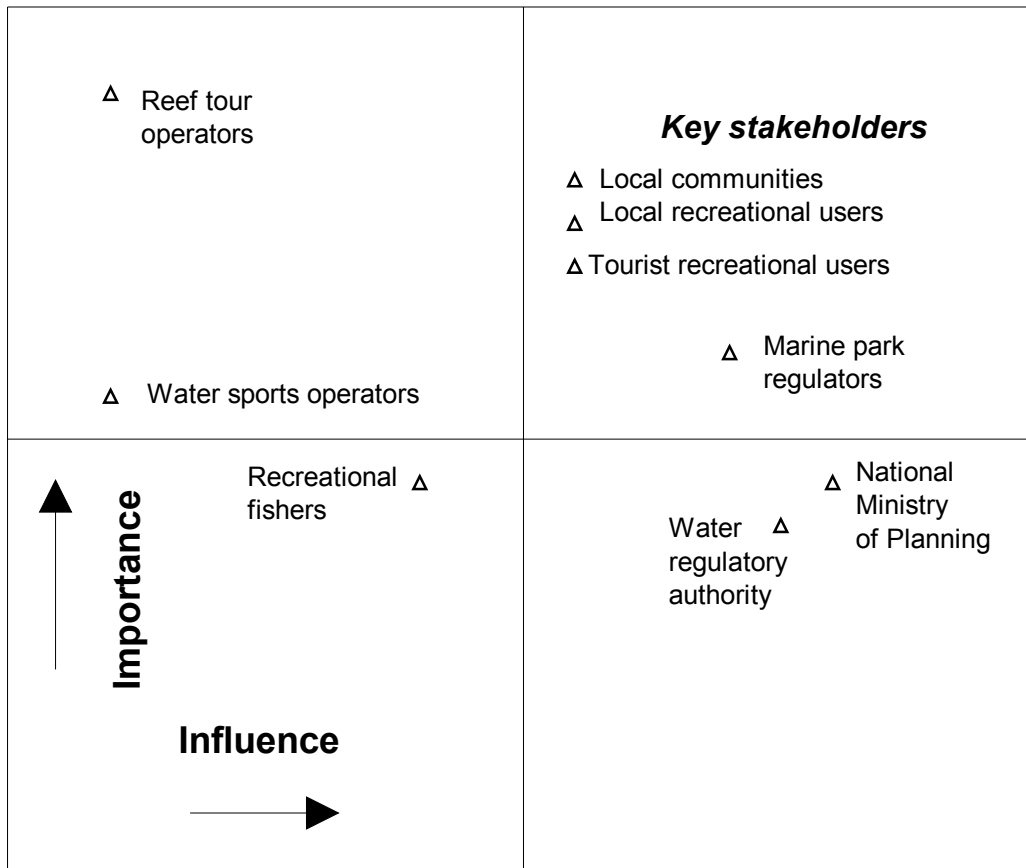
Water quality is an important issue as it is also linked to the other ecological criteria, particularly seagrass productivity and coral reef quality. Data on seagrass health was collected at the five sites on productivity and on algal growth to examine the effects of nitrate concentrations on biomass. The data shows the expected correlation between nitrate levels and seagrass productivity, and extrapolation from these trends gives the estimates of seagrass productivity in Table 4 in 2007. Again, further detail is given in Appendices 5 and 6.

### *Stakeholder weightings*

The set of systematically ordered information for the MCA is then used to engage with stakeholder groups in achieving increased knowledge of preferences and desired outcomes. The weights were derived through focused and structured discussions of the implications of the scenarios and options for management of BRMP, and development in South West Tobago with different stakeholder groups (Table 5).

Stakeholder groups included fishers, local communities, local businesses and entrepreneurs, reef tour and water sports operators, recreational users, and technical personnel from various departments of the Tobago House of Assembly (see Figure 2).

**Figure 2: Classification of primary and secondary stakeholders in Buccoo Reef Marine Park, Tobago**



**Table 5 Methods of eliciting weights for the MCA from the diverse stakeholder groups**

Stakeholder group	Method of eliciting weights
Marine park regulators	Expert judgement
Reef tour operators	Focus groups
Water sports operators	Focus groups
Fishers	Focus groups
Village councils	Focus groups
Recreational users	Sample survey

Stakeholders were asked to weight their priorities among criteria for making decisions about future development options. This process revealed that each group of stakeholders prioritised ecosystem health, and that livelihoods and long-term economic prosperity depended on its maintenance. Later stages of this research involved intensive focus group meetings with stakeholder groups and culminated in a series of meetings to bring different stakeholders together to resolve resource conflicts and build consensus on management strategies and development options for the management of the MPA. Some of the stakeholder groups are not best represented in focus groups. Indeed the THA and park regulators have specific statutory responsibilities and authorities. In their case a series of informant interviews were carried out, as well as some more participatory exercises. The interests of the tourists themselves, an important stakeholder group affecting the financial sustainability of the island economy, could not be easily engaged with in focus groups. In their case a series of questions were added to the contingent valuation survey to reveal their priorities and preferences. Table 5 shows the strategy for deriving weights for the MCA from each of the groups.

**Table 6 Results of stakeholder preference ordering of management issues based on second round focus group meetings**

Priority Areas	Bon-Accord Village Council	Buccoo Village Council	Depts of the THA*	Fishers	Recreational users**	Reef Tour operators	Water sports/dive ops.
Economic Growth	22%	25%	19%	18%	9%	27%	23%
Social issues	32%	35%	29%	40%	32%	32%	15%
Eco-system health	47%	40%	52%	43%	59%	42%	63%

Notes: \* The Departments of the THA only voted once.

\*\* Recreational users preferences are derived from a sample survey of 1,000 users of Buccoo Reef Marine Park in 1997.

The iterative process of engaging with stakeholders involved the groups agreeing to their group priorities across the management criteria and sub-criteria. First each of the groups met separately to discuss the issues. Over the following months each of the groups were presented with the outcome of their own deliberations and those of the other stakeholder groups, thereby challenging their pre-conceptions as to how others perceived the management issues. A second round of prioritising revealed considerable consensus as to the priorities for managing BRMP. This is illustrated in Table 6 which shows the outcome of exercises undertaken in the six focus groups consultations as well as revealed in the tourist survey. Appendix 7 gives details of these exercises and the first consensus building workshop. This final stage in the stakeholder engagement involved all the stakeholder groups including senior representatives from the THA (The Secretary for Agriculture), facilitated by a locally respected broadcaster with considerable experience in facilitating such processes. The consensus building workshops resulted in firm proposals for action by both individuals, the stakeholder groups and by the park regulators and the THA more widely. These are further outlined in Appendix 7.

## *Summary*

A high degree of consensus among stakeholder groups is observed, leading to potential action for co-management of the area. We argue that this approach has potential in other resource management situations where inevitable trade-offs exist between users of natural resources.

This study has demonstrated that trade-off analysis is an appropriate technique to bring together diverse quantitative and qualitative information for decision making and for building consensus. Engagement with stakeholder groups provides information on their explicit priorities and allows these groups to move beyond short term conflicts. The analysis has evolved to examine consensus building as a route to enhanced management, and the proposed project takes this further by examining the institutional constraints and opportunities for such activities in the land water interface and wider Caribbean contexts.

## **CONTRIBUTION OF OUTPUTS TO PROJECT PURPOSE**

The outputs of the project, as outlined in the original project memorandum have been directly addressed in the project as detailed in Box 1. The research has received wide and active support and collaboration with target institutions, and requests have been made to develop the approach in a number of ways. First, the Department of Marine Resources and Fisheries of the Tobago House of Assembly has directly requested further collaboration to build on the consensus reached amongst stakeholders in the project workshops and implement participatory approaches to managing coastal and marine resources. This has led to a new project on consensus building funded through LWI. Second, regional institutions, including Environmental Management Agency of Trinidad and Tobago, the Institute of Marine Affairs, and CANARI have all expressed interest in adapting the method for application to other sites or in collaboration in dissemination activities.

Second, the DFID Caribbean Senior Natural Resources Advisor has suggested the completion of a methods manual for wider dissemination and adoption of participatory approaches to natural resource management in the coastal zone.

In terms of land use planning, the project succeeded in encouraging land-use planners to take into consideration stakeholders views when making plans for the case study site. This was achieved by meeting regularly with land-use planners to explain the stakeholder participatory approach and revealing to the planners the merging of stakeholders views over time, as the stakeholders became more informed and as the process became more inclusionary. Contact with other government departments has resulted in requests for training and information. The Department of Town and Country Planning has been inquiring as to how such a process could also be applied to urban planning. The Environmental Management Agency is undertaking a similar exercise for national level consultations for Trinidad and Tobago's Biodiversity Action Plan.

### **Box 1 Summary of project outputs from the project logical framework**

**Output 1:** Costs and benefits of MPA management options and their distribution amongst different stakeholders assessed through stakeholder analysis and environmental economic valuation

This output was achieved through a number of activities. First, qualitative stakeholder analysis was undertaken through documentary research and key informant interviews with many regulatory agencies in both Tobago and Trinidad. Second the initial scenario development and criteria were developed in collaboration with these stakeholders. Third, demand in the tourism sector in Tobago was modelled to determine economic costs and benefits of various tourism development options. Fourth, environmental economic valuation of Buccoo Reef Marine Park (BRMP) was undertaken through a 1,000 respondent contingent valuation (CVM) survey of recreational users willingness to pay for a changing environmental quality of BRMP.

**Output 2:** Potential conflicts and trade-offs between different uses and users and synthesis of biophysical and socio-economic data and stakeholder analysis.

The potential conflicts and trade-offs between different uses and users identified through developing the multi-criteria analysis model. This demonstrates the impacts of different development options on the chosen criteria and results in a ranking of options which is dependent on weights given to each criterion. The framework defines ten year development scenarios for south-west Tobago and economic, social and ecological criteria for assessing the impact of these alternative scenarios.

**Output 3:** Sustainable management options identified through generation of actor-preference matrix developed by multi-criteria analysis.

Sustainable management options have been identified through the iterative process of including stakeholder weights in the multi-criteria analysis. Sustainable management options and priorities for action were prioritised at consensus building workshops involving all stakeholders in Tobago.

**Output 4:** MCA framework developed and promoted for policy-making and decision-making support and demonstrated to regional target institutions.

The data collection and model development outlined above was promoted within Tobago House of Assembly (THA) for decision making, and demonstrated to local organisations at the Trinidad and Tobago workshops.

Throughout the project, the project team has focused much of their work on ensuring that the findings and information were disseminated as broadly as possible to target institutions and beneficiaries. This was achieved through a series of presentations and workshops that have been held in Trinidad and Tobago throughout the life of the project, as outlined in Box 2.

By informing all stakeholders about the implications of resource use and the acceptability of changing practices, directly resolving conflicts between users of the resource, and building trust between the stakeholders it was possible for the stakeholders themselves to have an input into the management of BRMP. By working closely throughout with the Marine Park Managers office and the decision-makers within the THA meant that not only were the stakeholders using their collective voice to urge action, but that that THA was engaged and willing to respond.

The research strategy involved building trust among primary stakeholders and including them in decision making about the resource. This was established by providing the stakeholders with substantial amounts of information about the resource, its use and the implications of its use, as well as spending time listening to their hopes and concerns. Including the stakeholders in the decision making process required working very closely with decision makers to ensure that the voice of the collective stakeholder group, once formed, would be heard, and heeded.

The findings and methodology have been disseminated to target institutions and more widely through a number of means:

- Target institutions such as the IMA and THA are taking forward this approach and requesting further research, as outlined above.
- Presentations and workshops have been held in Trinidad and in Tobago. These include two workshops in Tobago in January and March 1999; and a workshop in Port of Spain, Trinidad in March 1999, as the culmination of the presentations and dissemination outlined in Box 2.
- A paper published by CSERGE at UEA outlining the methodology has been produced (Brown et al., 1998) and widely disseminated in the region. More than 100 copies have been distributed, some through the DFID regional office.

## **Box 2 Formal dissemination and presentations in Trinidad and Tobago**

- 1 Presentation to senior staff of the Government of Trinidad and Tobago Department of Planning and Development (Town & Country Planning) (October 1997).
- 2 Presentation to the 8th International Extension Field Workshop: Government and Community Support for Sustainable Agriculture, Forestry and Fisheries Development, Tobago (January 1998).
- 3 Presentation of CVM studies to Tobago House of Assembly (Secretary for Planning and Development) (October 1997).
- 4 Presentation to the Tobago House of Assembly Planning Team (for 15 Year Integrated Development Plan) (January 1998).
- 5 Poster presentations '*Functions and Benefits of Coastal Ecosystems in Tobago*' displayed at three prominent locations around SW Tobago as part of the Tobago House of Assembly Reef Awareness Education Programme.
- 6 Presentation by Emma Tompkins, David Shim and Kathy Young to the general public and to Tobago House of Assembly officials (January, 1999).
- 7 Two workshops were held for target institutions in March, 1999 - Department of Town and Country Planning, Port of Spain, Trinidad and at the Department of Works, THA, Scarborough, Tobago.
- 8 Presentation by Emma Tompkins, Kathy Young, and David Tourism and Industrial Development Company (TIDCO) of the Government of Trinidad and Tobago (April, 1999).
- 9 Distributed 35 copies of the *Report of Proceedings of Consensus Building Workshop* to all primary, secondary and external stakeholders, interested members of the Tobago House of Assembly, and the media in Tobago. (Appendix 7)
- 10 Over the course of the project, trained officials from Tobago House of Assembly (THA), Government of Trinidad and Tobago (GOTT), and others Tobagonians in the following areas: survey enumeration, economic analysis of tourism data, ecological data collection, semi-structured interviewing skills, and focus group management.
- 11 Worked with individuals in both GOTT and the THA to transfer analysis skills and also to pass on primary and secondary data collected.

The findings of the present research are of wider significance for the research and development in natural resource management. The results have therefore been disseminated to diverse scientific audiences. Papers have been presented, for example, at conferences on Environmental Assessment in the Development Process (Manchester, 1998) and at the International Society for Ecological Economics biannual conference (Santiago, Chile, November 1998), the Human Dimensions of Global Environmental Change Research Community (Kanagawa, Japan, June 1999). One book chapter is in press (Adger et al., 1999). Katrina Brown will discuss methodological issues in participatory resource management at an ESRC workshop on 'Deliberative and Inclusionary Processes' at UEA in July 1999. Three scientific journal articles are in preparation from the present research.

### *Lessons learned*



- The approach developed by this research informs the area of *integrated assessment* and provides an empirical application of ‘bottom-up’ modelling in a developing country.
- The approach effectively incorporates both *quantitative* and *qualitative indicators* (sub-criteria) within the multi-criteria framework. It demonstrates that it is not necessary to derive monetary values – to reduce all measures to monetary numeraire – to evaluate trade-offs.
- The approach represents the successful implementation of a *constructivist approach* to decision-making which is meaningful and applicable to development planning and natural resource management. It demonstrates that stakeholder views and values can be used in a rigorous framework which makes sense to politicians, regulators and planners.
- The approach has engaged with wide range of stakeholders and shows that *participatory approaches* are consistent more technical decision support tools, such as the multi-criteria analysis. The approaches are complimentary not oppositional.
- The approach is *flexible, applicable to other natural resources, and amenable to adaptation*. It is already being adopted and adapted to other resource management contexts. An NRSP-funded research project in dryland Kenya is adopted the framework to resolve conflicts between wildlife and pasture management. The Project Managers of this project are involved in a project in Canada to test the application of trade-off analysis to the multiple use management of forest resources in British Columbia. The approach will continue to be disseminated and discussed in the Caribbean, where support and demand for further research has been strongly articulated.

#### *Future directions*

An additional project, recently approved under the Land Water Interface programme, seeks to build on the work undertaken by the research team in the last two years. The new project will entail further development of this approach in three ways:

1. It will examine the opportunities and constraints to the institutionalisation of participatory techniques such as ‘Trade-off Analysis’ within target institutions, with particular emphasis on the management of coastal and marine resources within the Department of Fisheries and Marine Affairs in Tobago.
2. It will disseminate the approach developed and assess its applicability and adaptability to other land water interface and coastal resources in the region, primarily by linking with the DFID-funded bi-lateral project ‘Capacity building for community participation in natural resource management in the Caribbean’ supporting the regional institution, CANARI.
3. It will develop a manual on ‘Strategies for Involving Stakeholders in Coastal Zone Management’ for dissemination throughout the region. This will outline the approaches to stakeholder identification, conflict resolution and consensus building applied specifically to land water interface systems.

Institutionalising the approach is necessary at many levels:

- to ensure that decision makers are not threatened by the new inclusionary approach, and will continue to listen to the stakeholders without the presence of an international research team to ‘encourage’ them to do so;
- to ensure that technical officers are confident in knowing how to manage and include the existing participatory decision-making process at work in Buccoo Reef, but also,
- to ensure that there technical officers feel that they have the level of knowledge, and skills to replicate the method, to apply it to other issues.

#### *Plans for further dissemination*

Continued dissemination of the results of this project is planned both in the region and internationally. The trade-off analysis approach and the data from the first phase will be further disseminated in Trinidad and Tobago in the course of the new project on institutional dimensions of participatory resource management. The project has produced a poster on the functional values of coral reef ecosystems for display by THA officials. The data and experience to date will form the basis of a manual to be produced during 2000, and will form the basis of regional dissemination during that project.

The first direct regional dissemination involves presentation of the findings at the workshop ‘*Ecological and Social Impacts in Planning Caribbean Marine Reserves*’ under the Land Water Interface Programme in Montego Bay, Jamaica, 12-13 July 1999.

Three refereed journal articles are in final stages of preparation. These will also be circulated for comment as discussion papers either in the ODG and CSERGE series. The papers are:

Adger, W. N., Brown, K., Tompkins, E. Young, K., Shim, D. and Bacon, P. (1999 in prep.) Trade-off analysis for marine protected area management. To be submitted to *Ecological Economics*.

Brown, K., W. N. Adger, E. Tompkins, P. Bacon, D. Shim, and K. Young (1999 in prep.) Engaging with Stakeholders to Build Consensus for coastal resource management. To be submitted to *Society and Natural Resources*.

Tompkins, E., Adger, W. N. and Brown, K. (1999 in prep.) User and non-user preferences for coral reef attributes. To be submitted to *Environmental and Resource Economics*.

## PUBLICATIONS ARISING FROM THE PROJECT

1. **Adger, W. N., Brown, K., Tompkins, E. Bacon, P., Shim, D. and Young, K. (1999)** Evaluating Trade-offs between Uses of Marine Protected Areas in the Caribbean. In Kirkpatrick, C. and Lee, N. (eds) *Integrated Appraisal and Sustainable Development in a Developing World*. Edward Elgar: Cheltenham. in press.
2. **Brown, K., Adger W. N., Tompkins, E., Bacon, P., Shim, D. and Young, K. (1998)** *A Framework for Incorporating Stakeholder Participation in Marine Resource Management: A case Study in Tobago*. Global Environmental Change Working Paper 98-23. Centre for Social and Economic Research on the Global Environment, University of East Anglia, Norwich.
3. **Adger, W. N., Brown, K., Tompkins, E. Bacon, P., Shim, D. and Young, K. (1998)** Evaluating Trade-offs between Uses of Marine Protected Areas in the Caribbean. In *Proceedings of Impact Assessment in the Development Process: Advances in Integrating Environmental Assessment with Economic and Social Appraisal*. Institute for Development Policy and Management, University of Manchester, 23-24 October 1998.
4. **Adger, W. N., Brown, K., Tompkins, E. Bacon, P., Shim, D. and Young, K. (1999)** *Engaging with Stakeholders and Trading off their Preferences: Marine Protected Areas in the Caribbean*. Presented at 1999 Open Meeting of the Human Dimensions of Global Environmental Change Research Community, Shonan Village, Kanagawa, Japan, 23-26 June. Forthcoming in Adger, W.N. (ed.) *Innovative Social Sciences in the Coastal Zone*. LOICZ Reports and Studies, LOICZ-IGBP, Texel, The Netherlands.

### Internal Reports

All internal reports can be obtained from:

Dr. Katrina Brown, School of Development Studies, UEA, Norwich, NR4 7TJ

1. **Adger, W. N., Brown, K., Tompkins, E. and Young, K. (1999)** *Report of Consensus Building Stakeholder Workshop for Buccoo Reef Marine Park, Tobago*. ODG Research Working Paper. University of East Anglia, Norwich.
2. **Tompkins, E. (1997)** *Manual for CVM Survey Enumerators: Valuing Visitors Enjoyment of Buccoo Reef Marine Park*. University of East Anglia, Norwich.
3. **Adger, W. N., Brown, K., Tompkins, E., Young, K. and Shim, D. (1997)** *How Tobago might look in 2007? Four possible development scenarios for the area surrounding Buccoo Reef, Tobago*. University of East Anglia, Norwich.
4. **Adger, W. N., Brown, K., Tompkins, E., Young, K. and Shim, D. (1997)** *Economic, Social and Ecological Criteria for the MCA Effects Table*. University of East Anglia, Norwich.
5. **Tompkins, E., Adger, W. N., Brown, K., Young, K. and Shim, D. (1997)** *Background Information on Buccoo Reef Marine Park*. University of East Anglia, Norwich.
6. **Tompkins, E., Adger, W. N. and Brown, K. (1999)** *Calculation of Economic Criteria, under different development scenarios for the area surrounding Buccoo Reef in SW Tobago for the MCA Effects Table*. University of East Anglia, Norwich.
7. **Tompkins, E., Adger, W. N. and Brown, K. (1999)** *Calculation of the 3 Social Criteria, under different development scenarios for the area surrounding Buccoo Reef in SW Tobago for the MCA Effects Table*. University of East Anglia, Norwich.

8. **Bacon, P., Young, K. and Shim D. (1998)** *An Ecological Assessment Of Buccoo Reef/Bon Accord Lagoon Complex, Tobago*. Department of Zoology, University of the West Indies, St. Augustine, Trinidad.
9. **Tompkins, E. and Brown, K. (1997)** *Preliminary Identification of Stakeholders in Buccoo Reef Marine Park*. University of East Anglia, Norwich.
10. **Tompkins, E. and Brown, K. (1997)** *Possible Conflicts Between Stakeholders in Buccoo Reef Marine Park*. University of East Anglia, Norwich.
11. **Tompkins, E. and Brown, K. (1997)** *Timing and Level of Participation of Stakeholders in Evaluating the Trade-Offs Between Stakeholders in Marine Protected Areas in the Caribbean*. Project brief. University of East Anglia, Norwich.

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