A Marine Space Use Information System for the Grenadine Islands: Implications for collaborative planning and management

Supervisors:
Professor Robin Mahon and Professor Hazel Oxenford

PhD Committee Member:
Dr. Patrick McConney

Kimberly Baldwin
Centre for Resource Management and Environmental Studies (CERMES)
University of the West Indies
Cave Hill Campus
Barbados

kimberly.baldwin@cavehill.uwi.edu
(246) 417-4828

TABLE OF CONTENTS

1. Background

1.1 Geography

The Grenadine islands lie on the Grenada Bank extending some 120 km and located between the main islands of Grenada and St. Vincent (Figure 1). There are over 30 islands, islets and cays of which 9 have permanent settlements (CCA 1991a, 1991b; Sustainable Grenadines Project 2005, Table 1) and of which two are privately owned/leased resort islands. The inhabited Grenadine islands of Bequia, Mustique, Canouan, Mayreau, Union, Palm and Petite St. Vincent as well as a large number of islets and cays including the Tobago Cays come under the jurisdiction of St. Vincent and the Grenadines. The inhabited islands of Carriacou and Petite Martinique as well as several islets belong to Grenada. The largest islands have towns and communities with public and private supporting infrastructure. Most others are visited by yachters and fishers (Sustainable Grenadines Project 2005).

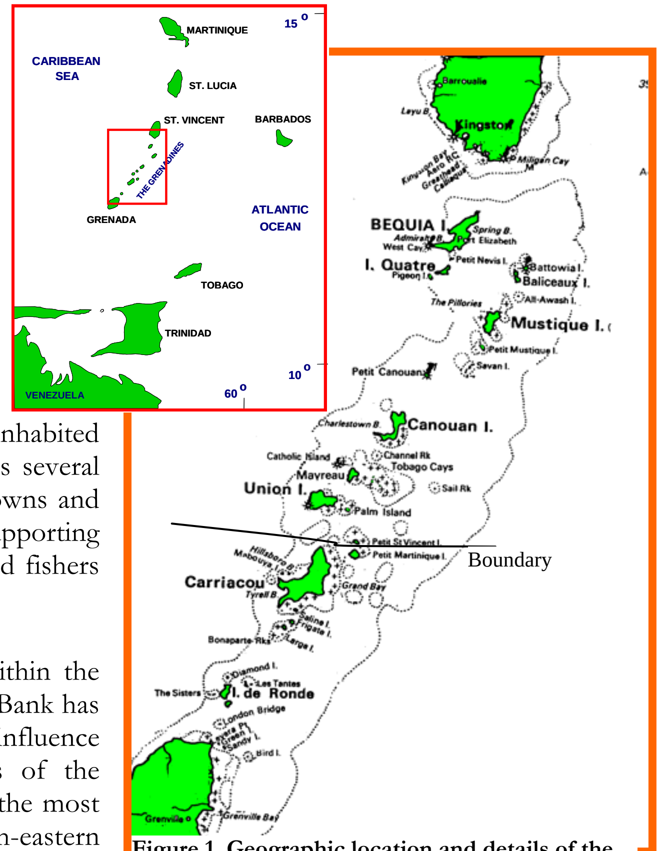


Figure 1. Geographic location and details of the Grenadine islands of the transboundary Grenada Bank. (*Adapted from Cooke et al. 2005*).

The Grenadine islands are one of the few areas within the Lesser Antilles with an extensive shelf. The Grenada Bank has an area of approximately 3,000 km^2 exposed to the influence of oceanic water (CRFM 1994). Three quarters of the Grenada Bank is shallower than 50 m and supports the most extensive coral reefs and related habitats in the south-eastern Caribbean (CCA 1991a, 1991b). In the Grenadine Islands all reef-related habitats are represented: seagrass and lagoon, areas of mangrove and a variety of patch, fringing and bank barrier reefs (ECLAC 2004).

1.2 Importance of Marine Resources

Although the international boundary between Grenada and St. Vincent and the Grenadines runs east to west across the Grenada Bank between Petite Martinique and Petite St. Vincent, linkages among all of the Grenadines islands are historically strong and continue to be active in the forms of fishing, informal trading, tourism and social life, with little attention to the boundary (Sustainable Grenadines Project 2005). Many people consider these connections among the people of the Grenadines to be stronger than those with their respective mainland (Sustainable Grenadines Project 2005).

Island	Area (km^2)	Population
Bequia	8.1	4,420
Mustique	5.2	1,290
Canouan	7.8	1,830
Mayreau	2.6	170
Union I.	8.3	1,900
Palm I.	0.5	Resort I.
Petit St. Vincent	0.5	Resort I.
Petit Martinique	2.3	600
Carriacou	33.7	8,000
Total	**69.0**	**18,210**

Table 1. Estimated population for each of the inhabited Grenadine islands (Sustainable Grenadines Project 2005).

The Grenadine islands are recognised for their beautiful natural scenery consisting of rolling hills, spectacular beaches, clear blue waters and diverse marine habitats (CCA 1991a). Marine-based activities are the mainstay of the economy of the area; in which fishing, transport and tourism are the major sources of employment. Private sector businesses include: resorts, hotels, guest houses, restaurants, SCUBA and snorkel dive operations, day charters, yachting tourism (including bareboat, charter and live-aboard cruisers), cruise ships, ferries and shipping companies. Tourism is a key sector for employment and revenue. The number of visitors to the Grenadines has increased steadily in recent years and tourism development is proceeding apace (ECLAC 2004). Fishing is the other main source of employment and livelihood and CCA (1991a) reported that some 85-95% of adult males in the Grenadines are fishers or active in related sectors. Fisheries resources of the Grenada Bank (i.e. not including oceanic pelagics and whales) consist of shallow-shelf reef fishes, lobster, conch, deep water (slope and bank) demersal fishes, coastal pelagics, sea turtles and sea urchins (Mahon 1990). Most fisheries in the Grenadines are small-scale artisanal, with fishers typically operating independently on a subsistence level with little or no organisation (Chakalall *et al.* 1994). These small-scale fisheries of the Grenadines are pursued by a variety of gear and vessel types. The gear consists mainly of fish traps, spear guns, SCUBA, handlines, trolling lines, gill nets/trammel nets, beach seines and longlines (Chakalall *et al.* 1994).

1.3 Current Status of Management

Both Governments perceive their Grenadine islands as having high potential for tourism and associated development, whilst also recognising their current value and long tradition of supporting coastal communities through fishing. They are also well aware of the high vulnerability of the marine resource systems of the area to environmental degradation and the dependency of sustainable development on conservation of the resources (see Sustainable Grenadines Project 2005 for review). Yet, unplanned development and the unregulated use of the coastal and marine resources of the Grenadines have already led to significant degradation in many areas. Increasingly serious infrastructural, socio-cultural and ecological problems have contributed to the declining quality of the natural resources of the Grenadines in recent years. Overfishing, coastal habitat destruction and degradation, sedimentation, solid waste and sewage disposal from land-based and boat sources as well as the recreational abuse of coral reefs have been cited as causative factors for this deterioration (CCA 1991a, 1991b; Price and Price 1994a, 1994b, 1994c; Price and Govindarajulu 1998; FAO 2000; FAO 2002; ECLAC 2004; Sustainable Grenadines Project 2005; CIA 2006).

Historically, each country's respective Fisheries Division has taken the lead role in managing marine resources of the Grenadine islands. Thus far, collaborative management has been limited both within and between the two countries; each has primarily administered management in a top-down fashion that has failed to adequately protect and conserve the transboundary marine resources and biodiversity of the Grenada Bank. Current management efforts of both Grenada and St. Vincent and the Grenadines have been unable to reduce the high fishing effort and destructive fishing practices attributing to the overexploitation of the majority of fishing resources of the Grenada Bank (FAO 2000; FAO 2002). Table 2 summarise the status of key fisheries, current regulations and management objectives for each country.

Table 2. Description of stock status, current regulations practiced and objectives for the management of various fisheries in St. Vincent and the Grenadines and Grenada (FAO 2000 and 2002).

COUNTRY	FISHERY	STATUS OF STOCK	CURRENT REGULATIONS	MANAGEMENT OBJECTIVES
ST. VINCENT & THE GRENADINES	**Shallow shelf demersals**	Overexploited	- No spear fishing in marine conservation areas	- Promote stock recovery - Divert effort to deep-slope demersals and offshore pelagics
	Deep slope demersals	Underexploited	- No spear fishing in marine conservation areas	- Maximize catches within Maximum Sustainable Yield - Reduce illegal fishing from foreign vessels - Protect stock from overfishing by limiting effort - Improve the collection of catch and effort data
	Inshore pelagics	Moderately exploited	- Net mesh size restrictions - Use of trammel nets are illegal	- Encourage co-management - Maintain artisanal nature of the fishery
	Offshore pelagics	Underexploited	- None	- Cooperate with ICAAT to assess and preserve the resource
				- Promote the wise development of commercial and sport fisheries by controlling effort
	Lobster	Overexploited	- Size restrictions (3.5 inches) - Close season from 1st May to 31st August - Illegal to catch or sell out of season - Illegal to remove berried lobsters or their eggs	- Rebuild stocks in depleted areas - Proper management by controlling effort is needed to ensure sustainable extraction
	Conch	Overexploited	- Size restrictions (7 inches) - Minister can declare any period as a closed season	- Manage sustainably and prevent further resource depletion by controlling fishing effort
COUNTRY	FISHERY	STATUS OF STOCK	CURRENT REGULATIONS	MANAGEMENT OBJECTIVES
GRENADA	**Demersals and shellfish**	Overexploited	- Net mesh size restrictions apply - All shellfish are subject to a 4 month close season (1st May to 31st August)	- Expand fishing effort to deep slope fisheries
	Offshore pelagics	Underexploited	- No effort restrictions, close seasons or area closures exist yet	- Sustainable exploitation of stocks - Relieve overfished demersal grounds - Apply licensing and taxes etc. to shape the direction of the fishery
	Inshore pelagics	-	- Nets require licensing - Net mesh size restrictions apply	-

Source: FAO 2000 & 2002.

Both Grenada and St. Vincent and the Grenadines are party to a large body of key international (Table 3) and regional (i.e. OECS) environmental agreements and possess national legislation and regulations to promote sustainable development and protect and conserve marine resources and biodiversity. Furthermore, many of these same instruments require the inclusion of stakeholder participation in planning and management initiatives. Despite this, there appears to be a lack of national integration between relevant government agencies, transboundary multi-sectoral collaboration and formal stakeholder participation in the management of the marine resources of the

Grenada Bank. This may be, in part, due to centralisation of both governments on their respective mainland and the physical constraints of access to the dispersed chain of Grenadine islands. This is no doubt exacerbated by a lack of formal fisheries and marine tourism management plans, limited enforcement capacity and limited formal stakeholder participation mechanisms in planning and management initiatives within both countries.

Table 3. Relevant environmental international conventions to which countries of the Grenadines are a party.

		COUNTRY			
		St. Vincent & the Grenadines		Grenada	
CATEGORY	CONVENTION	DATE	METHOD	DATE	METHOD
BIODIVERSITY, FORESTRY & WILDLIFE	**1992 Convention on Biological Diversity (CBD)**	03 June, 1996	Accession	03 December, 1992 11 August, 1994	Signed Ratified
	2000 Biosafety Protocol	27 August, 2003	Accession	24 May, 2000 05 February, 2004	Signed Ratified
	1973 Convention on International Trade in Endangered Species of Flora & Fauna (CITES)	30 November, 1988	Accession	30 August, 1999	Accession
	2000 Specially Protected Areas and Wildlife (SPAW) Protocol	26 July, 1991	Signed / Ratified		
CLIMATE CHANGE	**1992 United Nations Framework Convention on Climate Change (UNFCCC)**	02 December, 1996	Ratified	03 December, 1992 11 August, 1994	Signed Ratified
	1997 Kyoto Protocol	19 March, 1998 31 December, 2004	Signed Ratified	06 August, 2002	Ratified
	1987 Montreal Protocol	02 December, 1996	Accession	31 March, 1993	Accession
	1985 Vienna Convention on Substances that Deplete the Ozone Layer	02 December, 1996	Accession	31 March, 1993	Accession
MARITIME & FISHERIES	**1982 United Nations Convention on Law of the Sea (UNCLOS)**	1 October, 1993		25 April, 1991	
	Cartagena Protocol	11 July, 1990	Ratified/Acceded	23 March, 1983 17 August, 1987	Signed Ratified/Acceded
	1986 Oil Spills Protocol	11 July, 1990	Ratified/Acceded	24 March, 1983 17 August, 1987	Signed Ratified/Acceded
	1973 International Convention on the Prevention of Pollution from Ships, (MARPOL)	-	-	-	-
	Land Based Sources (LBS) Protocol	-	-	-	-

(Adapted from Mattai and Mahon 2007).

Marine resources are of vital importance to the people of the Grenadines, yet planning and management of the use of marine resources of the Grenada Bank is becoming increasingly complex. Not only are the marine resources distributed across the Grenada Bank but they are transboundary and utilised by a variety of marine resource users emanating from nine Grenadine islands as well as from both of the respective mainlands. Management thus far has taken a conventional, top-down, command-and-control approach guided by standard non-specific regional management plans and based on limited biophysical information. Furthermore, marine management of the Grenada Bank has not been integrated amongst disciplines, between nations or knowledge systems. This segregated management approach has not been effective thus far and has failed to prevent the environmental degradation of the Grenada Bank. It is proposed that effective and proper planning will require a complex and adaptive mechanism tailored to the local environment.

2. The Research Problem

2.1 Overview

It has been realised that coastal resource planning and management cannot be pursued from a biophysical focus alone. Moreover, fisheries are too diverse, dynamic and complex to be efficiently managed by one institution (Mikalsen *et al.* 2007). Community attitudes towards, and uses of coastal resources have serious implications on the biophysical health of marine resources and likewise the management of coastal resources have equally serious implications for the socio-economic health of the human communities (IIRR 1998; Bunce *et al.* 2000; Bunce and Pomeroy 2003; Sayer and Campbell 2004). Development efforts that have ignored local circumstances and knowledge systems have wasted time and resources (Grenier 1998). By including the social frame of reference and incorporating local ecological and popular knowledge systems with traditional scientific approaches, important information gaps can be filled, potential problems can be identified and management priorities focused accordingly (Maine *et al.* 1996; IIRR 1998; Grenier 1998; Walters *et al.* 1998; Sayer and Campbell 2004; Wiber *et al.* 2004).

Conventional top-down scientific approaches have failed to achieve the goals of sustainable development and are insufficient to respond to the complex nature of social, economic, political and environmental challenges in marine resource management (Maine *et al.* 1996; Grenier 1998; IIRR 1998; Sayer and Campbell 2004; Pomeroy *et al.* 2004; Wiber *et al.* 2004). It has been realised that for coastal resource management to be effective it must balance the sustainable use, resource protection and conservation with the communities' need for food security, livelihoods and equitable use of resources (Maine *et al.* 1996; Grenier 1998; IIRR 1998; Bunce *et al.* 2000; Bunce and Pomeroy 2003; Sayer and Campbell 2004). Academically, a paradigm shift has occurred in marine resource management which embraces the use of participatory mechanisms in order to combine quantitative and qualitative knowledge from a diversity of stakeholders thereby allowing for improved data and information. This process can also aid more 'interactive' governance better guiding decision-making and management initiatives (Pomeroy *et al.* 2004; Wiber *et al.* 2004). It has been argued that in the short-term the inclusion of 'local' or indigenous knowledge through participatory research is more time-consuming and costly than conventional top-down approaches, yet it can provide more appropriate information for long-term planning and management initiatives. Stakeholder engagement in management can provide for better compliance with rules and increased stakeholder capacity in problem solving and decision-making, thereby increasing local empowerment and community cohesion and ultimately build a more sustainable future (Grenier 1998; IIRR 1998; Cumberbatch 2001; Sayer and Campbell 2004; Wiber *et al.* 2004). Furthermore, it is believed that multi-sectoral collaboration and meaningful community participation involving a range of stakeholders in the information gathering, research and evaluation processes allows for equity in decision-making. By meaningfully including and considering both sectoral and community interests, mutual respect is created, a better understanding for management initiatives is gained and a participatory framework for co-management is fostered (Walters *et al.* 1998; Chuenpagdee *et al.* 2004; Sayer and Campbell 2004; Wiber *et al.* 2004). Moreover, many experts report that by ensuring that information is gathered, validated and accepted by all stakeholders in a transparent and equitable fashion stakeholder support for management efforts can be maximised (Maine *et al.* 1996; Grenier 1998; McConney *et al.* 1998; McAllistar and Vernooy 1999; Renard 2000).

In recent years, geographical information systems (GIS) have gained wide acceptance for natural resource management applications, as these inevitably have a spatial component allowing for integration of information from a variety of sources and at multiple scales. GIS can also facilitate data management by providing a visual framework to link, relate and analyse both spatial and attribute data (Calamia 1999; Quan *et al.* 2001; Balram *et al.* 2003). GIS can collate a range of natural resource data as automated spatial features which can be rapidly merged, accessed and easily updated allowing for innovative spatial queries (Douvere *et al.* 2007). Additionally, GIS technology can be used in natural resource management to statistically identify unique relationships and interactions between mapped variables (Berry 1995; Douvere *et al.* 2007) allowing for a range of spatial interpretation, modelling and planning (Quan *et al.* 2001).

Major constraints of GIS can be the unavailability of, or the cost of obtaining, comprehensive and reliable biophysical data (Balram *et al.* 2003). GIS also requires substantial finances to purchase software, computer hardware and acquire technical training; all of which may be beyond the capacity of many resource managers (Lindenbaum 2006). Despite the power of GIS for analysing information, another major criticism of conventional GIS has been its focus on spatial interpretation and modelling based primarily on a 'snapshot' of static biophysical information. Conventional GIS has thereby discounted the many social and dynamic aspects involved in natural resource management; including the recognition of continual database maintenance in order to update the GIS and ensure an accurate information base for decision-making.

The use of GIS in marine resource management is relatively new. Marine GIS applications have primarily focused on spatial planning or zoning to promote the sustainable use of coastal and marine resources and to reduce space-use conflicts (Douvere *et al.* 2007). Some examples include: the 'Representative Areas Program' for Australia's Great Barrier Reef Marine Park (Pattison *et al.* 2004); the Florida Keys National Marine Sanctuary in the USA; the Eastern Scotian Shelf Management Initiative in Canada; and the Provincial Resource Management Plan in the Philippines (Douvere *et al.* 2007). These examples have focused primarily on the utilisation of conventional scientific information inspired by driving forces of marine conservation and the reduction of space-use conflicts (Douvere *et al.* 2007; Pattison *et al.* 2004).

Participatory GIS (PGIS) is an emerging interdisciplinary community development and environmental stewardship tool based on action research principles. PGIS practice has developed from the merger of participatory learning and action (PLA) and participatory rural appraisal (PRA) methods with geographic information technologies (Aberly and Sieber 2006; Chambers 2006; Corbett *et al.* 2006; Rambaldi *et al.* 2006). The PGIS approach incorporates local knowledge, stakeholders' perspectives and socio-economic data in the GIS database and merges it with conventional biophysical information to provide for a more ethical, functional and holistic framework to promote social justice and ecological sustainability (Aberly and Sieber 2002; Corbett *et al.* 2006). Furthermore, the PGIS process includes participatory validation, control and access of information generated by stakeholders (Aberly and Sieber 2002). Therefore, PGIS can allow for a more comprehensive understanding of the social characteristics of natural resource use and its' users by promoting the interactive participation of stakeholders in the development of a technical representation of local spatial knowledge (Quan *et al.* 2003). It is alleged that the process of PGIS not only results in more comprehensive understanding of functional natural resource information, but that planning priorities can be better focused and effective coastal resource management, including the sustainability of livelihoods, is possible. Secondarily, it is believed that the utilisation of PGIS can strengthen civil-society education, build capacity and increase stakeholder acceptance of management initiatives (Aberly and Sieber 2006; Chambers 2006; Corbett *et al.* 2006; Rambaldi *et al.* 2006). Moreover, it is purported that PGIS can demonstrate the relevance of information provided by stakeholders and can support the utilisation of local knowledge together with conventional scientific knowledge (Calamia 1999; Corbett *et al.* 2006; Chambers 2006). This cannot be achieved using conventional GIS approaches.

It has been proposed that by including local knowledge and perspectives within a GIS database, a more comprehensive understanding of the marine environment and its' importance to livelihoods is obtained and management efforts can therefore be better focused (IIRR 1998; Walters *et al.* 1998; Calamia 1999; Corbett *et al.* 2006; Smith 2006). PGIS is relatively new to marine resource management; yet applications have shown to be both functionally and socially successful. PGIS processes were used to functionally assist in the design of the Colombian Biosphere Reserve protectorate Archipelago of San Andres, Old Providence and Santa Catalina (Friedlander *et al.* 2003); and in the Marine Protected Areas planning process in California under the California Marine Protection Act (Scholz *et al.* 2003). Within the Eastern Caribbean, the only case study of marine

PGIS utilisation is within the participatory mapping project of Laborie Bay, St. Lucia within the CANARI 'People and the Sea' Project. This project demonstrated the socially empowering benefits of PGIS technology; whereby the natural resource information base was developed through the integration of scientific and popular knowledge systems thereby strengthening local capacity to address and combat land-based sources of marine pollution (Smith 2003; Lindenbaum 2006; Smith 2006 personal communication). These case studies support the multifaceted benefits of utilising PGIS; not only to better understand marine resources and space-use patterns, but in aiding stakeholder capacity and social empowerment thus contributing to the development of collaborative planning and management initiatives. It must be noted that the success of these PGIS applications have occurred on a small-scale; occurring in one community and within one country. Therefore the success of PGIS applied to transboundary marine management has not been tested.

2.2 Objective of Research

A fundamental shift to amalgamate quantitative and qualitative knowledge systems is proposed to allow for a holistic multidisciplinary approach to marine resource management on the Grenada Bank. Towards this end, a collaborative spatial approach derived from the fullest possible information base is proposed to effectively understand, plan and manage the transboundary and multifaceted nature of the marine resources of the Grenada Bank and its users. This research will use the process of PGIS to integrate social, economic, cultural and conventional biophysical information together with the local knowledge system of marine resource users in a single framework; in order to test the added value gained from utilising this alternative approach. This research will investigate the development of an integrated multi-knowledge transboundary marine space-use information system as a planning tool for the marine resources of the Grenada Bank and test its effectiveness in providing a more holistic understanding of the value of coastal and marine resources in regards to conservation, biodiversity and to the livelihoods of the Grenadine people.

This research explores two propositions. The first, based on the literature, is that merging local ecological marine resource knowledge, socio-economic information and space-use patterns with conventional biophysical environmental information will provide significant planning insights over the use of the latter alone. To pursue this, the research will utilise a variety of participatory research methods (including key informant interviews, inventories of marine resource users, socio-economic surveys, learning exercises, focus groups, mapping exercises, ground-truthing and feedback/validation) to acquire local knowledge and integrate it with conventional scientific information. The second proposition is that integrating information from the full range of user groups through the use of GIS will provide management insights that cannot be acquired by examining the data and information independently. It is proposed that a transboundary marine space-use information system could be beneficial in advancing the integrated and sustainable management of the bilaterally-shared marine resources of the Grenada Bank. Furthermore, the research will evaluate the usefulness of participatory research and the quality of the multi-knowledge system information produced by examining the overall costs (in terms of time, money and resources) and the benefits (both functionally and socially) to the variety of stakeholders involved in the development, validation and production of this multi-knowledge PGIS. To this end, the Grenadine MarSIS will be developed as a public-access PGIS planning tool with the aim of facilitating an improved information base for decision-making as well as provide a foundation for the sustainable and equitable development of a transboundary marine space-use plan for the Grenadines.

3. Methods

The timeframe for the research is shown in a Gantt chart (Appendix I).

3.1 Geographical and Geodatabase Scope

The geographical scope of the study is the marine environment of the Grenada Bank, which spans more than 120 km and the jurisdiction of two countries: Grenada and St. Vincent and the Grenadines. This includes the coastlines of the Grenadine islands and extends to the 200 metre depth contour of the Grenada Bank (Figure 1). Data to be collected will include biophysical resources such as critical habitats (essential fish habitats including nursery areas and spawning aggregation sites, and areas used by endangered species), areas of high biodiversity and representative marine ecosystems (mangroves, seagrass beds and coral reefs). Socially and economically important areas will be identified based on: high aesthetic and recreational value, historical and cultural importance, important fishing grounds (including types of fishing, pressure and gear used), areas important for marine-based tourism and transport (including safe anchorages). Areas for livelihood and development opportunities as well as areas of highest human pressure (space-use overlap) and perceived threat (including locations of land-based sources of marine pollution) will also be identified. As a result, the geodatabase will be interactively utilised to progressively identify areas within the Grenadine islands of spatial importance for marine conservation and marine-based livelihoods as well as emergent areas which are currently or potentially high for space-use conflict of the Grenada Bank.

3.2 Geodatabase Structure

The geodatabase will be created using ESRI's GIS software package ArcGIS version 9.2. Existing relevant GIS data sets (global, regional and national) has been reviewed and will be adapted for use in this project where possible. ReefGIS is a downloadable global dataset, which is based on LANDSAT imagery for use in the 'Coral Reef Millennium Mapping Project' created by the principle investigator Dr. Serge Andrefoute at the University of South Florida's IMaRS Department, which has been reclassified by ReefBase. A large amount of regional transboundary GIS data is already available from The Nature Conservancy (TNC) who has been assembling GIS data for both countries of Grenada and St. Vincent and the Grenadines since 2002 for their 'Parks in Peril' Grenadines conservation programme. The majority of TNC GIS data sets have been produced either from clipping a variety of global datasets (including World Resources Institute, World Conservation Monitoring Center and the Global Land Cover Facility) and utilising conventional GIS modelling techniques or through the digitization of: existing maps, satellite images and aerial photographs obtained from each countries' respective Land Use Division, Planning Department, Forestry Department and Fisheries Division). National coastal resource GIS datasets (i.e. CRIS) were found to only exist for St. Vincent and the Grenadines. The range of existing GIS data will be further reviewed for relevance and if applicable areas in need of more information or validation will be identified from these large GIS databases. Therefore, all pre-existing spatial GIS data will be assessed and catalogued and used where possible by developing attribute tables with relevant ecological, socio-economic and local knowledge information of marine resources and corresponding users of the Grenada Bank.

The relational database will be constructed using Python database software included within ArcGIS 9.2 software. Appendices II and III list the possible 'data layers' or tables for each of the identified spatial categories. Marine resource and knowledge system information will be represented by user group and divided by island. In this manner data layers can be analysed separately but more importantly, can also be merged and corroborated for unique transboundary and multi-knowledge system spatial analyses. All spatial database files created will be accompanied by corresponding attribute tables and complrehensive ESRI FGDC compliant metadata.

3.2.1 Spatial Categories

Key spatial information will consist of biophysical habitats and resources, areas used by marine resource users and associated space-use patterns, legislative areas as well as areas identified as threatened or for livelihood opportunity. Possible spatial categories to be identified are listed in Table 4.

Table 4. Spatial categories or 'layers' to be included in the MarSIS geodatabase.

Spatial Categories	Description
Marine Benthic Habitats*	Reef classifications, associated fish species and organisms, spawning and nursery areas
Coastal Resources*	Key areas of use, seasonal patterns and intensity of use
Marine Biophysical Data	Bathymetry, currents, salinity, temperature
Fishing Villages/Communities	Demographics, activity profiles, socio-economic information
Important Fishing Grounds*	Key resources (i.e. fish species, conch, lobster), fishing intensity/pressure, gears used
Fish Landing Sites	Demographics, catch and landing statistics
Other Marine Resource Users	Demographics, activity profiles, socio-economic information
Areas Important for Marine-based Tourism*	Dive sites, snorkelling areas, sailing passages, anchorages and intenisty
Safe Anchorages, Marinas, Ports	Capacity, depth, infrastructure, intensity
Shipping (Commercial Use) Areas*	Inter-transit shipping routes, intensity
Areas of High Aesthetic, Historical, Cultural and Recreational Value*	
Conservation/Protected Areas	Proposed and legislated marine protected areas, marine monitoring survey information
Land-based Sources of Marine Pollution*	Type, source
Perceived Environmental Threats*	
Areas of Livelihood or Development Opportunities*	

** Indicates spatial categories which will include local knowledge obtained through the use of participatory research mechanisms*

3.3 Stakeholder Involvement

Research will be based on the premise that in order to obtain accurate information of marine resources (location and status) and their uses (both the value of marine resources to livelihoods and the spatial representation of the various users' activity profiles) as well as gain acceptance for marine planning and management initiatives, a variety of knowledge systems must be included in the geodatabase. It is proposed that by utilising a range of participatory communication, research and validation techniques throughout the development of the geodatabase, it will not only incorporate popular knowledge on marine resources but transparently bring a variety of stakeholders into a common space of understanding. Therefore through the utilisation of participatory research (PR) will be used to better understand, represent and validate the local knowledge systems of Grenadine marine resource users' in hopes of obtaining a better understanding of areas of importance for livelihoods and conservation and allow for more effective management of marine resources of the Grenada Bank.

3.3.1 Communication Mechanisms

Communication will be encouraged between identified stakeholders throughout the research process. The objectives, the role of stakeholder involvement, and the progress of the development of the research, including issues encountered and possible solutions, will be communicated to stakeholders through both one-way and two-way channels. One-way channels will be established through regular newsletters, emails and flyers as well as with the assistance of other civil-society organisations in the Grenadine islands. Two-way channels will include a yahoo e-group/website (www.GrenadinesMarSIS.yahoogroups.com). The e-group will be used not only to increase the accessibility of information gathered during the research but to augment transparent communication by facilitating an integrated discussion forum between all stakeholders throughout the research. All stakeholders with internet access will be encouraged to join this e-group. Furthermore, periodic summary reports and governmental and community stakeholder meetings will also be used to introduce the project, review the objectives, validate and share information collected by stakeholders to allow for feedback and evaluation of the research (see Appendix 1 for tentative meeting schedule). By actively involving stakeholders in each step of the research process; through information exchange, encouraging collaboration and allowing input on possible solutions to identified management issues, these stakeholder meetings will be aim to foster an equitable and transparent environment in the research and support an adaptive collaborative environment amongst stakeholders. Moreover, all stakeholder meetings and field research activities will be documented in a series of summary reports (see Appendix I for tentative meeting and report schedule) and shared through both the e-group / website as well as distributed in hard copy format in collaboration with the locally established NGOs and the civil-society organisation, the Sustainable Grenadines Project.

3.3.2 Participatory Mechanisms

The primary use of participation in the research will be for better understanding and documentation of local knowledge of marine resource distribution, abundance and space-use patterns. Secondarily, the process of PR will aim to lay the foundation for social transformation and increased empowerment by increasing the legitimacy of local knowledge as well as increasing stakeholder education and capacity. PR activities will be focused mainly on involving the identified primary stakeholders (direct marine resource users and key government agencies). PR activities will consist of: key informant interviews, participant observation, stakeholder assessment, marine resource user inventories and surveys, interactive learning exercises, community consultations, coastal profile transect walks, seasonal calendars, ground-truthing, fish and benthic surveys, semi-structured focus group interviews and participatory mapping exercises. PR activities will be guided by a combination of Socio-economic Manual for Coral Reef Management (SocMon) (Bunce *et al.* 2000), Participatory Methods in Community-based Coastal Resource Management (IIRR 1998) and Participatory Coastal Resource Assessment (PCRA) (Walters *et al.* 1998) principles and methodologies. PR methods will be critically evaluated and adapted accordingly based on local relevance. Furthermore the research will assess the effectiveness of the utilisation of these techniques in achieving the aims of the research.

3.3.3 Validation, Feedback and Evaluation Mechanisms

Periodically, information collected is presented to all stakeholders for validation and feedback through the identified communication mechanisms. Stakeholder assessment, validation, feedback and evaluation mechanisms allows for transparency in the research process. Acquiring verification and allowing stakeholder input and control of information produced aids both inter and intra-stakeholder understanding and support for information generated. A variety of Participatory Assessment Monitoring and Evaluation (PAME) techniques, specifically the cross-checking of results through numerous stakeholder validation meetings and the distribution of maps and summary reports (Maine *et al.* 1996; IIRR 1998; McAllister and Vernooy 1999) will be systematically used for learning. This will be done not only to better guide the participatory research, but validate information collected and provide for quality assurance of data. By evaluating the usefulness of the communication and PR activities, an environment of adaptive management is fostered. It is anticipated that through the utilisation of PR, stakeholders will in turn attain an increased understanding and appreciation of the importance and role of participation in planning equitable and sustainable development of marine resources of the Grenada Bank.

3.4 Data Collection

3.4.1 Secondary Data

The research will require an extensive review of global, regional and national secondary (i.e. existing) data on marine-related legislation, policies, management plans as well as research conducted on the marine environment, fisheries, tourism, civil-society and private sector organisations in the Grenadine Islands. All secondary data will be organised, systematically catalogued and converted to GIS where possible. Furthermore, site visits will be made to all government stakeholders' (including Grenada and St. Vincent) to source additional information and identify information gaps. This can also aid institutional strengthening by building working relationships while sharing and reviewing all secondary data collected.

3.4.2 Stakeholder Analyses

3.4.2.1 Stakeholder Identification

Stakeholder groups identified will be categorised as primary and secondary stakeholders (Figure 3). Primary stakeholders will include key government agencies (Fisheries Division, Physical Planning and Tourism) of each country and direct marine resource users (including the private sector). Direct Grenadine marine resource users will be grouped by type of use and by island and will include: dive shops, day tour operators (general, sailing and sport-fishing), water-taxi operators, fishers, yacht charter companies, ferry operators and ship owners. Fishers will be further grouped by landing site and will be analysed by fishing types (i.e.: baitfish, conch, lobster, reef fish, bottom fish and inshore/offshore pelagics). Secondary stakeholders will include civil society organisations and local NGO's, other relevant government agencies (Forestry, Ministry of the Environment, Coast Guard, Port Authority, Statistics, Harbour Master, Customs and Maritime Administration) and the communities of the nine inhabited Grenadine islands.

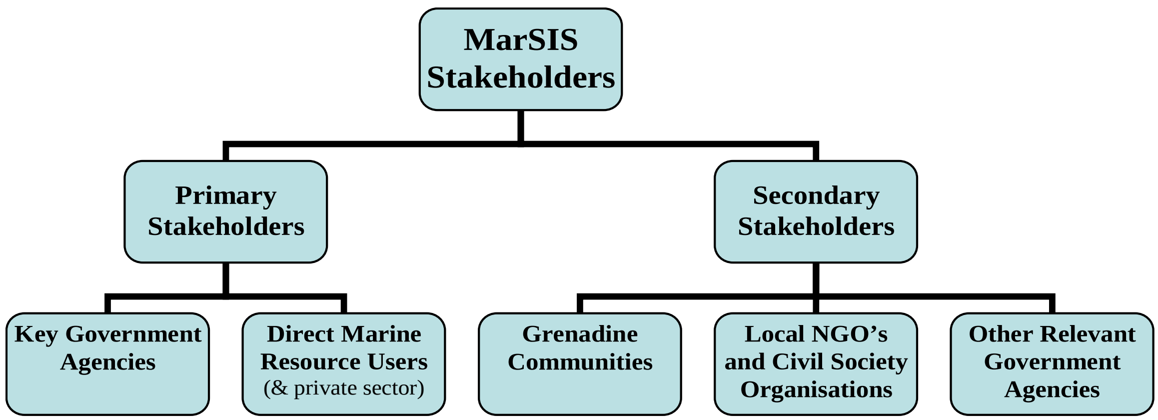


Figure 2. Identified marine resource stakeholders of the Grenadine Islands.

3.4.2.2 Preliminary Stakeholder Assessment

A three week data-scoping assessment will be undertaken in each of the inhabited Grenadine islands as well as in each respective mainland. Government institutional assessments and the identification of the abundance and distribution of direct marine resource users, including an initial assessment of the general locations of key marine resources and their current uses, will be priority. Secondarily, this exercise will be used to initially gain insight of the stakeholder dynamics and general environmental awareness, including the value of and threats to existing marine resources and livelihoods as well as any existing conflict among users within each of the Grenadine island communities'. Information will be obtained primarily through direct observation and key informant interview techniques (IIRR 1998; Walters *et al.* 1998; Bunce *et al.* 2000). A minimum of three key informants from each marine resource user group will be interviewed in each island. Information gathered during this data scoping assignment will also be utilised to further define research objectives as well as identify subsequent socio-economic survey variables and appropriate spatial data collection tools. A summary report on the data scoping and stakeholder assessment will be prepared and shared with stakeholders through communication mechanisms identified.

3.4.2.3 Socio-economic and Activity Profiles

An inventory of each marine resource user group and socio-economic survey instruments (Bunce *et al.* 2000) will be administered over a three month period with the assistance of four CERMES MSc students. Baseline marine space-use information will be collected to create spatial activity profiles for each marine resource user group. All survey instruments will be posted on the MarSIS e-group for feedback from stakeholders before being utilised. Furthermore, marine resource user activity profiles and associated socio-economic findings will be presented to primary stakeholders through a series of PAME meetings (Maine *et al.* 1996; McAllister and Vernooy 1999). This will be done in order to obtain stakeholder validation and feedback before being spatially translated into GIS data files accompanied by a technical report. Again, this report will be widely distributed to stakeholders in the communication mechanisms identified.

3.4.3 Coastal/Marine Classification

A science-based classification system will be collaboratively developed with government stakeholders. This benthic classification scheme will be developed at a scale that is useful for planning and management purposes and will include categories such as: sand, seagrass, coral-dominated reefs, algal reefs (low-relief) and rocky reefs (high-relief). Benthic habitat maps will be developed using a conventional GIS classification technique, the ArcView Habitat Digitizer extension and will include the reclassification of existing global, regional and national GIS datasets where possible. Additional collateral information including previously completed habitat maps, nautical charts, and other descriptive scientific sources as well as available aerial photography and satellite imagery sources (i.e. LANDSAT, IKONOS, Google Earth) will be used to assist with image interpretation.

A local knowledge classification system for both the location of key marine resources and critical fisheries habitats will be collaboratively determined with marine resource users. Initially, interactive learning activities (IIRR 1998) will be carried out with each type of the marine resource user to better understand, identify and classify each group's key marine areas of usage, including important resources and habitats as well as areas unsuitable for use. Further classification will be determined through the use of underwater surveys, coastal profile transects, seasonal calendars, and participant observation techniques (Maine *et al.* 1996; IIRR 1998; Walters *et al.* 1998). Additionally, it is anticipated that the utilisation of these PR techniques will allow the researcher to develop stronger relationships, respect and trust amongst marine resource user stakeholders. By experiencing each marine resource user's daily routine, insights can be gained into on users' livelihood and resource space-use patterns. Furthermore it is anticipated that this process will aid the identification and cooperation of potential key informants for subsequent participatory mapping exercises.

A month-long participatory habitat ground-truthing and validation research cruise across the Grenada Bank will be undertaken on a live-aboard dive vessel. This validation will include: areas in which it was confusing or difficult to interpret imagery, areas in which there was not consensus amongst the data sources and will be used to ground-truth the preliminary scientific habitat classification. Within each island, field activities will be conducted with the guidance and advice of local marine resource users. Furthermore, descriptive information, pictures, depths, GPS locations, space-use patterns and an inventory of existing marine resources of the Grenada Bank will be systematically collected at each site. Following the processing of field data and the final revision of habitat maps, all information will be reviewed and validated with the guidance of a variety of stakeholders at PAME meetings.

3.4.4 Spatial Data Collection

3.4.4.1 Basemap Production

A basemap of the Grenada Bank consisting of coastlines, bathymetry, high-resolution satellite imagery and territorial boundaries has been created in ESRI's ArcGIS version 9.2 for spatial data collection (Appendix IV).

In order to aid stakeholder understanding of this simple basemap for use in subsequent mapping exercises, community stakeholder mapping exercises will be undertaken to determine the 'topogy' (i.e. locally-used names) for the beaches, bays and cays of the Grenada Bank. Standard government 1:10,000 Lands and Surveys topographic maps will be used for this mapping exercise due to their easy availability and community members' familiarity with known landmarks. Community members from each island will be asked to provide the local names for all the beaches, bays and cays for which they are familiar with and all names will be written directly on each topographic map. Each map will be carried around to the various communities within each island until all named coastal features are identified and general consensus is gained. At a minimum, at least three key informants will need to verify and agree on the names provided, before each island's 'topogy' map is considered complete. Information collected will be spatially referenced and used to annotate the basemap with the local names of coastal features for use in subsequent mapping exercises.

3.4.4.2 Mapping Exercises

Participatory mapping will be conducted in the form of small semi-structured focus group interviews and individual interviews (Walters *et al.* 1998; Bunce *et al.* 2000). Individual mapping exercises will be used to map space-use patterns amongst marine resource users. Focus group interviews will be used to identify and map critical habitats and resources as well as ascertain current or potential issues/conflicts and opportunities. Focus groups will consist of a diverse group of selected direct marine resource users (comprising four to six participants), a facilitator and a record keeper/computer assistant. During each series of mapping exercises at least one focus group interview will be held in each of the inhabited Grenadine islands, although in larger islands with multiple discrete communities, such as Bequia and Carriacou, two to three focus group interviews will be conducted. Duration of each mapping exercise will be limited to two hours to minimise fatigue of participants.

At the start of each mapping exercise, stakeholders will first be orientated with the basemap of the Grenada Bank annotated with the local names of beaches, bays and cays (Walters *et al.* 1998). To better orientate stakeholders with the basemap and the areas to be mapped; all mapping exercises will be visually supplemented using Google Earth Web-based satellite imagery of the equivalent area. Each mapping exercise will conclude with a review of major points to ensure all topics have been fully addressed and will allow time for initial validation and correction of spatial information collected. Furthermore after each mapping exercise, data will be digitised into the GIS and validated utilising PAME techniques (as outlined in section 3.4.7) before proceeding to the next phase of mapping.

<u>3.4.4.2a Coastal/Marine habitats</u>

Participants in each Grenadine island will be asked to identify the locations of critical coastal and marine habitats for each key fishery. Anticipated categories[1] to be mapped will include: mangroves, seagrass beds, beaches, coral reefs, algal reefs, hard substrate/rocky reefs and salt marshes/swamps. Participants will be asked to draw polygons around the boundaries of each marine habitat using a provided basemap and a simple colour-coded marine habitat legend provided. Local names will be used wherever given.

<u>3.4.4.2b Coastal/Marine resources</u>

Participants will then be asked to identify locations of coastal and marine resources that provide food or materials of tangible value for local communities. Anticipated categories to be mapped include: mammals (turtles, whales, dolphins), fish (sub-categorised as: coastal pelagics, shallow shelf/reef fish,

[1] Coastal and marine habitats and resources will ultimately be classified by the direct resource users. See section – 3.4.5 Coastal and Marine Classification for a detailed explanation.

deep-slope fish, and offshore pelagics), invertebrates (lobsters, conch, wilks, oysters, crabs, sea urchins) and algae (sea moss). Locations of marine resources will be mapped by drawing polygons around each resource area and coded using an Arabic numeral.

3.4.4.2c Marine space-use patterns

Using the basemap overlaid with habitats, resources and space-use profiles participants will be asked to identify any residual areas for important for conservation of livelihoods. These sites will include areas for: use of particular fishing gears (sub-categorised as: handlines, spears, SCUBA, gill nets, trolling, beach seines, trammel nets, palang: floating or sinking, commercial long-lines); coastal resource gleaning activities, sand-mining; mangrove cutting; recreational or cultural/historical activities; shoreline protection; conservation areas; nursery and spawning grounds. Areas identified will be mapped using polygons and a letter coding system.

3.4.4.2d Marine space-use conflicts and issues and opportunities

A final series of integrated mapping exercise workshops will interactively utilise the spatial datasets created from the previous coastal and marine habitats, resource and space-use mapping exercises to progressively identify marine space-use conflicts, issues and opportunities. Initially this mapping exercise will conduct a comprehensive participatory validation and feedback exercise of all previously created datasets (Maine *et al.* 1996; McAllister and Vernooy 1999). Furthermore during this mapping exercise, GIS spatial datasets will be presented and queried with stakeholders to highlight emergent areas of overlap and utilised to identify existing or potential space-use conflicts/issues as well as ascertain areas in which marine resources may provide potential opportunities or benefits to the Grenadine communities (Figure 3).

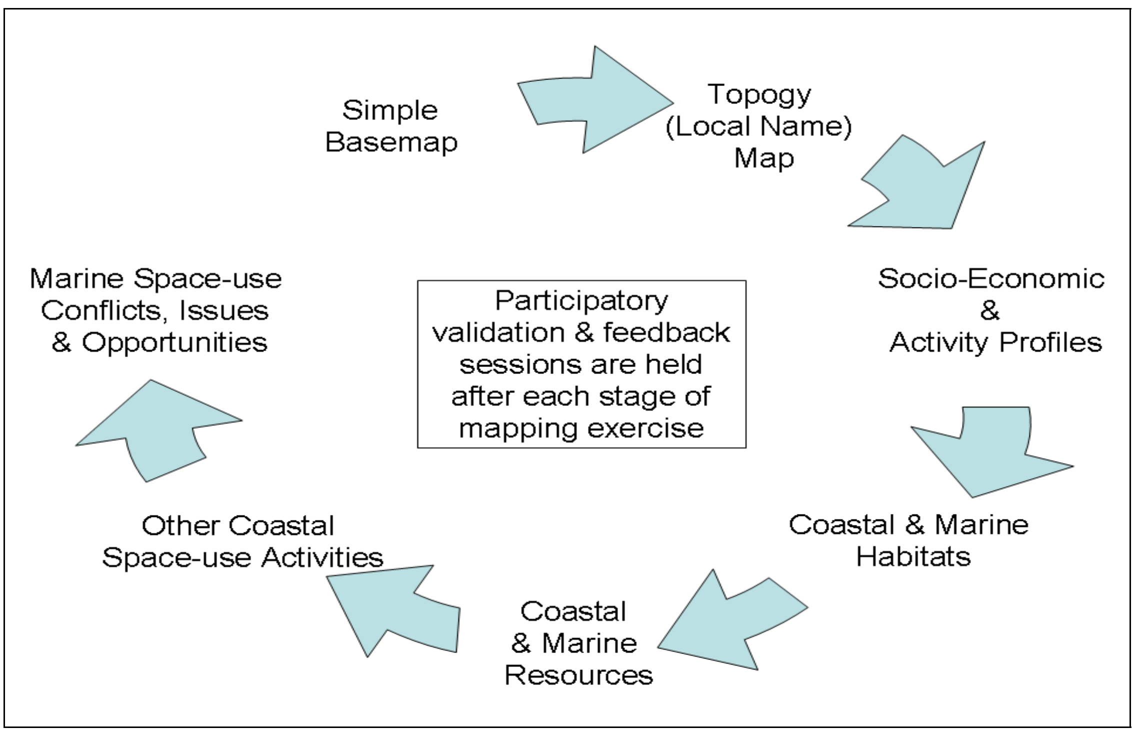


Figure 3. Summary of participatory mapping exercises.

3.5 Data Analyses

3.5.1 Spatial Data Analyses

Identified features will be digitised using points, lines or polygons and geo-referenced subsequent to the completion of each mapping exercise. Notes will be reviewed for supplementary information not spatially captured during the mapping exercises and annotated in attribute tables and/or metadata. Information from individual mapping exercises, areas in which there is not spatial consensus between participants, or areas of spatial overlap between different mapping exercises will be analysed using the ArcGIS 9.2 'Spatial Analyst' extension tool. The 'Spatial Analyst' tool can combine various datasets and accommodate areas of difference (or overlap) by re-drawing polygons to statistically represent the 'best fit'. All spatial data will be organised by knowledge source, catalogued and will be accompanied with complete ESRI FGDC metadata.

3.6 Evaluation of the Geodatabase and the Utilisation of Participation Research

On completion of the development of the MarSIS geodatabase, a series of stakeholder utilisation workshops will be conducted to examine the practical application and usefulness of the integrated information system. A range of participants will be invited including government, direct marine resource users, civil society and community-based NGO stakeholders. Participants will be guided through a series of structured computer exercises to test the application of the geodatabase and quality information generated. Additionally, the legitimacy of including local knowledge through the utilisation of participatory research in comparison to existing conventional scientific knowledge will be investigated during these workshops. Participation will be examined in terms of: the added value of functional information produced and the increases of cost in terms of time, resources and money from both the researcher and stakeholders perspectives'. Participants will be administered evaluation surveys to critique both the overall functional usefulness of the geodatabase and to evaluate the use of participatory research, communication, validation, feedback and evaluation mechanisms. Ultimately, this research and final evaluation process will aim to increase capacity; expand relationships between government agencies, NGO's and communities; as well as foster national and transboundary support for further participatory marine resource planning and management initiatives of the Grenada Bank. Although these peripheral effects of participation are out of the scope of this research and will not be critically evaluated, a 'Lessons Learnt' document will be produced as a result of this overarching multi-stakeholder evaluation to allow guidance in other participatory marine-based GIS initiatives, particularly those in the Caribbean.

4. Summary

This research will utilise a PGIS approach to integrate a range of interdisciplinary and multi-knowledge information on the marine resources and users' of the transboundary Grenada Bank and produce a unique and functional marine resource space-use information system. The added value and costs of utilising this alternative approach will be collaboratively examined and the process of development of this geodatabase will be evaluated as a result. Secondarily, it is anticipated that through the collaborative process of PGIS development, a range of stakeholders' capacities will be strengthened and foster a more participatory and holistic approach to sustainable marine resource planning, development and management. Ultimately, this research will aim to result in an easily accessible integrated information base to support participatory transboundary resource management and decision-making processes in the Grenadines as well as strengthen multi-stakeholder communication, education and advocacy.

6. References

Aberley, D. and R. Sieber. 2006. Public participation GIS (PPGIS) guiding principles. http://www.iapad.org/ppgis_principles.htm (accessed 26th July 2006).

Balram S., S. Dragicevic and T. Meredith. 2004. A collaborative GIS method for integrating local and technical knowledge in establishing biodiversity conservation priorities. Biodiversity and Conservation. **13**: 1195-1208.

Berry J. 1995. Is the GIS cart in front of the horse? GIS World, March: 34-38. Brough, P.A.

Bunce, L., P. Townsley, R. Pomeroy and R. Pollnac. 2000. *Socioeconomic manual for coral reef management*. Australian Institute of Marine Science. 251 pp.

Bunce, L. and R. Pomeroy. 2003. *Socioeconomic monitoring guidelines for coastal managers in the Caribbean: SOCMON Caribbean*. World Commission on Protected Areas and Australian Institute of Marine Science. 88 pp.

Calamia M.A. 1999. A methodology for incorporating traditional ecological knowledge with geographic information systems for marine resource management in the Pacific. SPC Traditional Marine Resource Management and Knowledge Information Bulletin **10**. 36 pp.

Caribbean Conservation Association. 1991a. *Grenada country environmental profile*. Island Resources Foundation. Tortola, BVI. 276 pp.

Caribbean Conservation Association. 1991b. *St. Vincent and the Grenadines country environmental profile*. Island Resources Foundation. Tortola, BVI. 222 pp.

Caribbean Regional Fisheries Mechanism (CRFM). 2004. Report Of The Reef And Slope Fish Resource Working Group (RSWG) *in* Report of the first Annual CRFM Scientific Meeting. 22nd – 30th June 2004, Belize City, Belize. CRFM Fishery Report **11**. 103pp.

Central Intelligence Agency. 2006. The world factbook: St. Vincent and the Grenadines. http://www.cia.gov/cia/publications/factbook/geos/vc.html (accessed July 28th 2006).

Chambers, R. 2006. Participatory mapping and geographic information systems: Whose map? Who is empowered and who disempowered? Who gains and who loses? The Electronic Journal on Information Systems in Developing Countries (EJISDC). 25**(2)**: 1-11.

Chakalall Y., R. Mahon, H. Oxenford and R. Ryan. 1994. Fish exporting in the Grenadine Islands: activities of trading vessels and supplying fishers. CARICOM Fishery Research Document **17**. 82 pp.

Chuenpagdee R., J. Fraga, J. Euan-Avila. 2004. Progressing toward comanagement through participatory research. Society and Natural Resources. **17**: 147-161.

Cooke, B. and U. Kothari (eds). 2001. *Participation: The new tyranny*. Zed Books. London. 207 pp.

Corbett, J., G. Rambaldi, P. Kyem, D. Weiner, R. Olson, J. Muchemi, M. McCall and R. Chambers. 2006. Overview: Mapping for change – the emergence of a new practice. Participatory Learning and Action. **54**: 13-19.

Cumberbatch, J. Case study of the Folkstone marine park and reserve, Barbados. CANARI Tehcnical Report No. **281**. Caribbean Natural Resources Institute (CANARI), St. Lucia. 11 pp.

Douvere, F., F. Maes, A. Vanhulle and J. Schrijvers. 2007. The role of marine spatial planning in sea use management: The Belgian case. Marine Policy. **31**: 182-191.

Food and Agriculture Organization (FAO). 2000. Information on fisheries management in Grenada. http://www.fao.org/fi/fcp/en/GRD/body.htm (accessed 18 August 2006).

Food and Agriculture Organization (FAO). 2002. Information on fisheries management in St. Vincent and the Grenadines. http://www.fao.org/fi/fcp/en/VCT/BODY.HTM. (accessed 18th August 2006).

Economic Commission for Latin America and the Caribbean (ECLAC). 2004. Yachting in the Eastern Caribbean. ECLAC Technical Report LC/CAR/R.**75**. 286 pp.

Friedlander A., J. Sladek Nowlis, J. Sanchez, R. Appledorn, P. Usseglio, C. McCormick, S. Bejarano and A. Mitchell-Chui. 2003. Designing effective marine protected areas in Seaflower Biosphere Reserve, Columbia, based on biological and sociological information. Conservation Biology. 13 **(6):** 1769-1784.

Grenier L. 1998. Working with indigenous knowledge: A guide for researchers. International Development Research Centre (IDRC), Ontario Canada. 115 pp.

IIRR. 1998. Participatory methods in community-based coastal resource management. 3 vols. International Institute of Rural Reconstruction, Silang, Cavite, Philippines.

Linderbaum, S. 2006. GIS/Mapping Case Study: CANARI. Open Society Institute Information Program. 5 pp.

Maine, R., B. Cam and D. Davis-Case. 1998. Participatory analysis, monitoring and evaluation for fishing communities: A manual. FAO Fisheries Technical Paper **364**. 142 pp.

Mahon R. 1990. Fisheries management options for the Lesser Antilles countries. FAO Fisheries Technical Paper **313**. 126 pp.

Mattai, I. and R. Mahon. 2007. Review and interpretation of environmental and sustainable development legislation for the Grenadine Islands. CERMES Technical Report No. **15**. 95 pp.

McAllister K. and R. Vernooy. 1999. *Action and reflection: a guide for monitoring and evaluation*. PMandE Resource Book Volume 8, 2nd Edition. International Development Research Centre (IDRC). Ontario, Canada. 85 pp.

McConney P., A. Atapattu and D. Leslie. 1998. Organising fisherfolk in Barbados. Proceedings of the Gulf and Caribbean Fisheries Institute. **51**: 299-308.

Mikalsen, K., H. Hernes, and S. Jentoft. 2007. Leaning on user-groups: The role of civil society in fisheries governance. Marine Policy. **31**: 201-209.

National Oceans Office. 1997. Multiple Use Management in the Australian Marine Environment: Principles, Definitions and Elements. Australia's Ocean Policy: Oceans Planning and Management. Issues Paper **3**. 123 pp.

Pattison D., D. dosReis and H. Smillie. 2004. An inventory of GIS-based decision-support tools for MPAs. National Marine Protected Areas Center and NOAA Coastal Services Center. NOAA Technical Report. 16 pp.

Pomeroy, R., P. McConney and R. Mahon. 2004. Comparative analysis of coastal resource co-management in the Caribbean. Ocean and Coastal Management **47**: 429-447.

Quan J., N. Oudwater, J. Pender and A. Martin. 2001. *GIS and participatory approaches in natural resources research. Socio-economic Methodologies for Natural Resources Research. Best Practices Guidelines*. Chatham, UK: Natural Resources Institute. 36 pp.

Scholz A., K. Bonzon, R. Fujita, N. Benjamin, N. Woodling, P. Black and C. Steinback. 2004. Participatory socioeconomic analysis: drawing on fishermen's knowledge for marine protected area planning in California. Marine Policy. 24 **(4)**: 335-349.

Sayer J. and B. Campbell. 2004. *The science of sustainable development: Local livelihoods and the global environment*. Cambridge University Press. Cambridge, United Kingdom. 268 pp.

Smith A.H. 2003. Mapping Laborie Bay, Saint Lucia. CANARI LWI. Project document No. **8**. CANARI Technical Report No. **329.** 13 pp.

Sustainable Grenadines Project. 2005. Sustainable Integrated Development and Biodiversity Conservation in the Grenadine Islands - Overview. Clifton, Union Island, St. Vincent and the Grenadines. 7 pp.

Rambaldi G., P. Kwaku Kyem, P. Mbile, M. McCall and D. Weiner. 2005. Participatory spatial information management and communication in developing countries. Mapping for Change International Conference Proceedings. Nairobi, Kenya. September 7-10. 9pp.

Rambaldi, G., R. Chambers, M. McCall and J. Fox. 2006. Practical ethics for PGIS practicioners, facilitators, technology intermediaries and researchers. Participatory Learning and Action. **54**: 106-113.

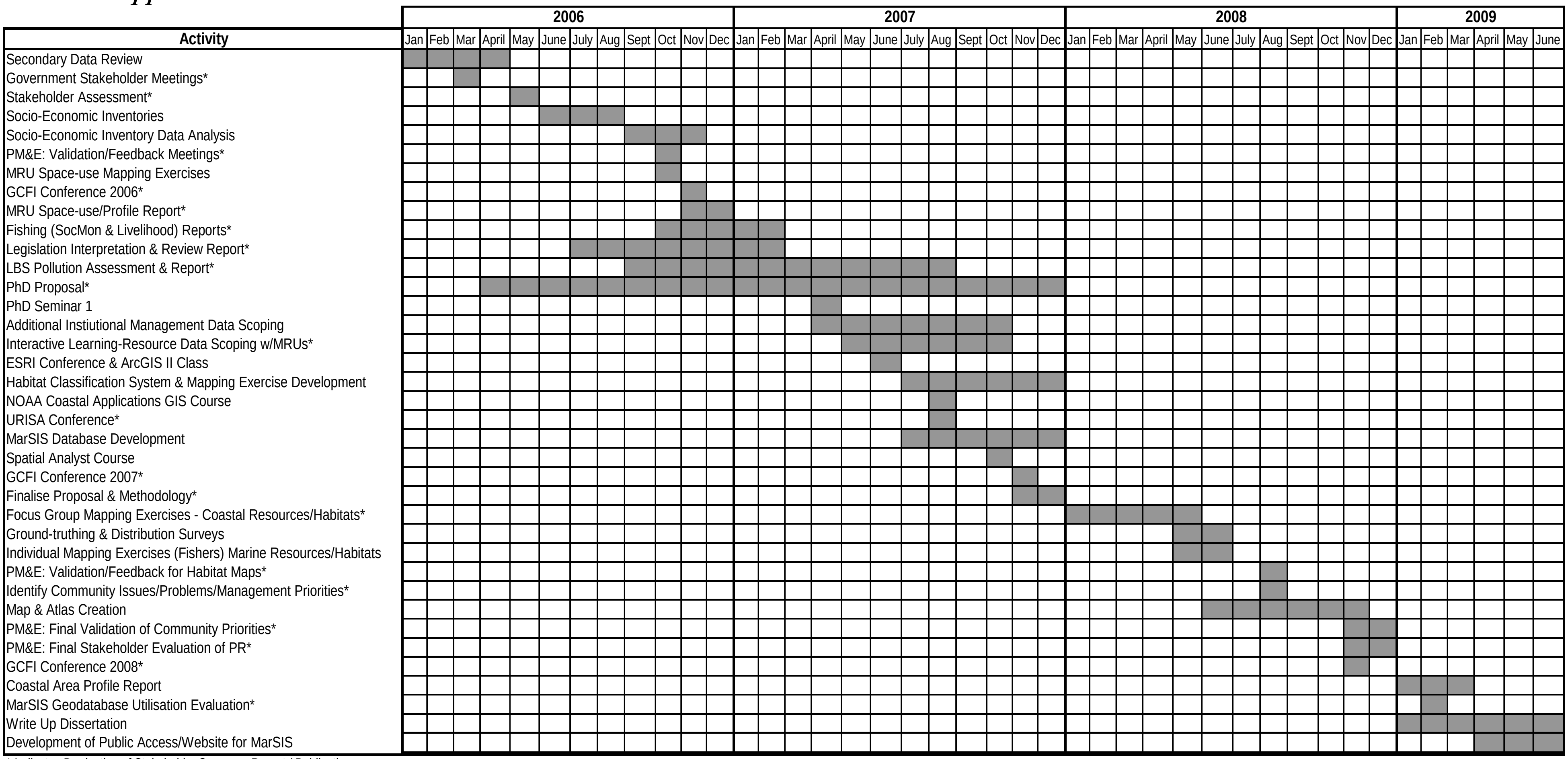
Renard Y. Case of Soufriere Marine Management Areas (SMMA), St. Lucia. Prepared for the Seminar Integrating Stakeholders in Participatory Natural Resource Management, Kingston, Jamaica, April 2000. CANARI Technical Report No. **285** 8 pp.

Walters J., J. Maragos, S. Siar, and A. White. 1998. Participatory coastal resource assessment: A handbook for community workers and coastal resource managers. Coastal Resource Management Project and Silliman University. CRMP Document No. **2**. 98 pp.

Wieber M., F. Berkes, A. Charles and J. Kearney. 2004. Participatory research supporting community-based fishery management. Marine Policy. **28**: 459-468.

7. Appendices

7.1 Appendix I. Gantt chart of the timeframe of the Grenadine MarSIS research activities.



** Indicates Production of Stakeholder Summary Report / Publication*

7.2 Appendix II. Existing GIS layer attribute information included in the Grenadines MarSIS geodatabase

Dive Sites	Dive Centres	Landing Sites	Marinas	Anchorages	Cruise Ports
NAME	NAME	NAME	NAME	NAME	NAME
DEPTH	PADI CODE	# FISHERS	# BOATS	# BOATS	TYPE
LEVEL	# EMPLOYEES	SPECIES	TYPE OF BOATS	TYPE OF BOATS*	INFRASTRUCTURE
HABITAT	# BOATS	TYPE OF BOATS	SERVICES	# MOORINGS	CALLS
SPECIES*	# TOURISTS	# BOATS	MOORINGS	FEES	SIZE CATEGORY
USAGE (#DIVES)	ADDRESS	INFRASTRUCTURE	IMMIGRATION	DEPTH	DEPTH
MOORING	PHONE #	ZONE	HABITAT	REGULATIONS	PHONE #
DIVE CENTRES	EMAIL	WORKERS (# / TYPE)	PHONE #		
	OWNER				

Potential SPAG	Lobster Grounds	Conch Grounds	Fishing Banks	Turtle Beaches	Seagrass Habitat
POTENTIAL SPAG?	HABITAT	HABITAT	NAME	NAME	SPECIES
SPECIES	DEPTH	DEPTH	SPECIES*	SPECIES	DENSITY
SPAWNING SEASON	# FISHERS	# FISHERS	HABITAT	SEASON	AREA
DEPTH	GEAR	GEAR	DEPTH	NUMBERS	CURRENT USES
GEOMORPHOLOGY	FISHING INTENSITY	FISHING INTENSITY	# FISHERS	STATUS	NURSERY GROUND
FISHED?	SEASON	SEASON	GEAR	PROTECTION	
HISTORICAL?	LANDING SITES	LANDING SITES	TYPE OF BOATS	RANK	
	NURSERY AREA	NURSERY AREA	INTENSITY		
			SEASON		
			LANDING SITES		

Protected Areas	Benthic Habiatat	Mangroves	Marine Mammals	Coastlines
NAME	LOCAL KNOWLEDGE	NAME	SPECIES	TYPES
TYPE		SPECIES	HABITAT	LOCAL NAMES
LEGAL STATUS	SCIENTIFIC / CRIS DATA	AREA	SEASONS	
IUCN CATEGORY	based on habitats	HEALTH	THREATS	
REGULATIONS		USES		
MANAGEMENT		PROTECTION		
USES				

7.3 Appendix III. Proposed GIS layer attribute information included in the Grenadines MarSIS geodatabase

Watertaxis	**Yachting Companies**	**Ferry Ports**	**Ships**
HOME PORT	NAME	NAME	NAME
# BOATS	# BOATS	# BOATS	# BOATS
NAMES (BOAT/OWNER)	SIZE OF BOATS	SCHEDULE	SIZE OF BOATS
INTENSITY	CAPACITY	ROUTES	SCHEDULE
AREAS USED	INTENSITY	PHONE #	ROUTES
ROUTES	PHONE #	PICTURES	HOME PORT
WATERTAXI ASSOCIATION	EMAIL	SIZE	SERVICES

Recreational Areas	**Fishing Villages**	**Marine Monitoring Sites**	**Water Quality**
NAME	NAME	SURVEY TYPE	NAME
USE	POPULATION	HABITAT	SALINITY
USER GROUPS	# FISHERS (FT:PT)	DEPTH	TEMPERATURE
RANK	INFRASTRUCTURE	% CORAL	DISSOLVED O2
PICTURES	TYPES OF FISHING	% NIA	MICRO-BIOLOGY
INTENSITY	GEAR	% SOFT CORALS	TURBIDITY
	# BOATS	FISH ABUNDANCE	NITRATES
	HP OF BOATS	DISEASES	PHOSPHATES
	PICTURES	PICTURES	AMMONIA

NGOs	**Coast Guard**	**Cultural/Historical Areas**	**Day Charters**
NAME	NAME	NAME	NAME
TYPE	FACILITIES	USE	# BOATS
# MEMBERS	# EMPLOYEES	USER GROUPS	SIZE
PHONE	PHONE	TYPE	TOURISTS
EMAIL	EMAIL	PICTURES	PHONE
		INFRASTRUCTURE	EMAIL
		INTENSITY	OWNER

7.4 Appendix IV. Basemap to be used in participatory mapping exercises for spatial data collection in the Grenadines MarSIS project.