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

Kimberly Baldwin, PhD Candidate
Centre for Resource Management and Environmental Studies (CERMES)
University of the West Indies, Cave Hill Campus, Barbados, West Indies
Supervised by: Professor Robin Mahon and Professor Hazel Oxenford

Rationale

The transboundary Grenadine Islands lie on the Grenada Bank extending 120 km and are shared between the countries of Grenada and St. Vincent and the Grenadines. There are over 30 islands, islets and cays of which nine have permanent settlements (CCA 1991a, 1991b; Sustainable Grenadines Project 2005). 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). Marine-based activities are the mainstay of the economy of the area; in which fishing, transport and tourism are the major sources of employment (Baldwin *et al.* 2006).

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. 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 (Price and Price 1994, Price and Price 1998; Price and Govindarajulu 1998; FAO 2000; ECLAC 2004).

Marine resources are of vital importance to the people of the Grenadines, yet planning and management of the use of these resources 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 environmental degradation.

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 can also provide for better compliance with rules and increased stakeholder capacity in problem solving and decision-making, thereby increasing local empowerment and community cohesion building a more sustainable future (Grenier 1998; Cumberbatch 2001; Sayer and Campbell 2004; Wiber *et al.* 2004).

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 technology can thereby be used 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). Participatory GIS (PGIS) is an emerging interdisciplinary community development and environmental stewardship tool based on participatory research principles. 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). It is alleged that the collaborative process of PGIS development not only results in more comprehensive understanding of natural resource information, but that planning priorities can be better focused and effective coastal resource management 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).

Objective of Research

It is proposed that effective and proper planning will require a complex and adaptive mechanism tailored to the local environment. Towards this end, a collaborative spatial approach derived from the fullest possible information base is recommended to effectively understand, plan and manage the transboundary and multifaceted nature of the Grenada Bank marine resources and its' users. This research uses the process of PGIS to integrate social, economic and biophysical information together with local knowledge in a single framework in order to test the added value gained from utilising this alternative approach. This research will investigate the collaborative development of an interdisciplinary multi-knowledge transboundary marine resource and space-use information system (MarSIS) as a spatial planning and management tool.

This research explores two propositions. The first, based on the literature, is that merging local ecological 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 utilises a variety of participatory research methods to acquire local knowledge and assimilate it with conventional scientific information. The second proposition is that amalgamating information 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 multi-knowledge system information by examining the costs (in terms of time and resources) and the benefits (both functionally and socially) to the variety of stakeholders (government, marine resource users, NGOs, communities) involved in the development, validation and production of this PGIS.

Methods

The geographical scope of the study is the marine environment of the Grenada Bank (to the 50 meter depth contour) under the jurisdiction of two countries: Grenada and St. Vincent and the Grenadines. The MarSIS geodatabase is built with ArcGIS and Google Earth files will be also produced for greater public distribution of information produced. The MarSIS has been collaboratively developed with a range of stakeholders (including both governments, NGOs, marine resource users) over the past three years and data collection is anticipated to be complete by year end 2009. Key spatial information includes: marine habitats (reefs, mangroves, seagrass beds, beaches), infrastructure (seaports, jetties, desalination plants), marine resource users (dive shops, day-tours, yachting, fishing, ships, communities), associated space-use patterns (anchorages, dive sites, fishing grounds, shipping lanes, recreation areas), biological (sea turtle nesting, seabird roosting sites) and conservation areas (marine protected areas, nursery grounds, historical sites, shipwrecks) as well as areas of threat (sand-mining, beach erosion, dumping, land-based sources of pollution, mangrove cutting). As a result, the MarSIS will be used to progressively identify areas of spatial importance for marine conservation and livelihoods as well as highlight emergent areas which are currently or potentially high for space-use conflict.

The research is based on the premise that in order to obtain accurate information of marine resources (location and status) and their uses (both the value to livelihoods and the spatial representation of the users' activity profiles) as well as gain acceptance for marine planning and management initiatives, a variety of knowledge systems must be included. Furthermore periodic information sharing is a key part of the research in which a range of participatory communication, validation, feedback and evaluation techniques are systematically used (Maine *et al.* 1996; McAllister and Vernooy 1999). This has been done not only to incorporate popular knowledge on marine resources and their use patterns but to transparently bring a variety of stakeholders into a common space of understanding.

Data collection included an extensive review and summary of existing marine-related legislation, policies, management plans and research conducted on the marine environment, fisheries, tourism, civil-society and private sector organisations of the Grenadine Islands (Baldwin 2006a, Blackman *et al.* 2006, Mattai and Mahon 2006). A stakeholder analysis was conducted in which a total of 835 direct marine resources users (comprising of day tour operators, dive shops, ships, ferries, water taxi operators and fishers) were identified as well as a large amount of quantitative and qualitative information was collected on the social, economic, environmental and space-use patterns of these users (Baldwin *et al.* 2006, Baldwin 2006b).

A marine habitat classification scheme has been collaboratively developed with government stakeholders at a scale useful for local planning, management and decision-making purposes. These include: mangrove, seagrass, salt pond/swamp, sand, coral reef, mixed live bottom, hard bottom and unknown. Satellite imagery and NOAA's Habitat Digitizer extension were used to produce a habitat map for the shallow waters of the Grenada Bank and will be validated during a month-long ground-truthing research cruise this August. This habitat mapping cruise will be undertaken by a diverse team consisting of: two fisheries scientists, two Grenadine fishers and a local captain. In order to model habitat in the deeper waters, a 1 km^2 grid will be overlaid on the Grenada Bank in which 10% of the grid cells will be selected for sampling. At each survey site, a drop-camera will be used to identify the type of habitat and fishing ground and combined with bathymetry data collected to develop a baseline 3D marine habitat model of the Grenada Bank. Furthermore in each Grenadine island, community meetings will be held to share the findings of the on-going marine habitat mapping cruise as well as to validate marine resource datasets previously collected. Emergent areas important for marine conservation, livelihoods and space-use conflict will also be collaboratively identified during these meetings.

On completion of the development of this integrated transboundary information system, comparative statistical analyses will be conducted using both ArcGIS and SPSS software packages. This will be done in order to determine: the thematic accuracy of the habitat maps, relationships between marine habitats and fishing grounds and to progressively identify the variety of marine space use patterns.

In conclusion, a series of stakeholder utilisation and final evaluation workshops will be conducted in order to collaboratively appraise the research. These workshops will examine the practical application, added value and cost of using this alternative approach. A variety of participants including: government, marine resource users and local NGO stakeholders will be guided through a series of structured computer exercises to test the application of the MarSIS geodatabase and quality of information generated. Participation will be examined in terms of the added value of the multi-knowledge system information produced and the increases of cost in terms of time and resources. Evaluation surveys will be administered to critique both the overall functional usefulness of the geodatabase as well as to appraise the use of participatory research, communication and validation mechanisms applied throughout the research.

On conclusion of these final stakeholder workshops MarSIS information will be made accessible to stakeholders via a website. An interactive mapping website will be developed to allow MarSIS data to be viewed and will also be available for download both as ArcGIS and Google Earth files. Furthermore this website will allow download to a series of maps and marine atlases as well as reports including access to the Grenadines e-library documents. Therefore a large range of marine resource information will be freely and easily downloaded by the public, NGOs and government alike.

Relevance & Implications of Research

The initial concept for the need for this research originates from a local civil-society initiative "The Sustainable Grenadines Project" whose goal is to assist with the sustainable integrated development and biodiversity conservation in the Grenadine Islands. One mandate of this group is to strengthen civil-society in order to enable enhanced participation in governance. As a result, the need for not only a better understanding of, but easy access to both integrated and transboundary information of the distribution and abundance of existing marine resources and its users' space-use patterns was identified. Moreover, in order to render the research useful for the local environment, objectives have been developed in collaboration with a wide range of stakeholders since the onset. Stakeholders include government (Planning, Fisheries, Forestry, Environmental Services, Tourism, Port Authority, Coast Guard, Maritime Administration) of both countries', local NGOs, marine resource users (namely fishers, dive shops, day tours, yachts, ferries, ships) and the Grenadine communities. Much time and care has been taken to obtain the full support of both countries as well as develop a geodatabase beneficial for management and readily incorporated into the existing land-use GIS planning systems of both countries. The use of PGIS has been embraced by stakeholders thus far. This process may encourage a more integrated, holistic and adaptive approach to each country's marine management thereby strengthening governance within and between the two countries. Moreover, the stakeholders envision that the development of MarSIS will lay the foundation for a broader goal of a transboundary marine space-use plan and assist on-going efforts to designate the Grenadines as a World Heritage Site. Ultimately both the process and product of this research aim to foster a more integrated approach to transboundary marine decision-making, planning and management initiatives allowing for more equitable, effective and sustainable conservation and livelihood opportunities for the people of the Grenadine Islands.

Literature Cited

Aberley D, Sieber R (2006) Public participation GIS (PPGIS) guiding principles. IAPAD Website. http://www.iapad.org/ppgis_principles.htm

Blackman K, Mahon R, Pena M, Simmons B (2006) Annotated Bibliographic Information on the Grenadines. Centre for Resource Management and Environmental Studies, University of the West Indies, Barbados p64

Baldwin K (2006 a) Summary Report for the Data Scoping of the grenadines Marine Space Use Information System. A summary of preliminary observations and key informant interviews from Grenada, St. Vincent and the Grenadine Islands. Centre for Resource Management and Environmental Studies, University of the West Indies, Barbados p13

Baldwin K (2006 b) Summary Report for the Stakeholder Meetings and Space-use Mapping Exercises of the Grenadines Marine Space Use Information System (MARSIS). Centre for Resource Management and Environmental Studies, University of the West Indies, Barbados p21

Baldwin K, Gill D, Cooke A, Staskiewicz T, Lizama D, Mahon R, McConney P, Oxenford HA (2006) A socio-economic and space-use profile of Grenadine marine resource users. Centre for Resource Management and Environmental Studies, University of the West Indies, Barbados p116

Baldwin K (2007) A marine space-use information system for the Grenadine Islands: A basis for collaborative planning and management. PhD Proposal Seminar. Centre for Resource Management and Environmental Studies, University of the West Indies, Barbados p26

Berry J (1995) Is the GIS cart in front of the horse? Proceeding GIS World Conference, Brough, PA, pp34-38

Caribbean Conservation Association (1991a) Grenada country environmental profile. Island Resources Foundation, Tortola, British Virgin Islands p276

Caribbean Conservation Association (1991b) St. Vincent and the Grenadines country environmental profile. Island Resources Foundation, Tortola, British Virgin Islands p222

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 25(2):1-11

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

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

Cumberbatch J (2001) Case study of the Folkstone marine park and reserve, Barbados. Caribbean Natural Resources Institute (CANARI) Tehcnical Report 281, St. Lucia p11

Douvere F, Maes F, Vanhulle A, Schrijvers J (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. FAO. http://www.fao.org/fi/fcp/en/GRD/body.htm

Economic Commission for Latin America and the Caribbean (ECLAC). 2004. Yachting in the Eastern Caribbean. ECLAC Technical Report LC/CAR/R.75, p286

Grenier L (1998) Working with indigenous knowledge: A guide for researchers. International Development Research Centre (IDRC), Ontario, Canada p115

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

Maine R, Cam B, Davis-Case D (1998) Participatory analysis, monitoring and evaluation for fishing communities: A manual. FAO Fisheries Technical Paper 364, FAO, Rome p142

Mattai I, Mahon R (2006) Review and Interpretation of Environmental and Sustainable Development Legislation for the Grenadine Islands. Centre for Resource Management and Environmental Studies Technical Report 15, University of the West Indies, Barbados p94

McAllister K, Vernooy R (1999) Action and reflection: a guide for monitoring and evaluation. International Development Research Centre (IDRC), Ontario, Canada p85

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

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

Price W, Price P (1994) A survey of the nearshore marine environment of Union Island, St. Vincent and the Grenadines. Union Island Association for Ecological Preservation (UIAP), St. Vincent and the Grenadines p41

Price W, Price P (1998) Paradise lost: A post-mortem of the Ashton Marina project ecological impact on Ashton Lagoon, Union Island. Union Island Association for Ecological Preservation (UIAP), St. Vincent and the Grenadines p12

Price W, Govindarajulu P (1998) Near-shore marine resources of Carriacou, Petit Martinique and outlying Islands: Status, concerns, and recommendations. Government of Grenada, Physical Planning Unit. United Nations Development Program (UNDP) / United Nations Centre for Human Settlements (UNCHS) / Caribbean Development Bank (CDB) p113

Quan J, Oudwater N, Pender J, Martin A (2001) GIS and participatory approaches in natural resources research. Socio-economic methodologies for natural resources research: Best practices guidelines. Chatham, United Kingdom p36

Sayer J, Campbell B (2004) The science of sustainable development: Local livelihoods and the global environment. Cambridge, United Kingdom p268

Sustainable Grenadines Project (2005) Sustainable Integrated Development and Biodiversity Conservation in the Grenadine Islands - Overview. Union Island, St. Vincent and the Grenadines p7

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

Renard Y (2000) Case of Soufriere Marine Management Areas (SMMA), St. Lucia. Prepared for the Seminar Integrating Stakeholders in Participatory Natural Resource Management. CANARI Technical Report 285, Kingston, Jamaica p8

Walters J, Maragos J, Siar S, White A (1998) Participatory coastal resource assessment: A handbook for community workers and coastal resource managers. Coastal Resource Management Project Document 2, Philippines p98

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