

Technical Letter

A CLEAR Endeavor to Address Development and Environmental Challenges in the Caribbean Region

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Abstract

The Caribbean region consists of many small islands that span a large geographical area. The region faces numerous challenges in managing environmental and development problems and in ensuring that it has sufficient numbers of qualified personnel to meet its developmental needs. Many of the issues that need to be addressed in the region require cross-disciplinary collaboration. Consequently, the Centre for Caribbean Land and Environmental Appraisal Research (CLEAR) was constituted within the University of the West Indies (UWI), to embark on the necessary research and development efforts. This paper reviews the major issues that faces the Caribbean region and discusses how CLEAR is effectively assisting with sustainable development, environment protection and capacity building. The Center promotes multidisciplinary research, undertakes education, training and extension activities such as short courses, workshops and conferences as well as professional services including spatial database development. A review of the work recently completed by the Center is provided and future directions are presented.

1. Introduction

In the coming decades the Caribbean region is expected to witness significant changes in climate, weather patterns, sea level rise, land availability, food systems and the environment. These changes are due to several external and internal factors. The major external factors include global climate change, global economics and geopolitics. Internal factors include regional governments' national land policies, population growth and illegal settlements (Baban, 2004a). These factors may adversely affect the existing land base of these islands. Climate change and sea level rise are expected to affect the oceans, the

coastal zone, soils, agriculture, food systems, human health and lead to rainfall and temperature variations. International forces may influence national land policies and put pressure for land development to cater for the tourism market. Internal factors such as governments' land policies may cause the sterilization of prime lands especially if relevant, up to date information is not available for decision support. Illegal use of land such as slash and burn agriculture or squatting may lead to the degradation of significant expanses of land leading to landslides and flooding (Baban, 2001a; 2001b; 2003a).

These often lead to environmental degradation of water, soil, air, natural habitats and loss of

biological diversity. Some of these aspects are already being experienced in a noticeable way. In turn, this will eventually slow down and threaten the pace of economic development possibly leading to major economic and social hardships for the region in the future. Managing the environmental, social and economic consequences of these changes in the Caribbean region will require developing suitable strategies. However, the lack of appropriate spatial data and an understanding of the factors that control climatic and other processes on a regional basis are major problems. This information poverty severely affects the decision-making process (Baban, 2001b; Baban et al., 2004).

As a result, there is a real need to collect the necessary data sets at the appropriate spatial and temporal scales, attempt to understand and contain these natural and anthropogenic phenomena with the view to effectively manage the limited land and marine resources in the Caribbean region. This situation necessitates the use of the most efficient and cost effective methods and technologies in the quest to sensibly manage and conserve available natural resources whilst obtaining the highest possible production to further the development process.

2. The Centre for Caribbean Land and Environmental Appraisal Research (CLEAR)

Achieving and maintaining sustainable development in the future will need focused promotion of education and research in Environment-related fields underpinned by Geo-sciences including Remote sensing, Photogrammetry, Geodesy, Cartography, Surveying, Land management, Life sciences, Ecology and Planning (Baban, 2004a).

A holistic approach and a regional focus are also needed in order to address the challenges and to better serve the needs of the Caribbean region in the new millennium. To meet these needs, a group of researchers from the University of the

West Indies initiated discussions towards the formation of multi-disciplinary research group. This initiative led to the creation of the Centre for Caribbean Land and Environmental Appraisal Research (CLEAR) in 2000. The intention is to provide the framework and infrastructure necessary for achieving the above objectives by assisting in generating and providing reliable information and decision support to improve the performance of Caribbean businesses and industry in environmental terms. Furthermore, CLEAR aims to provide information, advice and guidance to form the foundation for the next phase of economic and social development planning and to, hopefully, influence future development choices in the Caribbean. CLEAR promotes a bottom up approach through participatory decision making as well as the traditional top down approach.

CLEAR is a Campus wide research entity based in the *Office of Research*, St. Augustine Campus of the University of the West Indies, Trinidad. The University of the West Indies (UWI) is a multi-campus system that serves the Caribbean region. UWI comprises of three campuses on the islands of Jamaica, Barbados and Trinidad. The system serves mostly the English speaking countries. While each campus offers a wide range of programs, some programs are only offered on a single campus.

This paper reviews the major issues that face the Caribbean region and discusses the strategies that CLEAR has utilised to address them. These include a range of activities and services including multidisciplinary research, education, training and extension activities such as short courses, workshops and conferences in addition to professional services including spatial database development. A review of the work recently completed by the Centre is provided and future directions are presented.

2.1 Mission of CLEAR

The mission of CLEAR is to support and promote sustainable development and improve-



ments in human welfare through applicable multidisciplinary research and development as well as training activities. This is implemented by means of evaluating the current and future Caribbean state of affairs in environment-related fields using Geosciences. This entails collecting, analyzing, managing and disseminating spatial information on natural resources and the condition of the environment of the region. Moreover, CLEAR seeks to identify the impact of a range of natural hazards, development and human activities on the environment and to propose a range of management scenarios and operational measures tailored to the specific needs and priorities of the Caribbean region.

2.2 Goals of CLEAR

CLEAR promotes education in, and carries out multidisciplinary research in Geoinformatics and Environment-related fields underpinned by Geosciences including Remote sensing, Photogrammetry, Geographic information Science, Geodesy, Cartography, Surveying, Land Management and Physical Planning.

In particular the Centre aims to:

- Advance multidisciplinary research and development in Geoinformatics and geo-based sciences in general and in new relevant technologies such as remote sensing and GIS in particular.
- Provide the infrastructure to foster interdisciplinary research in Geoinformatics and Environmental geo-based studies.
- Assist with expanding and strengthening Geoinformatics, Environmental and Geo-spatial research, consultancy and outreach at all levels.

CLEAR operates on the basis of forming multi-disciplinary teams comprising of academic staff and other professionals depending on the nature of the project(s) being conducted and managed.

3. Activities of CLEAR

The Centre pursues the necessary activities for capacity building in understanding, assessing, evaluating and managing all technical and environmental issues relating to the mission and goals of the Centre. Current activities can be summarized as follows:

3.1 Education, Training and Extension Activities

Since its formation CLEAR has been involved in significant education, training and extension work including technological transfer. CLEAR has designed/developed and delivered several formal and informal courses in Geoinformatics, Environmental and Geo-spatial studies. These include short courses in Environmental Geographic Information Systems, Participatory GIS, GIS for Environmental Engineers, GIS for Surveyors, Environmental Remote Sensing, Global Positioning Systems, Digital Cartography, and other related areas. The clients for these courses includes the Environmental Management Authority, the National Emergency Management Authority, the Forestry Division, the Institute of Surveyors, Land and Surveys Division, Petroleum Company of Trinidad and Tobago, Town and Country Planning Division and Water and Sewage Authority in Trinidad and Tobago. Additionally several participatory Geographic Information Systems courses have been held in collaboration the Greenplains Foundation, the Environmental Management Authority and the Cropper Foundation.

Several of these courses were designed to supplement the existing programs offered by the University of the West Indies especially for those persons who cannot afford to take long periods of time off from their jobs or are in need of very specialized training unavailable elsewhere. So far, the response has been extremely positive. Many of the participants have returned to their

organizations better able to function in the new spatial information environment in which they find themselves. The objective is to fill the void of trained persons in the field of geosciences especially geoinformatics.

During 2004 the Caribbean region suffered significant damage due to a number of landslide and flood events. In an attempt to contain and manage these hazards, CLEAR organized a regional workshop entitled “Enduring Geohazards in the Caribbean Region” on the 8th of December 2004. The workshop introduced participants to the concepts involved in mapping and modeling geohazards with particular emphasis on landslides and floods. Participants also gained an understanding of issues and data requirements for geohazard modeling and the tools necessary for spatial variability assessment. Representatives from all relevant government and public organizations were present, the findings and resolutions were circulated to all relevant agencies.

The center plans to offer several other courses, workshops and conferences in the future including:

- *Workshops and conferences relating to the mission and goals of the Centre.*
- *Special courses to High School Students on New Technologies, the Environment and Sustainable Development.*

3.2 Research

The current and potential future states of the development and the environment in the Caribbean indicate the need to develop the necessary data sets and to execute urgent technical and environmental studies focusing on biodiversity, coastal zone and wetlands management, geohazards and global climate change. The Center’s current research topics and themes include:

- Managing land use/cover, natural habitat loss, biodiversity, conservation and biophysical land units using remotely sensed information, field data and geographical information systems.

- Evaluating the potential impact of Global Climate Change and Sea Level Change on the Caribbean Region.
- Managing Geo-hazards, landslides and floods, in the Caribbean region utilizing Geoinformatics.
- Coastal Zone and Wetlands Conservation and Management using Geoinformatics.
- Analysing socio-economic and infrastructure data for the energy sector, banking and insurance industries and emergency services.

CLEAR is involved in collaborative research dealing with the issues above with Universities and research institutions of international repute. As such, the Centre has maintained close, active, and strategic alliances with several international research institutes and sponsors in the Middle East, Far East, Jordan, Malaysia, UK, USA and Canada.

Research Projects and Activities

Members of the centre are actively involved in carrying out research, consultancy and advisory work as well as extension activities including short courses. This section provides a review of recent, ongoing and planned projects and activities.

A. Completed Projects

Since its establishment, the Centre has in collaboration with research institution worldwide been able to successfully complete the following projects:

- *Developing a Catchment based Management and Planning Strategy for two sites in Malaysia, Using Remote Sensing and Geographical Information Systems.* This project was funded by MARA Institute of Technology, Malaysia. Outputs from this project included; developing a land use/cover map (Baban and Wan Yusof, 2001a) and a map indicating the probability of soil erosion on Langkawi Island, Malaysia (Baban and Wan Yusof, 2001b). In addition to modelling optimum sites for locating reservoirs, responding to future demands



for water (Baban and Wan-Yusof, 2003), modelling management scenarios with the view to minimise the traditional problems with reservoir sedimentation in developing tropical countries (Baban et al. 2003a) as well as modelling the optimum routes for linking potential reservoir sites to demand areas in mountainous tropical islands (Baban et al., 2004b).

□ *Investigating groundwater quality in the Jordanian Badia Region using Geographical Information Systems.* Funded by the Jordanian Badia Research and Development Programme, Jordan. Outputs from this project included generating and mapping agricultural land change in the Badia Region, Jordan between 1990 and 2000 using field based data, aerial photographs, Landsat TM and Spot imagery (Figure 1). The sustainable development and environmental protection in the Jordanian Badia region was also examined (Al-Adamat et al., 2003; Baban et al., 2003b; Al-Adamat and Baban, 2004; Baban et.al, 2004).

□ *Protection of Water Resources in the Badia Region, Jordan.* A project funded by Department of International Development Higher Education Scheme, The British Council, UK. Outputs included the development of a methodology for using GIS in the decision-making process in the Badia Region (Baban, 2001c) (Figure 2).

□ *Rationalization of Gas Station Network for Trinidad and Tobago Using GIS.* Funded by the Ministry of Energy and Energy Industries in Trinidad and Tobago to determine the optimum size of the retail stations network and the most appropriate areas for these sites for Trinidad and Tobago. Outputs from the project includes: the determination of the optimal total number of gas stations in Trinidad and Tobago, the optimal number of stations in each geo-graphic area based on demand, the best geographic area location of gas stations in order to best serve the motoring public, businesses and other commercial activities, and to allow for economic viability for Gas Station owners.

□ *Developing a Geological Database for the Eastern Block of Trinidad.* Funded by the Talisman Trinidad Oil Company, West Indies. This project entailed the development of a geological database for the southeast quarter of the island of Trinidad. In addition to the geological database, the project generated a 1: 50,000 geological map ready for cartographic reproduction as well as a comprehensive metadata report for the database.

B. On going and Planned Projects

The center is involved in several ongoing projects; these can be categorized into the following themes:

□ *Mapping and Modelling Land Use/Cover.*

A number of projects are being conducted under this theme these include;

a. Mapping Biophysical Land Units in Trinidad Using Remotely Sensed Information, Field Data and Geographical Information Systems. A Project funded by the University of the West Indies (UWI). This Project has the support of the *Environment Management Authority and the Forestry Authority* in Trinidad and Tobago (Baban, 2003b).

b. Sustainability and Land Use in the Caribbean Region. The research sites for this project include Trinidad, Porto Rico, British Virgin Island and Florida. Funded by the United States Department of Agriculture Cooperative State Research, Education, and Extension Service. Joint award to CLEAR, UWI and the University of Florida, Gainesville, USA.

Managing Geohazards in the Caribbean Region. A number of projects are being conducted under this theme, these include;

a. *Examining Landslide Hazards in Trinidad using Remote Sensing and GIS.* A Higher Education Link project funded by Department of International Development Higher Education Scheme, The British Council, UK. This project is a joint award to CLEAR, UWI and the School of Environmental Sciences, University of East Anglia, UK. Outputs from this project includes a landslide

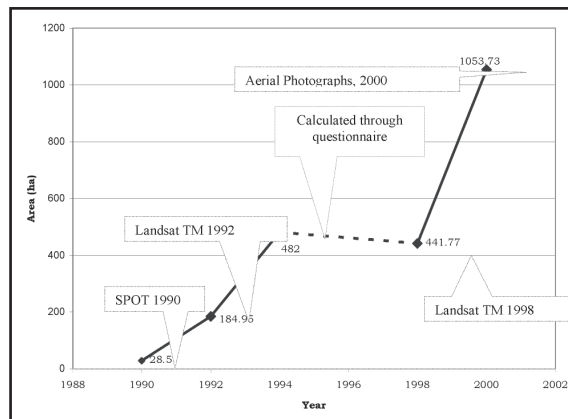


Figure 1: Agricultural land change in the Badia Region, Jordan between 1990 and 2000 (After Al-Admat, Baban and Foster, 2003)

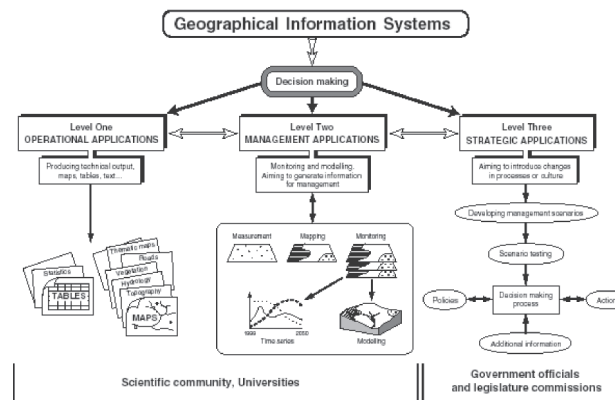


Figure 2: A GIS Methodology for Decision making (after Baban, 2001c)

vulnerability map of the island of Trinidad together with an analysis model for identifying areas that are susceptible to landslides (Baban and Sant, 2004).

b. *Minimizing Environmental Degradation and Population Vulnerability due to Landslide Hazards in Tobago Using Remotely Sensed Information and GIS*. A project being funded by the University of the West Indies. Outputs from this project include susceptibility maps and other data products that may be used for other studies.

c. *Modelling Landslide Susceptibility in Trinidad Using Geoinformatics (Remote Sensing, GPS and GIS)*. Funded by the Office of Research, The University of the West Indies. This work is undertaken as a graduate research project. The output of this work is a research thesis and additional knowledge on landslide analysis.

d. *Mapping Floods in the Caribbean Region Using Remote sensing and GIS*. This work developed a flood risk and assessment map for the St. Joseph watershed in Trinidad (Baban and Kantasingh, 2005) in addition to dealing with flood issues in general (Ahmad et al., 2004).

e. *Coastal Zone Management and Sea Level Change*. A number of projects are being conducted under this theme, these include; Developing indicators for quantifying the impacts of Sea Level Change; Mapping and Modelling Coastal Habitats; Examining the impacts of Sea Level Change on food systems and Evaluating water circulation and contaminant transport models for the region (Baban and Jules-Moore, 2005). CLEAR is also immersed in investigating to the possible impact of EL NINO/Southern oscillation (ENSO) pheno-



mena on the climate of Trinidad and Tobago using remotely sensed data (Ramdath et al., 2004).

f. *Tobago Integrated Watershed and Coastal Zone Demonstration Project.* CLEAR is currently involved with this project which is intended to integrate a multi-sectorial approach towards natural resource management of Tobago's coastal areas in respect of tourism and fishing. The major issues of eutrophication of Tobago's coral reefs, coastal erosion and siltation of inshore reefs are addressed. Reforestation and community-based interventions are also components of the demonstration project. A GIS coupled with the integration of socio-economic and environmental data is being used to map, model processes and develop mitigation strategies. Much of the environmental data is being developed from remotely sensed data sources and augmented by existing published records. Tobago's marine ecosystems are also being mapped for inclusion in the GIS.

g. *Hillside Development Project in Trinidad and Tobago, Towards a Policy Framework.* CLEAR is involved in this project, which is facilitated, by the Town and Country Planning Division of the Ministry of Planning and Development of Trinidad and Tobago. Its purpose is to develop a policy towards hillside development, via a Technical Working Group, whose mandate is to seek consensus, endorsement and compliance with a development policy; assess the implications of hillside development on natural and man-made processes; and provide technical inputs in terms of standards and design guidelines in the interest of sustainable development.

h. *Sustainable development, modeling and suitability studies.* CLEAR's research include identifying optimum waste disposal site locations in the Caribbean region using Geoinformatics (Baban, 2004b) as well as developing a Geoinformatics -based approach to locate wind farms in the Caribbean region, using Trinidad and Tobago as a case study (Baban, 20004c). Finally, CLEAR is involved in utilizing Geoinformatics to develop responses for the effects of climate change on

agriculture, fisheries and tourism in the Caribbean Region (Baban, 2003a) (Figure 3).

i. *Fulbright Scholarship – Lecturing/Research.* CLEAR has actively sought and secured the award of a Fulbright Research Fellow to visit its facilities in 2004-2005. Dr. John B. Ritter has been awarded a scholarship to visit CLEAR for the purpose of conducting research and to interface with post Graduate students from the University of the West Indies (UWI). Dr. Ritter is an Associate Professor of Geology and the Director of Environmental Studies at Wittenberg University in the USA. His major areas of research involve fluvial and alluvial system evolution and small drainage basin hydrology. Dr. Ritter is currently involved in teaching in the Department of Surveying and Land Information of UWI at the MSc level, he is also participating in a number of research projects involving Geohazards in Trinidad and Tobago.

3.3 Professional Services and Spatial Database Development

The Center has engaged in several consultancy projects to satisfy immediate needs for specific clients in terms of spatial and geographic based services and data.

Obtaining relevant data sets in a digital format is one of the main obstacles for conducting environmental research/projects/consultancy in the region. Therefore, CLEAR has developed and is developing and validating a number of GIS ready data sets for geo-based environmental projects (e.g. DEM, geology, soils, etc..) in various parts of the Caribbean Region.

4. Conclusions

Over a very short period of time CLEAR has laid solid groundwork for much greater contributions to the development of the Caribbean region. The Center is poised to not only provide a cadre of well-trained professionals and technicians but also to ensure that sound scientific knowledge is available to decision-makers. CLEAR continues

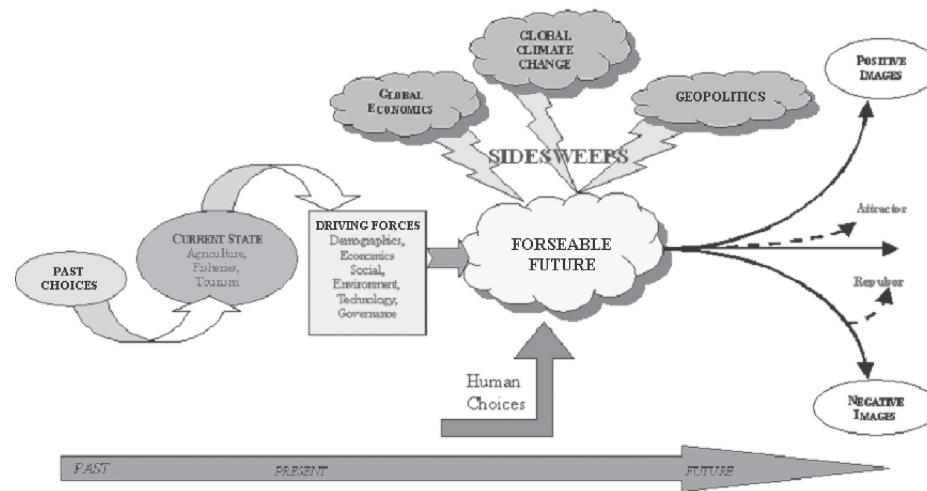


Figure 3: Scenario dynamics for agriculture, fisheries and tourism in the Caribbean Region (after Baban, 2003a)

to be involved in region based research that is geared towards sustainable development, environment protection, capacity building and technology transfer in the Caribbean region.

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He obtained his PhD in Environmental Remote Sensing from the University of East Anglia, UK in 1991 and his MSc in Geophysics and BSc in Geology from the University of Baghdad, Iraq during 1983 and 1980 respectively.

His research interests are in Geosciences, Environmental Sciences and Geoinformatics (Environmental Remote Sensing and GIS). He has undertaken extensive research and consultancy work in these areas in Iraq, Morocco, Tunisia, Jordan, Malaysia, UK, the Caribbean region and USA. He also has interests in teaching innovation and curriculum development at both the undergraduate and postgraduate levels. He has published extensively and is an academic referee for a wide range of National and International Journals. His research has been funded by various local, regional, national and global organisations worldwide.

To date, he has successfully graduated and is currently supervising a number of MPhil/PhD students, some of whom were/are jointly supervised with various Universities in the Middle East, UK and the USA, and has been involved in examining MSc and MPhil/PhD student's world-wide. He is a Fellow of the Royal Geographic Society (FGS), a Fellow of the Royal Geological Society (FRGS), a Fellow of the Remote Sensing and Photogrammetry Society (FRSPSoc) and a Visiting Fellow at the School of Environmental Sciences, University of East Anglia, UK.



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Engineering from the University of Baghdad (Iraq) in 1980, and MSc and PhD from Ohio State University (USA) in 1989 and 1995, respectively. His research activities are focused on the integration of spatial information and geo-images with GIS for mapping and monitoring the environment and natural resources. His research is also related to the reconstruction of surfaces from digital photography and altimetry data as well as automatic extraction of cartographic features related to surface discontinuities.