A Modular Approach to a Caribbean Certificate Programme in Geographic Information System

Jacob Opadeyi, PhD; Eva Chin, MSc; Shahiba Ali, MSc; and Keith Miller, PhD
Centre for Geospatial Studies, Engineering Institute
Faculty of Engineering,
The University of the West Indies
St. Augustine, Trinidad and Tobago
Tel: 1-868-662-2002
Fax: 1-868-662-4414
jopadeyi@hotmail.com

ABSTRACT
Several agencies in the Caribbean have acquired GIS technology in support of their organizational responsibilities. Much of these efforts are, however, focused on technological acquisition with very little done in terms of capacity building. The Centre for Geospatial Studies of The University of the West Indies (UWI) has designed and developed a certificate programme in GIS that caters for the needs of the archipelagic region. A modular approach that facilitates accessibility to persons living in non-UWI campus territories and those with limited internet facilities was designed. This paper provides the details of the programme and results achieved to date.

1.0 GIS in the Caribbean

The Caribbean consists of a chain of islands bounded by the Caribbean Sea and the Atlantic Ocean. Cuba and Hispaniola are the two largest of these islands (114,000 and 76,460) sq. km respectively) followed in size by Jamaica; the rest of the islands have a very small land area, Montserrat for instance, has a total area of 84 sq. km. Population though sizable, but population density is on the increase in the urban areas. Geologically the islands are related to the mainland of Central and South America. The climate is generally considered a natural resource for tourism and agriculture with an average temperature of 24°C all year round. Rainfall is less uniformed because of varying factors such as relief and trade winds. The occurrence of hurricanes is however, a major threat to life and property. Politically, the West Indies is composed of independent countries and dependent territories of the British, Americans, Dutch and French. The limited landmass, the danger of hurricanes, and continued dependence on agriculture are major factors that continue to influence socio-economic development in the West Indies.

Geographic Information Systems (GIS) are computerized information systems which are designed to capture, edit, store, retrieve, process and disseminate spatial and attribute data which are referenced to some predefined geographic/geodetic referencing systems (Opadeyi, 1992). The increasing adaptation of GIS in different areas of applications is due to its special data handling and data processing capabilities. Its application to real-life phenomena is widely growing and it cuts across professional boundaries. Its specialized use for temporal analysis, time-series analysis, trend analysis, spatial analysis, three

dimensional analysis, and multivariable analysis are invaluable to natural and physical resource management.

Two priority areas that require GIS application in the Caribbean are: land administration and natural resource management. Land administration includes land tenure administration and urban facilities management. Land tenure administration is heavily tied to history and settlement patterns. Farm plantations and colonial heritage still play a dominant role in the land tenure pattern. The land registration system is either under the Titles or Deeds system of registration. The largely manual registration systems of Jamaica, Barbados, and St. Lucia are now being moved to an automated environment using GIS technology. Trinidad and Tobago and Guyana are currently embarking on national projects that would use GIS for land tenure administration.

The use of digital maps and map products for managing urban infrastructure is becoming popular in both the private and public sectors. The electricity transmission and distribution companies, telephone, water and sewage agencies are adopting GIS technology to manage resource allocation and network analysis.

The rich mineral resources, both land and marine based, continue to be a major economic resource of the region. Bauxite, oil and gas are major foreign exchange earners in Jamaica and Trinidad and Tobago. Tourism, a major economic source, depends on the sustainability of the marine resources for its survival. The efficient management of these resources possesses new challenges in terms of cost efficiency and effectiveness. The use of GIS concepts and technology is an innovative approach to meeting these challenges.

In the last twelve (12) years, several agencies in the Caribbean have acquired GIS technology in support of their organizational responsibilities. St. Lucia, St. Vincent and the Grenadines, Guyana, Dominica, Antigua and Barbuda, British Virgin Islands, Anguilla, Jamaica, Trinidad and Tobago have invested in GIS/LIS technology. Much of these efforts are, however, focused on technological acquisition and very little has been done on human resource development which is necessary to effectively and efficiently utilize these technical resources. One of the reasons for this is the limited access to formal training programmes in the Caribbean that would adequately cater to the needs of implementing agencies.

2.0 GIS TRAINING AND EDUCATION IN THE CARIBBEAN

The efficient and effective use of GIS concepts and technology is dependent on the availability of educated and trained personnel who would design, develop, use, and manage the system over time. Investment in GIS software and hardware on their own cannot bring about improvement in resource management without well-trained and educated personnel. With the rapid adoption of GIS in the region, the availability of capable GIS resource persons is a challenge facing many implementing agencies. Due to the newness of a GIS curriculum, it is often very difficult to find persons who have been exposed to GIS courses during their tertiary education.

The vendor-push factor is the prevailing implementation approach in the region. This approach places immediate emphasis on the acquisition of computer hardware and GIS software. Very little attention is paid to capacity building and the employment of educated and trained personnel. The experience of nearly all the implementing agencies who have acquired GIS technology is to arrange software training for existing staff and later, if funding permits, seek to improve the skill level of these staff. This approach has often led to prolonged effective utilization and delayed realization of the benefits of investment in GIS. Furthermore, implementing agencies rarely have budgetary allocations for capacity building for effective use of GIS. This also, is the root cause of the limited use of the GIS resources in the Caribbean.

The availability of training opportunities in the region is also a challenge. The island nature of the countries of the region has made training programmes inaccessible due to the high cost of travel and lodging cost in another country. The two tertiary institutions in the English-speaking Caribbean which currently provide formal education and training in the arts and science of GIS are The University of the West Indies (St. Augustine Campus, Trinidad) and the University of Technology (Jamaica). The offerings of these institutions are mainly designed as full-time programmes with a minimum of a one-year residency requirement at the institution. The delivery mode constrains accessibility to persons who are non-resident in the country of the offering institutions. As such, implementing agencies in other States do have problems in increasing the capacity of the staff and attracting new staff with GIS knowledge.

3. Capacity Building through a Modular Certificate Programme

In response to the needs of the region, the Centre for Geospatial Studies in collaboration with the Department of Surveying and Land Information, UWI has developed a modular Certificate Programme in Geographic Information Systems. This programme was designed to meet the needs of persons who are unable to attend the formal degree programmes offered in Jamaica and Trinidad because of costs and family commitments and those who need to update their knowledge of GIS while retaining their jobs.

The objectives of the certificate programme are:

a. To enhance the capability of the participants in the development and use of GIS concepts and technology.
b. To provide the participants with the working knowledge required in the acquisition, preparation and management of GIS data.
c. To develop a core of trained GIS personnel who can provide support for GIS projects throughout the Caribbean.

The programme was designed for those engaged in GIS development and implementation in both the public and private sectors. In particular, it has attracted the following professionals: surveyors, engineers, planners, geographers, agriculturists and others who are interested in the use, development, and management of GIS to enhance their professional responsibilities.

3.1 The Programme

The Certificate in Geographic and Land Information Systems is offered over one calendar year, using a sequence of six one-week intensive modules taught in a classroom setting, plus a special independent project taken at the end of the six modules. Table 1 shows typical months of the year when the modules are offered. By using the one-week intensive modules, teaching instructions are taken to the students in their respective countries thus making the education accessible to persons from the non-UWI campus territories.

The week-long activities consist of formal lectures, group discussions, tutorials and demonstrations. At the end of the week, students are given two or three assessed assignments to be completed in their own time. The assignments are due for submission at the beginning of the next module. The students thus have about 5 weeks in which to study and learn the content of a module. With the exception of SV47A which is assessed as 100% coursework, all other courses shall be assessed: 60% for final examination and 40% for assessed assignments.

The modular one-week intensive delivery mode also provides access to practitioners who are not interested in the full certificate programme but only need to the exposed to any of the modules. Since the modules are self-contained, participants may register for any of them.

Upon the completion of the taught modules, each student is expected to undertake an independent special project on a topic of interest to the student's background. The projects are normally designed around the development of GIS applications of real importance to the student or the country. The normal duration for the completion of the special project is three months. Since the projects address a wide array of issues, co-supervision of the projects are undertaken by notable subject-related professionals, resident in the students´ country of residence.

3.1.1 Entry Requirements

Conditions for entry: Passes in at least five (5) O' level GCE/CXC subjects including English Language and Mathematics or equivalent qualifications. Applicants must also be computer literate, as knowledge of the MS Windows operating system will be required.

3.1.2 The Course Modules

The modules are designed with the objective of providing technical level education that builds competency in principles and concepts rather than competency in the use of GIS software. Software training is provided through tutorials and assessed assignments. The challenge of choosing which of the 4 viewpoints on GIS education and training to pursue was overcome by providing a mix of all the viewpoints: data driven, function driven, systems driven, and application driven (Unwin et al, 1990). Table 1 provides the list of the modules, number of credits and the credit hours associated with each of the seven modules.

The data driven viewpoint was supported by exposing the students to GPS and remote sensing as data acquisition tools together with a module on database design and development. The students will thus be able to design and populate GIS spatial and attribute databases. The function viewpoint is supported with the Spatial Analysis modules. The ESRI Virtual Campus is used to expose the students to the many functional tools of GIS software. Students are expected to complete the Virtual Campus module on ArcGIS Spatial Analyst; 3-D Analyst; Geostatistics Analyst; and the ArcView Network Analyst. The application driven viewpoint is supported by both the Spatial Analysis and the Special Project modules. The system viewpoint is reinforced with the first module: introduction to GIS. Together the seven modules provide a complete learning tool for the design, development, use, and management of GIS.

Table 1: Typical Programme Schedule

Modules	Credits	Contact Hrs.	Month of the year
SV41A - Introduction to GIS/LIS	3	39	October
SV44B - Database Design & Development	3	39	November
SV49B - Data Acquisition Using GPS	4	52	January
SV42B - Satellite Image Processing	4	52	March
SV45C - Spatial Analysis	3	39	April
SV42A - Digital Cartography & Visualization	3	39	June
SV47A – Special project	6	78	July
Total	**26 Crs.**	**338 Hrs.**	

3.1.3 Detailed Contents of the Modules

Below are the details of each of the modules. The learning outcomes as well as the content of each module are provided.

SV41A - Introduction to GIS/LIS
This course would provide the participants with a full understanding of GIS concepts and principles and how it can be used for resource management.

Content: Introduction to concepts; areas of application; system planning & acquisition; data automation; implementation and evaluation strategies; costs and benefits analysis; spatial query and analysis; towards a national GIS strategy.

SV42A 2 - Digital Cartography and Visualization
This course provides participants with the knowledge to design and develop appropriate visuals of GIS data using cartographic design principles and desktop mapping software.

Content: Introduction to cartographic visualization and the mapping process; the basic components of a map; map design; symbol design; name design and placement; concept

of scale; map projections; data preprocessing techniques; thematic mapping; digital mapping.

SV49B - Data Acquisition Using GPS
To provide an understanding of systems available for positioning using terrestrial and satellite methods and to compare these techniques in terms of accuracies achievable and operational constraints.

Content: A review of satellite systems currently available, the components involved, modes of operation, infrastructural needs and sources of data available in the public domain. Conventional survey techniques for establishment of control and detailed surveying. The requirements and techniques for combining data acquired by traditional survey techniques with that from satellite methods. The definition of traditional geodetic datums for horizontal and vertical control and a comparison with those used by satellite systems. Methods of converting between datums and accuracy levels. Practical surveying and tutorial work concentrates on the survey requirements of example applications and means of assessing the quality of data obtained.

SV43B - Database Design and Development
This course is designed to expose participants to how GIS can be used to develop applications. Using real-life data, the participants will develop GIS databases.

Content: Conceptual and logical database design; building and coding the attributes; digitizing and scanning of maps; relating spatial and attribute data; using databases; and database management.

SV45C - Spatial Analysis
Participants will acquire the skills and knowledge to use desktop mapping software for various spatial data analyses.

Content: ArcView basics; creating views and themes; working with themes; the power of tables; spatial query and analysis; working with charts; creating a map layout; addresses and other events; digital terrain models; network analysis; address-matching system.

SV45C – Satellite Image Processing
Participants are be introduced to basic principles of remote sensing, image processing and mapping.

Content: Satellite image exploration; image enhancement; image rectification; image classification; image georeferencing and mosaicing.

SV47A – Special Project
To elicit from the participants their understanding of the programme and their ability to apply concepts learned to relevant situations.

Content: Independent design, development and implementation of a GIS application relevant to the land management issue of a particular country.

3.1.4 Teaching Resources

The programme is well resourced in all Caribbean countries it has been offered. The modules are delivered by well qualified and regionally recognized academics with long standing professional GIS practice. Modules are delivered by one or two facilitators who travel to meet the students in their country of residence. During the week of delivery, students have full physical access to the facilitators and virtual access thereafter. When necessary, facilitators are invited back to provide classroom revisions for one to two days. There is a class group email address for communicating class-wide information and personal emails for individual consultation with module facilitators.

Software resources for the programme was provided mainly through the ESRI-FIG Educational Grant. This grant provided 25 seats of ArcGIS suite of software plus access to the Virtual Campus web-based training courses. These training courses were integrated into the modules by using them to reinforced concepts and principles taught in the classroom. At the end of a module, students are assigned one or two Virtual Campus courses as an assessed coursework. The coursework are completed at students time and credits are given upon successful completion of the coursework. This is very rewarding to the students being able to access web-based quality software training at the leisure of the homes. IDRISI software is the main raster-based software used for image processing.

Hardware resources are provided through the computer laboratories of the University Campus or Centre in the countries. A minimum of one computer to two person is assured in all the countries. The laboratories are used for both the delivery of lectures and tutorials. Students have access to the laboratories for completing their coursework and other learning needs. All the computers are internet-ready and are configured to facilitate group learning.

3.2 Constraints to Training and Education Programmes

Availability of technical resources poses a challenge to the existing training institutions. The ratio of computer seats to students need to be improved. Image processing software, scanners and plotters are not available at some of the institutions. These technical challenges, however, have a direct link to financial resources. Apart from programmes developed by the Department of Surveying and Land Information, most of the other programmes are partly or wholly funded by foreign agencies. This has a limiting effect on the full development of these programmes and the tendency to dictate the area of emphasis. The availability of human resources poses another constraint. The region has very few known local resource persons who have adequate knowledge and education to

conduct training and education programmes in GIS. Existing training facilities are currently under-utilized for they mostly attract nationals of the state where the institutions are situated.

4.0 CONCLUSIONS

Capacity building requires a long-term plan for its success. The plan should examine the various elements of GIS: data acquisition and automation, data analysis, data management, data presentation and data dissemination, and devise training programmes for these plans. Access to funding will always play a major role in the success of the plan. This effect of scarcity of funds could be lessened placing emphasis on “Training of Trainers” programmes. This would ensure that the training investment reaches more persons in the agency. The forming of alliances with training institutions is another novel way of ensuring that modern training opportunities are readily available to the staff of an agency.

REFERENCES

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1. Section **2.3 Constraints to Training and Education Programmes** should be numbered section **3.1.5**.