THE DEVELOPMENT OF COASTAL RESOURCE INVENTORY SYSTEMS FOR CARIBBEAN COUNTRIES TO SUPPORT ADAPTATION TO GLOBAL CLIMATE CHANGE

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FOR PROCEEDINGS OF URISA'S 2001 CARIBBEAN GIS CONFERENCE

Abstract: The Caribbean Planning for Adaptation to Global Climate Change (CPACC) project is a four-year initiative serving twelve Caribbean countries. The project's overall objective is to support participating countries and relevant institutions prepare to cope with the adverse effects of global climate change, particularly sea level rise through vulnerability assessment, adaptation planning and related capacity building. A number of challenges were evident prior to and during the implementation of the project, including the availability of relevant and reliable coastal data, access to existing data, and capacity to manage and utilize data to support the decision-making and policy formulation processes.

GIS based coastal resource inventories for each country were developed to address these challenges. This paper outlines the structure of the Coastal Resource Inventory Systems (CRIS) and the strategy used for its implementation in the recipient countries. The CRIS has been designed to manage both attribute and spatial data and make it accessible to a wide range of users to inform decisions and policies. Challenges faced and outstanding issues are addressed.

BACKGROUND

The Caribbean Planning for Adaptation to Global Climate Change (CPACC) project (www.cpacc.org) commenced in April 1997 to serve twelve Caribbean countries and is scheduled to conclude at the end of 2001. The project's overall objective is to support participating countries and relevant institutions prepare to cope with the adverse effects of global climate change, particularly sea level rise, in coastal and marine areas through vulnerability assessment, adaptation planning, and related capacity building. The Project is funded by the Global Environment Facility (GEF), through the World Bank and

executed by the Organization of American States. A Regional Project Implementation Unit (RPIU) is responsible for actual implementation with the support of the University of the West Indies through its Centre for Environment and Development (UWICED) and the Caribbean Community (CARICOM).

The main beneficiaries of this project are national governments and the regional institutions including the University of the West Indies (UWI) and the Caribbean Institute for Meteorology and Hydrology (CIMH). Assistance has been provided to:

- Strengthen the regional capability for monitoring and analyzing climate and sea level dynamics and trends, seeking to determine the immediate and potential impacts of Global Climate Change (GCC);
- Identify areas particularly vulnerable to the adverse effects of climate change and sea level rise;
- Develop an integrated management and planning framework for cost-effective response and adaptation to the impacts of GCC on coastal and marine areas;
- Enhance regional and national capabilities for preparing for the advent of GCC through institutional strengthening and human resource development; and
- Identify and assess policy options and instruments that may help initiate the implementation of a long-term programme of adaptation to GCC in vulnerable coastal areas.

There are nine components in the project, four of which are regional and five pilot activities. All of the countries participate in the regional components and each country participates in one of the pilot components. The components are as follows:

- Regional Components
  1. Design and Establishment of Sea Level/Climate Monitoring Network
  2. Establishment of Databases and Information Systems
  3. Inventory of Coastal Resources and Uses
  4. Formulation of a Policy Framework for Integrated (Adaptation) Planning and Management
- Pilot Components and participating countries
  5. Coral Reef Monitoring for Climate Change
     - ***Bahamas, Belize and Jamaica***
  6. Coastal Vulnerability and Risk Assessment
     - ***Barbados, Grenada and Guyana***
  7. Economic Valuation of Coastal and Marine Resources
     - ***Dominica, St. Lucia and Trinidad & Tobago***
  8. Formulation of Economic/Regulatory Proposals
     - ***Antigua & Barbuda and St. Kitts & Nevis***
  9. Enabling the preparation of national Communication in Response to Commitments to the UNFCCC
     - ***St. Vincent & the Grenadines***

CPACC COMPONENT 3: INVENTORY OF COASTAL RESOURCES AND USES

The original objective of this component as specified in the Project Document was to further develop each participating country's inventory of coastal resources so as to provide the necessary baseline data for the execution of other project activities. The coastal resource data specified for the proposed project include coastal physical characteristics, natural environments, and information on the use of coastal areas and resources.

The technology transfer process also required the provision of Geographic Information System (GIS) capability to the twelve participating countries through hands-on and formal training; the establishment of data management procedures and standards; collation and automation of existing data; and the provision of equipment and software. Satellite imagery would also augment the data compiled. A regional training course was considered the means to providing the capability to the countries in resource inventory preparation.

The RPIU critically reviewed Component 3 prior to implementation resulting in adjustments to the design of this activity. The review process included:

- Meeting with stakeholders in each country to sensitize them about the project, determine their issues and priorities, and assess institutional and national GIS capacity;
- Convening a meeting of selected GIS practitioners regarding regional priorities and appropriate strategies;
- Consideration of relevant initiatives including the United Nations Environmental Programme (UNEP) CEPNET activities and the Organisation of Eastern Caribbean States Natural Resources Management Unit's (OECS NRMU) 1996-1997 assessment of GIS capacity in the OECS.

The most significant adjustment to Component 3 was the decision to develop a GIS-based management information system for each country. This coastal resource inventory system (CRIS) would support the types of analyses to be conducted under CPACC as well as to facilitate better planning and decision-making within beneficiary agencies. This required a reassessment of the relationship between Component 3 and the pilot components of the project, as the former activity would be a more extensive and longer exercise. The pilot components would therefore be more independent of Component 3.

Another major adjustment related to the training process. The CRIS development was considered to be very comprehensive and in order that effective capacity building was achieved, a more extensive programme was necessary. In so doing, countries would have the capacity to use, manage and adapt the CRIS to serve institutional and national needs, including application to pilot component elements following the project.

Finally, the last major adjustment related to the acquisition and application of the satellite imagery to support the inventory process. The selection and acquisition of the imagery took place after the CRIS process started, as the latter would inform the imagery most appropriate to the Component as well as the project more generally. The acquisition of the IKONOS imagery took a significant amount of time. As a result, it was decided that country representatives would be trained and given the tools for extracting the information to populate the CRIS rather than have the consultants undertake this activity. This also had the benefit of further capacity building in the countries.

One strategy that was followed and served as a key element in the implementation of the project was to have each country designate a lead agency for the coordination of each of the regional components and their pilot component. The lead agency for component 3 was given the responsibility of national repository for the spatial data and the CRIS in particular.

THE CRIS DEVELOPMENT PROCESS

To facilitate the CRIS process, the RPIU commissioned the development of a Technical Implementation Guide for a coastal resource information system. This guide specified categories, associated variables and the data to be recorded. In addition, the importance of the data was also defined (Nurse and Opadeyi, 1998 – available at http://www.cpacc.org/c3wn.htm). This guide would assist the both the CRIS development through identifying priorities and also inform the pilot components in the data collection exercises.

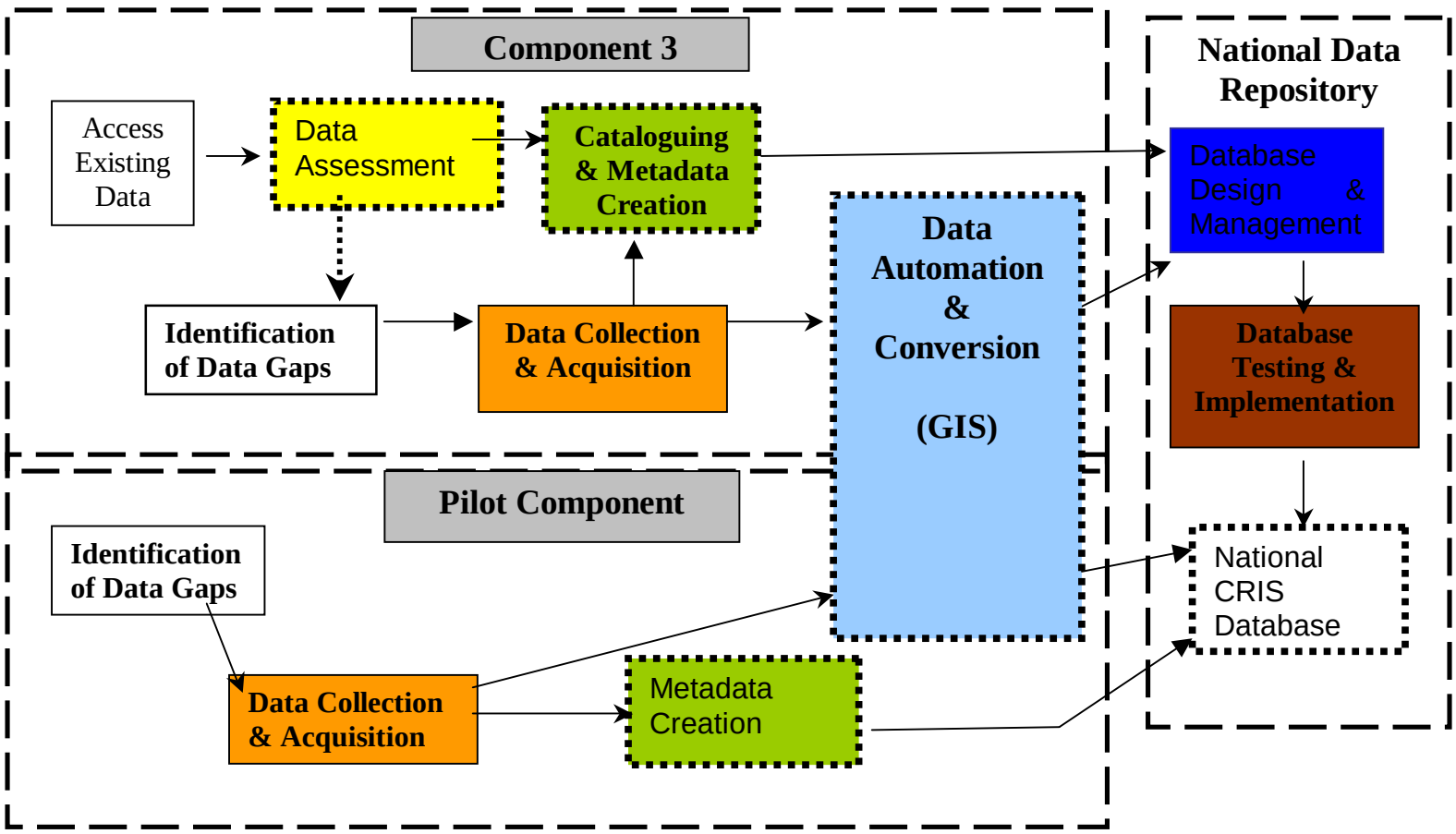
A regional meeting of representatives from the national repositories and other key agencies involved in Component 3 was convened in mid-1998 to discuss what coastal inventories could achieve and what this should mean in the CPACC context. This activity also provided another opportunity for countries to identify national issues and priorities. Regional and international experts in the area of coastal inventories and GIS were facilitators for the meeting.

Following this review and preparatory process, the selection of the consultants following requests for proposals was completed by mid-1999 and the CRIS development started in July 1999.

The strategy adopted for the development of the twelve CRIS was ambitious and extensive. It required a high degree of involvement by the country representatives, particularly the lead agencies or national repositories as these are referred. The elements and objectives of the CRIS are outlined as follows:

- Data Assessment
  - To assess the status of coastal resources management data in each of the participating countries.
- Metadata creation
  - To establish a data catalogue for coastal resource inventories of each participating country.

Diagram I: Implementation of Coastal Resources and Uses Component
CPACC RPIU June 1999



Component 3: Training Modules.

T1: **Metadata Regional Workshop**
T2: **Database Design Regional Workshop**
T3: **Data Collection and Automation Regional Workshop**
T4: **Systems Use & Decision Making National Seminars**

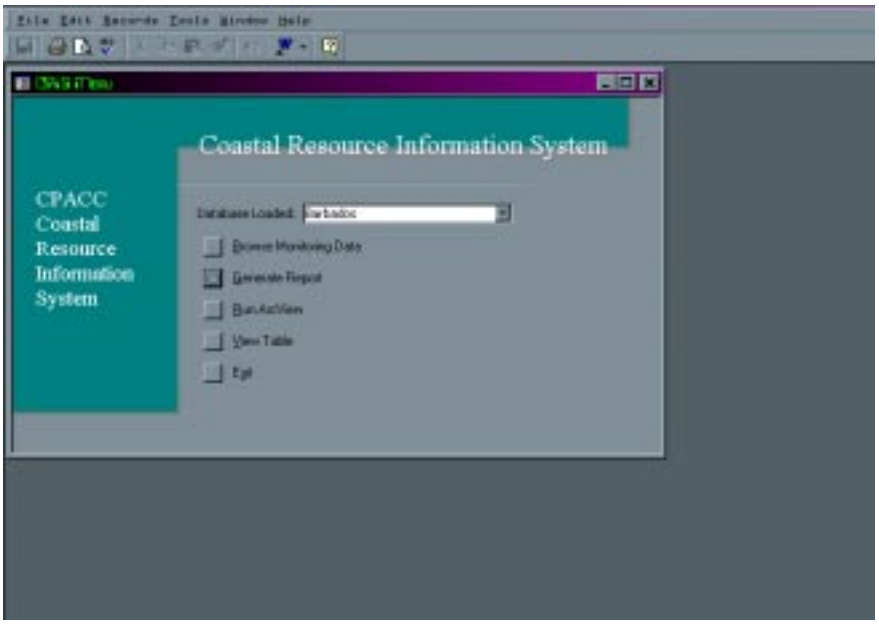
- Database Design and Management
  - To develop a database system design and management strategy for the coastal resource inventory.
- Data Collection
  - To collect baseline coastal resource data for each participating country.
- Data Automation/Conversion
  - To convert the baseline coastal resource data collected for each participating country into digital form.
- Database Implementation
  - To implement the CRIS and deliver it to the appropriate agencies in each participating country
- Training
  - To develop the capacity to create, use and maintain a coastal resource inventory in each participating country.

Diagram I illustrates the relationship between the elements described and the pilot components.

As the CRIS was to be based on existing analog and digital data, the first step required was a Data Assessment for each of the respective countries. Using the Implementation Guide developed by Nurse and Opadeyi, detailed questionnaires were sent to each country to determine data availability, quality and accessibility. After lengthy review including follow-up on the questionnaires by telephone, email, fax and country visits, data assessment and data strategy reports were produced to inform the metadata creation, data collection and database design. Emphasis at this first stage was on identifying reliable and relevant information for populating a spatial database.

The experience and strategies of the UNEP CEPNET programme for metadata development and capacity building were reviewed and adapted. This included adopting Metalite as the standard metadata creation tool and acquiring the services of the United States Geological Survey EROS Data Center for training, support and hosting of the CPACC Clearinghouse Node.

The Database Design and Management element involved designing the structure of the CRIS and in particular, the relational database structure. The CRIS was developed in Microsoft Access with a front-end menu system providing functionality (see Slide 1) and the attribute and monitoring data stored in the database. ESRI Arcview 3.2 stores the spatial data and allows visualisaton and spatial analysis.



Slide 1: CRIS Interface

CAPACITY BUILDING

The approach to capacity building under Component 3 has been to ensure that at least one key agency in each country understands the processes involved in the development of all aspects of the CRIS, and has the capability to manage, maintain and develop the system to support decision making. Further, whereas the main focus is on an agency that has some prior capability to manage spatial data, involving other agencies that are expected to be primary users of the CRIS is another element of the capacity building strategy.

As the lead agency for component 3, the intention has been to supplement the designated national repositories' capability to manage, maintain and develop spatial databases and specifically the CRIS. These agencies were integrally involved in the entire process and as a result are expected to provide technical support to other national agencies likely to use the CRIS.

The training element of the process supported the various stages of the CRIS development, particularly the data assessment, data collection, metadata creation and data automation and conversion. The format of the training activities undertaken has mainly been regional workshops. The CRIS training workshops were as follows (see http://www.cpacc.org/c3wn.htm for workshop reports):

- Metadata Development
- Data Automation/Conversion
- Database Development and CRIS Administration
- Feature Extraction.

These workshops have been attended by two persons per country, usually one from the national repository and the other an agency likely to use the CRIS such as a Fisheries Department of a Coastal Zone Management Agency.

CPACC has also sought to address deficiencies in key agencies by two main approaches. Where specifically requested, CPACC has facilitated one-week GIS introductory classes at the national level. This was undertaken to ensure that a basic level of confidence and understanding in the use of GIS in decision-making was established among key national stakeholders. This was considered a part of the preparatory process for utilization of the CRIS.

The project has also supported participation in the UWI one-year modular Certificate in Geographic and Land Information System (CGLIS) for two years. This support included providing equipment and software to the Centre for Resource Management and Environmental Studies at the UWI campus in Barbados. This facilitated a second center for the CGLIS programme along with the Lands and Surveys Department at the St Augustine campus of UWI in Trinidad. Over the period, CPACC sponsored the participation of representatives from six of the CPACC countries in the CGLIS programme. This initiative provided more rigorous individual development for officers from repository or lead agencies further supporting the application and adaptation of the CRIS in the respective countries.

Provision of equipment, both software and hardware, was also integral to the capacity building activities. Each of the repositories received a GIS workstation as well as ArcView 3.2 and Arcview Image Analysis extension to support their function. In collaboration with the pilot Component 6: Coastal Vulnerability and Risk Asssessment, the relevant agencies have also been provided with Arcview 3D Analyst extension to support defined activities.

SATELLITE IMAGERY

As noted earlier, the acquisition of satellite imagery to populate the coastal inventories was part of the project design for component 3. IKONOS imagery was selected because it was a high-resolution product that could satisfy most of the requirements of the pilot projects and possible applications in the CRIS. Specifically, the 1-meter pan sharpened Map product was selected. This represented the combination of the 1-meter panchromatic and the 4-meter multi-spectral products. This product is considered a high resolution, metrically accurate product suitable for GIS use as a map base or for source material for feature extraction.

The areas of interest (AOI) selected included the entire landmass for the small islands and selected areas for the larger islands, archipelagoes, and continental countries. In the case of one country, Jamaica, a contribution was provided directly to the government as that country had decided to acquire full island coverage of the highest quality IKONOS product.

The delivery of the IKONOS imagery has taken longer than expected due in part to the difficulties that cloud cover in the Caribbean has posed for the data collection. The deadline for delivery has been extended to almost 4 months, however, less than half of the imagery ordered is expected to be delivered.

CHALLENGES AND SUCCESSES OF THE CRIS PROCESS

Challenges

The first challenge faced was to adapt a project component conceived three to four years earlier to one that was relevant to the stakeholders and beneficiaries, and would serve as a basis on which to build as needs evolve. The extensive review process referred earlier was necessary to achieving this, including country and regional discussions and expert review.

Another major challenge was to deliver the CRIS in one-year period. This was recognized by all involved to be a very ambitious goal given the elements involved and the number of countries. Eventually, the process took about two years, mainly, but not solely, due to the difficulties that the counterparts in the respective countries had in meeting the tasks required in the given time. Specifically, the data assessment and metadata collection elements were very dependent on input from the countries demanded a significant amount of effort.

The challenge of the metadata creation was met by facilitating overtime and hiring of part-time support. Each country was given a target of producing a minimum of 100 metadata records, which are currently hosted on the CPACC Metadata node. With a few exceptions due to resource limitations and institutional difficulties, this target was realized by the end of May 2000, representing a significant milestone. This activity was also supported by an egroup of the country participants, consultants and project coordinators, which allowed shared experiences, particularly in addressing difficulties that may have been encountered.

The challenge of continuing the creation of the metadata still exists. The CRIS was to have incorporated the metadata records, but as a result of the time constraints and resource limitations, this has not been achieved.

The actual collection of data was another hurdle due to two basic problems. First there is generally no official policy or procedure for sharing electronic data in the majority of the countries. This means that data access can require some negotiation and is unpredictable. Additional travel by the CRIS consultants was required, coupled with a familiarity with the key individuals and institutions as well as a degree of charm.

The second issue relating to data access was that spatial data was far more available than was attribute and monitoring data with the exception of one country. This really challenged the whole CRIS concept as much of its strengths are in the management of the attribute and monitoring data (see King, Opadeyi et

al. and Colin Daniel's paper on the technical aspects of the CRIS for the URISA 2001 Caribbean GIS Conference).

The use of CARICOMP coral reef monitoring data was invaluable in testing and populating the CRIS, and demonstrating its effectiveness. This data was made available through the cooperation of the Center for Marine Sciences at the UWI Mona Campus in Jamaica and especially, the Data Manager, Mrs. Dulcie Linton. Some meteorological data from the monitoring stations established under Component 1: Design and Establishment of Sea Level/Climate Monitoring Network was utilized, mainly for demonstration purposes. This was made available through the cooperation of the CPACC Regional Archive Centre (RAC) manager, Ms. Shelley-Ann Jules.

A lot of the existing attribute and monitoring data was either too sensitive for release, in the case of nearshore water quality, or more worrisome, not adequately collected or managed to be useful for such an inventory. In the latter case, data was often not regularly collected or alternately the collection sites not georeferenced. This clearly indicated an area in need of some intervention at the national and possibly regional levels.

The difficulties faced with the satellite imagery have already been identified, however, the underlying lesson was that the technology was too new. IKONOS imagery has only been collected from late 1999 and therefore, there has not been a significant archive covering the Caribbean countries involved in the CPACC project.

One major challenge that was faced and recognized from the beginning was that the CPACC project was developing a common solution for countries that varied significantly in GIS and coastal zone management capacity. Some countries would have a greater capability for participating in the entire process given the available human resources, experience and infrastructure than would others.

Successes

There were a number of successes, most obviously the project has been able to complete preparation of the CRIS for each country involved. However, the greatest success is probably in the process adopted and implemented, in which a tremendous effort was placed on developing the national and regional capacity to advance the work undertaken under Component 3. It would have been easier to simply have consultants prepare very attractive inventories for each country and deliver these along with a workshop on how they should be applied. The CPACC approach, while riskier, did achieve a number of definite goals, including:

- Establishing a network or community of GIS practitioners and institutions that can provide assistance particularly in common matters from metadata creation and management and the application of the CRIS to more general issues of software applications. This has already been realized with the

metadata development particularly with the establishment of an egroup that served to assist individuals in the teething problems they faced.

- The development of regional capacity was also very important. The bulk of the consultants were regional and they have established a relationship with the participants that has enabled easier access when issues have arisen and also for other related endeavors.
- The development of capacity within the countries has been one of the over-riding goals and this has also been successful. Several of the individuals involved in the training have been able to transfer that knowledge to their counterparts in their own countries by running national or departmental seminars based on the regional activities. In one case, the enthusiasm and effort of one of the beneficiaries, Mr. Rajkumar Singh of Guyana, has resulted in him being requested to help at least one other country train local officers in metadata development and management and also convinced the consultants to utilize his services to coordinate the quality assurance aspect of the metadata production. Further, Mr. Singh has adapted the CRIS to apply it to the Sea Defense Information Management System in Guyana (see his paper for the URISA 2001 Caribbean GIS Conference).

CONCLUSION

The CPACC approach to the CRIS process taught quite a few lessons and indicated where future regional activities addressing spatial information for decision making, including adaptation to climate change, might invest some resources. The CPACC Project is concluding at the end of 2001, but given the project's overall impact, a follow-up initiative termed Mainstreaming Adaptation for Climate Change (MACC) has gained approval for development by the CARICOM Heads of Government, the World Bank and the Global Environment Facility. Indeed the MACC is likely to be one of the very first Stage 2 Adaptation initiatives approved by the United Nations Framework Convention on Climate Change (UNFCCC) and therefore the English-speaking Caribbean will likely be a global pioneer for adaptation to Climate Change. The MACC will build on and extend the work done under CPACC. There is therefore an opportunity to develop on the CRIS to ensure it addresses country needs and that the capacity in the countries will exist to adapt it based on departmental and national priorities.

Some future areas for attention could include working with countries to develop base data to be widely accessible; addressing common issues such as data management policy, including data sharing; and looking at strategies to ensure information technology, information systems and monitoring serve decision making. On this last point, the CRIS concept could be applied to address specific applications on a pilot basis in different countries to capitalize on the investments made as well as to further illustrate the utility of the approach.

In conclusion, I would like to reiterate that the entire Component 3 process has not been smooth nor have all goals been realized, but it can be deemed a success based on the achievements described.

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AKNOWLEDGEMENTS

I wish to express appreciation to my colleagues of the CPACC RPIU and the OAS Unit for Sustainable Development; to the consultants who developed the CRIS, Alleyne Planning Associates in Barbados, ESSA Technologies Ltd. In Canada and the UWI Centre for Geospatial Studies in Trinidad and Tobago; and last but by no means least the National Repositories, National Focal Points and colleagues all of whom have endeavored to ensure the successful implementation of the CPACC Project and Component 3.