The Capacity Building of the Environmental
Conservation Department Project (ECD-CAB),
Sabah, Malaysia

Planning and implementation of a Geographical Information System for the Environmental Conservation Department, Sabah

Background paper

March 2001

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Abbreviations

DKK	Danish Kroner
ECD	Environmental Conservation Department (State of Sabah)
ECD-CAB	Capacity Building of the Environmental Conservation Department Project
EIA	Environmental Impact Assessment
GIS	Geographical Information Systems
KK	Kota Kinabalu
M&E	Monitoring & Enforcement

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1 GIS in ECD

1.1 Introduction

The core business of the Environmental Conservation Department requires processing and decision-making related to environmental data, largely in the form of Environmental Impact Assessments, environmental monitoring activities. Much of the decision making requires spatial data, i.e. the location of the activity, for example, what is the neighbouring land-use, where in the catchment does the activity take place, who will be affected be the activity and so on. To date much of this work has been carried out with reference to traditional map sheets; however, the amount of data a paper map can portray is limited by the map's size and scale.

Therefore the primary objective of developing a GIS capability in the Department is to assist in the day-to-day workflow and decision-making. This objective will be achieved by the better management of spatial information while at the same, the accumulation of incoming project and monitoring information will contribute towards a relevant environmental database

The choices that must be faced in the initial stages of initiating a GIS are complicated and the strategy selected will have a significant impact on the design of the entire project and costs required to implement it. Moreover if the GIS is to be used to its fullest potential it will need to be integrated throughout the department. For these reasons even the smallest GIS application requires careful planning. The decision to commit to a GIS therefore demands the careful planning that any significant investment requires. Planning of this scope forces any organization to examine its basic goals and strategies.

Data layers from other users will initially be used, however, when necessary, primary data will be generated on a 'needs' basis. Ultimately the organisation of ECD information will generate enough data on its own and eventually it can be envisaged that a functioning ECD GIS system could also be an important data provider for other departments and users.

Short-term objectives will investigate the possibility of ECD joining the NARLIS (National Infrastructure for Land Information System), primarily as a data user with a medium to long-term objective of being a data provider. Subscriptions and additional hardware/software requirements will be investigated – as will subscription and data costs when the information becomes available.

The collection of data is often the most expensive and time-consuming component of establishing a GIS, which in turn defines the operating capacity of the GIS. Existing resources that are pertinent and available for ECD include data layers available from other government departments e.g. the Forest Department, however, most available data is less detailed i.e. small scale maps which cover the State – generally at the scale of 1:500,000. State wide coverage of Forest Reserves and other forested land in Sabah was published in January 2000, however, this does not reflect forest cover but the boundaries of the different reserves at a scale of 1:1,300,000; 1:270,000. The data set is available in a digital format upon request. Actual forest cover was resurveyed in 1995 and the new map is currently in a draft format and it is expected to be finalised and published sometime in 2001.

Many departments do have more detailed data but this is usually not available because of confidentiality issues. In addition most of the larger departments that produce or use spatial data are currently committed towards contributing towards the NARLIS data hub but again because of confidentiality it is unlikely that anything beyond general data will be placed on the system.

Other data sets already available include the thematic layers generated as part of the West Coast Shoreline Management Plan.

It is the intention of Department of Survey and Mapping, Malaysia (JUPEM) to convert all 67 of the 1:50,000 topographic maps that cover the State into digital format. Currently 19 are in digital format and available for sale at MR900.

Both in terms of finance and manpower and given the resources currently available, it was decided that a two dedicated workstation be established to as an appropriate entry level for ECD.

1.2 List of hardware purchased to date

- Dell 700mhz Pentium III Windows based PC with a 21" trinaton monitor
- Asus 800mhz Pentium III Windows based PC with a 19" trinaton monitor
- CD-Burner and Iomega Jazz drive for moving data and backup.

The projected life cycle of existing machines is approximately 3 years as from January 2001. Software will require more frequent upgrading.

1.3 List of software purchased to date

- ESRI Arc View 3.2   1 licence
- ESRI Arc View upgrade of existing license   1 licence
- ESRI Arc View extension Spatial Analyst   1 licence
- ESRI Arc View extension image analyst   1 licence
- R2V Raster to vector conversion software   1 licence
- ESRI Data Automation Kit   1 licence
- Surfer 7.0 Surface mapping software   1 licence.

1.4 Remotely sensed data

SPOT 4 (April 14 2000) covering Part of the District of Tuaran, Kota Kinabalu and the District of Penampamg down to the mouth of the Papar river.

1.5 List of training implemented

- Introduction to GIS (ESRI Arc View)
- Introduction to Raster to Vector conversion procedures using R2V
- ESRI Southeast Asia User conference
- Building of topology (ESRI Data Automation Kit) February 2001.

1.6 List of training planned

Introduction to image classification and analysis.

2   Identification of GIS objectives

Given the type and format of reports and data submitted to ECD, it was determined that a GIS could increase the operational capacity, particularly with regard to decision making, in two key areas and one support area

The key areas are the Environmental Assessment area and the Monitoring and Enforcement area. The support area refers to the utilisation of data by the planning section

Possible working procedures are outlined in Annex 1-7.

3   Staffing requirements

As with all components of an organisation, a functional GIS requires adequate and suitably trained staff. Depending upon the size and ambitions of the GIS, sometimes one person can carry out the tasks of more than one position. Conversely, for larger, more ambitious systems, several staff may be required to fulfil a single role. The basic staffing requirements of a GIS are as follows:

GIS Manager

This position requires a broad general knowledge of GIS applications and the needs of the organisation. Responsibilities would include knowing how to plan production steps for GIS applications.

An important role of this position would be to understand the needs of users and to communicate between users and the GIS. Other tasks would include planning and estimating resource and budget requirements for the future.

GIS Database manager

To plan and organise data sets into layers and descriptive fields and choose the data sources, levels of resolution, coordinate systems and mapping procedures to be used. The design of attribute databases and the linkage with map features – manages all data automation and maintenance and knows how to use the GIS software, hardware and data to generate the products required by the manager.

Remote sensing-image analyst specialist

This person should understand the principles of remote sensing and image analysis and be able to abstracting data layers for conversion to vector format for inclusion in the GIS.

Cartographer

This person has experience in cartography and in general GIS operation and data entry. Other tasks and responsibilities include scanning and digitising and data clean up and editing needs. May be required to compile map data from many sources including satellite imagery. The cartographer is also responsible for map production. Normally works under the direction of the database manager.

System Manager

The post requires the knowledge and experience in managing a computer system, including hardware, software requirements and peripheral supplies. The person is responsible for the computer system including setting access privileges for users, backing up files and maintaining and installing software. Helping users, troubleshooting problems. Usually reports to GIS manager

Depending upon management requirements a programmer may be required to develop and maintain macro commands and custom menus – usually supervised by systems manager.

If departmental staffs are not available and financial resources are available, outside consultants can be contracted to undertake routine duties or specific tasks, however, the setting the Terms of Reference for the consultant will require some form of knowledge to understand what is achievable.

4   Statement of risks

Even with the best GIS software and hardware available – if the system does not have sufficient support staff, at best the system will be inappropriately used or under-utilised, or at worse will quickly fail and users of the results will become dissatisfied. It is not uncommon for GIS to fail and only survive for the duration of the lifetime of the initial investment i.e. a one off purchase of hardware and software. Many GIS systems are significantly under-utilised.

The keys issues related to the successful implementation of a GIS must include continued attention to the following:

- Management support
- Continued attention to data conversion, management and maintenance
- Regular upgrades of hardware and software
- Continued user training
- Continued attention given to data communication
- User support
- Planning for funding requirements.

While the most commonly encountered pitfalls are:

- Using GIS as an experiment
- Failure to define goals
- No long-term planning
- Lack of management support
- Lack of user involvement
- Continuation of existing manual systems
- Lack of user training
- Budget overrun or underestimation
- Failure to report results.

5   Annexes

5.1 Annex 1. Workflow 1; EIAs and DPs

Objectives

- To develop a spatial database of EIAs and Development Plans submitted. The database will also include attribute information such as type of project, project proponent etc.
- To develop a spatial database and data layers that will assist in the EIA decision-making process.

Training

To develop a practical set of working procedures that will process all EIAs and Development Plans (that include spatial information).

Staff

FS, VM, RL, CR.

Overview

Activity	Activity	Resource available	Resource available	Resource created
Submission of EIA and or DP	Incorporate information into GIS	Data layers 1:50,000 or larger Rivers & slope for the Districts of Penampang, Papar, and parts of KK and Tuaran Shoreline management plan	Data layer 1:500,000 Topography Slope Forest reserves Protected areas Major river catchments	Database of submitted Development Plans and EIAs

5.2 Annex 2. Workflow 2; M&E activities

Objective

To develop a spatial database of ongoing activity based monitoring programmes. The database will also include attribute information e.g. type of activity and water quality results.

Training

To develop a practical set of working procedures that will process record all ECD environmental monitoring results.

Staff

FS, RL, TK, JA, RP.

Overview

Activity	Resource available	Resource available	Resource created
Incorporate environmental monitoring information into GIS	Data layers 1:50,000 or larger Rivers & slope for the Districts of Penampang, Papar, and parts of KK and Tuaran Shoreline management plan	Data layer 1:500,000 Topography Slope Forest reserves Protected areas Major river catchments	Database of ambient and activity based environmental quality

5.3 Annex 3. Workflow 3: Complaints handling

Objective

To develop a spatial database of complaints received. The database will also include attribute information such as type of complaint, date of site visit, samples taken etc.

Training

To develop a practical set of working procedures that will process all environmental complaints received by the Department.

Staff

FS, RL, TK, JA, RP.

Overview

Activity	Activity	Resource available	Resource available	Resource created
Environmental complaint received	Incorporate type of complaint and relevant site visit information into GIS	Data layers 1:50,000 or larger Rivers & slope for the Districts of Penampang, Papar, and parts of KK and Tuaran Shoreline management plan	Data layer 1:500,000 Topography Slope Forest reserves Protected areas Major river catchments	Database of number and type of complaints received and action taken

5.4 Annex 4. Workflow 4; Planning Information utilisation

Objectives

• To assess and utilize information and data generated within the ECD and communicate results with other relevant data users
• Additional activities when requested.

Training

None identified as yet (technical training probably not required).

Staff

FS, RL, SP, VM, TK.

Overview

Activity	Activity	Resource available	Resource available	Resource created
Ad hoc requests for environmental and other relevant data	To assess and utilize summary GIS data and maps generated within ECD	Summary maps	Summary statistics	Utilisation and communication of ECD and other environmental data

5.5 Annex 5. Workflow 5; GPS familiarisation

Objectives

- To be conversant with the use of a Global Positioning System (GPS)
- To be conversant with coordinate systems (longitude and latitude) and to be familiar with the appropriate conversions (Annex 6)
- To be able to convert coordinate data to a Rectified Skew Orthomorphic (RSO) projection (Annex 7).

Training

- Introduction to the basic principles of the workings and capabilities of a GPS
- Field exercises in using a GPS
- GPS data entry exercises
- Introduction to map projections
- Projection of data using GIS utilities.

Staff

FS, VM, RL, CR, FS, RP, JA.

Overview

Activity	Department activity	Resource	Resource created
Complaint Monitoring Compliance monitoring GIS data input	Site visits (determine location) Check boundaries Incorporate information into GIS	Garmin GPS 12-GXL	Contributes towards overall environmental

5.6 Annex 6. Workflow 6; Working with degrees, minutes, and seconds

Minutes and seconds are another remnant of the base 60 system. Parts of degrees are represented in minutes and seconds, where there are 60 minutes in a degree and 60 seconds in a minute. And what makes things worse is that we are not consistent about the matter and often use decimal values of degrees as well. Calculators mostly use decimal degrees, so if you see something in degrees, minutes, and seconds, you have to convert to decimal degrees in order to put it in your calculator. And for some crazy reason--I'm not sure what--somebody might want something written in degrees, minutes, and seconds. So you need to be able to convert back and forth between them.

DMS to Decimal

- To convert minutes to decimal degrees, divide by 60
- To convert seconds to decimal degrees, divide by 3600
- Then add the two together and write it after the degrees.

Decimal to DMS

- Multiply the decimal by 60 and the whole number part is the number of minutes.

Then multiply the decimal part of that by 60 and round to the nearest unit to get the number of seconds.

5.7 Annex 7. Workflow 7; RSO (Rectified Skew Orthomorphic) geographic conversion procedures

Objective

To convert points in geographic coordinate system to rso coordinate system using the RSO conversion software stored in the ECD RSO directory.

Steps

Get at least 4 points in Geographic coordinate system to be used as CONTROL POINTS of the map to be digitized

Make sure the control points identified are assigned with numerical numbers and matched the one on the map.

Open RSOCON directory and go to INP directory

Create a new file (use the name of the map) with an ".inp" file extension (e.g. M1108.inp) with the following format example

- 111.750000 1.500000
- 111.866667 1.500000
- 111.750000 1.616667
- 111.866667 1.616667.

Notice that all values are in 6 decimal points and that the first value refers to longitude (east value – most GPS systems report the north value first).

Go back to RSOCON directory highlight CONVERT.BAT file then right click, choose Edit. The CONVERT.BAT will appear in Notepad. Make necessary changes as shown below:

RSOCON GEORSO.PAR INP/<input_file> OUT/<output_file>

e.g.:

RSOCON GEORSO.PAR INP/m1108.inp OUT/m1108.out

where m1108.inp is created by the user and m1108.out is an output of RSOCON command.

Sample output should like below:

- 229696.754 165879.422
- 242675.872 165886.137
- 229690.436 178776.861
- 242668.828 178783.584.

Use that figure to input control points value in R2V or Data Automation Kit.