GEOGRAPHIC INFORMATION SYSTEM FOR COASTAL AREA MANAGEMENT AND PLANNING PROJECT

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Report on the National Workshop on Geographic Information Systems for Coastal Area Management and Planning

ICLARM-IDRC-NEDA Region I
GISCAMP Project 1994

Introduction

Geographic information systems (GIS) technology is fast becoming an integral part of resource management and planning in many developing countries. In the Philippines, the number of agencies and institutions using GIS is few but growing. Thus far, most are concentrated within the national capital region (i.e., Metro Manila). The use of GIS has been largely cartographic, however.

While GIS can be used for mapping purpose, this severely underrates the utility of the technology as a spatial modelling tool. Such usage is understandable because most demonstrations on GIS are vendor-initiated and often, the generic functionality of the technology is seldom explained. This situation is changing, however, as formal GIS courses are being offered in some universities worldwide.

Although GIS is widely known, its capability for spatial modelling is seldom appreciated. Moreover, the initial impression of the technology is for mapping purpose. So far, most GIS applications deal with land resources management as well as demographic assessment.

One of the activities of the GISCAMP Project is to create awareness on the usefulness of the technology for spatial data management and modelling for decisionmaking purpose through training and workshops. This report is a summary of the national workshop on GIS for coastal area management and planning held in December 1993 in Bauang, La Union, Philippines. The GIS applications covered both the terrestrial and marine environments and using the Lingayen Gulf area as the pilot site.

Objectives of the workshop

The national workshop had the following objectives:

1. To introduce the use of geographic information systems (GIS) as integrative tool for resource planning and management with special emphasis on the coastal zone.

2. To disseminate the GIS output of the GISCAMP Project to relevant regional and national agencies that undertake resource planning and management.

3. To demonstrate how GIS can be used in coastal area management and planning (CAMP).

4. To identify issues regarding data acquisition and processing applicable to CAMP GIS operation and recommend possible resolutions.

Summary of activities

The workshop was held at the Cresta Del Mar Resort, Bauang, La Union, Philippines in 13-15 December 1993. There were 65 participants coming from various parts of the country including 11 project staff. There were 33 participants from the NEDA (3 from the central office based in Manila and 30 from various regions including 18 from Region I). Three participants were from the private sector and two from the Southeast Asian Fisheries Development Center in Tigbauan, Iloilo. The rest (38 participants) were from various provincial and central line agencies including two participants from the academe (University of the Philippines Marine Science Institute and Palawan National Agricultural College). The list of participants is in Annex I.

The workshop was declared official opened by Director L. Quitos, NEDA Region I Office during the opening ceremony. Dr. L. Stifel, Director General of ICLARM was unable to attend the workshop and his speech was read by the project manager. On behalf of ICLARM, Dr. Stifel welcomed the participants and wished them a productive workshop. The full text of Dr. Stifel's speech is in Annex II.

Presentation of the preliminary project output was made during initial 1-1/2 days of the workshop. Since many of the participants have very limited exposure on GIS, particularly the concepts, a series of "lecture" on GIS principles was presented before the presentation of the project's output. Open forum was held after each presentation. The workshop timetable and the list of topics presented are as Annex III and IV, respectively. The papers presented are appended at the end of this report.

The last part of the workshop (1-1/2 days) was the workshop proper and plenary session. The closing ceremony was held in 15 December 1993 and participants were given certificates of participation (Annex V).

Workshop and plenary session

The participants were grouped into four (4) groups. They chose their workshop topics based on their lines of expertise and interest as well as geographical location (as in the case of some Region I-based participants). Each group chose a chairman, secretary and presenter. Project staff, particularly the subject specialists served as facilitators during the workshop discussions.

The four workshop topics were:

Topic 1 Planning and management of the coastal zone

Topic 2 GIS and coastal area management and planning

Topic 3 Data acquisition and processing

Topic 4 Institutional issues on the use of GIS technology

In each of the topics, the relevant issues and problems including their causes, implications and effects were discussed. Possible recommendations and appropriate actions or measures were also deliberated. Agencies and institutions to whom these issues and recommendations should be directed for consideration and appropriate actions were also identified. The tabular output of the workshop is in Table 1.

Each group presented their output during the plenary session. An open forum followed to answer queries, share relevant experiences and to accommodate suggestions and/or recommendations.

The results of the plenary session are summarized below.

Topic 1 Planning and management of the coastal area

The enforcement of fishery laws, particularly their ineffective implementation was critically considered. Because of its open access nature, proper management control should be observed which include, among others, the concerted efforts of agencies, local government units (LGU) and resource users to properly and strictly enforce fishery laws.

While the territorial use rights for fisheries (TURF) or the common property management scheme (CPM) maybe ideal to manage the fishery resources, their implementation need a lot of will power (e.g., political will) and solid cooperatives to undertake them. Experiences and case studies from other regions may serve as reference or take off points.

Topic 2 GIS and coastal area management and planning

Discussion focused on the methodology of data generation. After duly considering the pressing issues and problems, the following recommendations were emphasized:

a. enhance the publication of scientific data including appropriate disaggregation of data;

b. data generators should be updated on GIS application and technology;

c. methodology of data collection should be part of agency reports and publications;

d. develop data networking systems;

e. increase awareness and appreciation on the role of GIS in integrated coastal zone management and planning; and

f. identify office sources of data.

Topic 3 Data acquisition and processing

The problem of inaccurate data and maps was discussed. The recommendations of the working group 3 are summarized below.

a. Field validation and ground truthing should be undertaken when necessary.

b. NAMRIA can serve as clearing house for ambiguous maps.

c. Enhance sharing and networking of GIS and information.

d. The national government agencies should be able to address the data needs of the localities, e.g., LGUs, farmers, other specific locations/areas.

e. Disaggregation of data should not be limited at the macro level, rather local disaggregation should be undertaken to suit data needs of localities.

It was also emphasized that GIS is one of the tools for data analysis and for decisionmaking. It should not be treated as a panacea, however.

Topic 4 ***Institutional issues on GIS technology and its implementation in government***

It was mentioned that GIS capability building is very expensive as well as the acquisition of the system. For cost effectiveness and optimal operation and utilization of the system, therefore, an added suggestion was to appropriately screen participants attending GIS-related trainings with due consideration to those with permanent positions. Also, sharing and networking were recommended by the group.

MASTERLIST OF PARTICIPANTS TO THE NATIONAL WORKSHOP ON GEOGRAPHIC INFORMATION SYSTEM FOR COASTAL AREA MANAGEMENT AND PLANNING
Cresta del Mar Resort and Beach Club, Inc.
Bauang, La Union
December 13 - 16, 1994

Participants	Agency	Address
	National Capital Region	
Mr. James N. Paw	Int'l. Center for Living Aquatic Resources Mgt.	Salcedo St., Legaspi Vill., Makati, Metro Manila
Ms. Zoraida N. Alojado	Int'l. Center for Living Aquatic Resources Mgt.	
Mr. Alexis F. Fabunan	Int'l. Center for Living Aquatic Resources Mgt.	
Dr. Flordeliz Y Guarin	Dames & Moore, Inc.,	Alfaro St., Makati, Metro Manila
Ms. Teresita Manipon	Director, Management Information System Staff	NEDA sa Pasig, Amber Ave., Pasig, M. M.
Ms. Rebecca Malacaman	Management Information System Staff	
Ms. Romelie Suayan	Regional Development Coordination Staff	
Ms. Evangeline Cruzado	Deputy Administrator,	
	National Mapping & Resource Information Authority	Fort Bonifacio, Makati, Metro Manila
Dr. Clarissa Marte	Southeast Asian Fisheries Development Center	Tigbuan, Iloilo City, Iloilo
Dr. Luis Ma. Garcia	Southeast Asian Fisheries Development Center	
Ms. Zelpha Jeremias	Bureau of Fisheries and Aquatic Resources	Arcadia Bldg., Quezon Ave., Quezon City
Ms. Mercedita Tan	Bureau of Fisheries and Aquatic Resources	
Ms. Ma. Jayvee Ubarde	UP - Marine Science Institute	UP Diliman, Quezon City
Mr. Richmond Roman Gonzales	Bureau of Soils and Water Management	Elliptical Road, Diliman, Quezon City
Engr. Rodolfo Lipaopao, Jr.	Forest Management Bureau	Visayas Ave., Diliman, Quezon City
Mr. Gerry Gabuya	Project Consultants Group, Inc.	27 Don Alejandro Ave., Quezon City
Mr. Jojo Anoos	Project Consultants Group, Inc.	
Mr. Nikki del Rosario III	Bureau of Agricultural Resources	Elliptical Road, Diliman, Quezon City

NEDA Regional Offices

Mr. Leonardo Quitos, Jr.	Regional Director, Region I	Guerrero Road, San Fernando, La Union
Ms. Agnes Grace Cargamento	Assistant Regional Director, Region I	
Mr. Ernesto Datuin	Staff, Region I	
Ms. Fe Domingo		
Mr. Medardo Panlilio		
Mr. Konifacio Casuga		
Ms. Lily Grace Orcino		
Ms. Florence Gacad		
Ms. Lucy Torio		
Ms. Ines Meneses		
Ms. Melanie Untalasco		
Mr. Edwin Cacanindin		
Ms. Cleofe Pastrana		
Ms. Irma Devadeb		
Mr. Nestor Rillon		
Ms. Marissa Gorospe		
Mr. Josefino Tadifa		
Mr. Jonathan Guiang		
Mr. Leon Dacanay	Region III	San Fernando, Pampanga
Ms. Liza Zuño		
Mr. Bernie Atienza	Region IV	Epifanio delos Santos Ave., Quezon City
Mr. Felix Lositaño	Region V	Arimbay, Legaspi City, Albay
Mr. Othelo Derecho	Region VI	Fort San Pedro, Iloilo City, Iloilo
Mr. Dionisio Ledres, Jr.	Region VII	Escario St., Cebu City, Cebu
Ms. Virginia Mabute	Region VIII	Government Center, Candahug, Palo, Leyte
Mr. Rustico Varela, Jr.	Region IX	Cawa-cawa, R.T. Lim Blvd., Zamboanga City,
Mr. Isagani Salazar	Region X	Capistrano-Echem St., Cagayan de Oro City
Mr. Elpidio Jayagan	Region XI	J.P. Laurel Ave., Davao City
Ms. Brigida Tangonan	Region XII	Regional Government Center, Cotabato City
Ms. Dolores Molintas	Cordillera Autonomous Region	Botanical Garden Leonard Wood Rd Baguio City

Provincial Governments

Mr. Geoffrey Tilan	Provincial Planning & Development Office - La Union	Provincial Capitol, San Fernando, La Union
Ms. Armi Nieto	Provincial Planning & Development Office - Pangasinan	Provincial Capitol, Lingayen, Pangasinan
Mr. Roel Añonuevo	Provincial Planning & Development Office - Pangasinan	
Ms. Eva Ibarra	Provincial Planning & Development Office - Ilocos Norte	Provincial Capitol, Laoag City, Ilocos Norte
Ms. Florence Soria	Provincial Planning & Development Office - Ilocos Sur	Provincial Capitol, Vigan, Ilocos Sur
Mr. Ramon Lapastora	Provincial Planning & Development Office - Ilocos Sur	

Regional Field Offices

Mr. Nestor Domenden	Department of Agriculture - Region 1	Aguila Road, San Fernando, La Union
Ms. Wilma Tomas	Department of Environment & Natural Resources	Florentino Bldg., San Fernando, La Union
Ms. Marizel Libertine Calpito	Department of Environment & Natural Resources	
Mr. Cesario Nazarro	Department of Environment & Natural Resources	
Engr. Conrado Ordono	Department of Health - Region 1	Sevilla Norte, San Fernando, La Union
Engr. Emil Ganaden	Department of Public Works & Highways	Aguila Road, San Fernando, La Union
Mr. Steveson Orcino	Department of Trade & Industry	Quezon Ave., San Fernando, La Union
Ms. Rowena Calica	Department of Tourism	Guerrero Road, San Fernando, La Union
Mr. Julio Gaffud	Phil. Human Resource Development Council	Bonuan Binloc, Dagupan City, Pangasinan
Mr. Roderico Beltran	Housing and Land Use Regulatory Board	Botanical Garden,Leonard Wood Rd,Baguio City
Mr. Reynaldo Ponce de Leon	Palawan National Agricultural College	Aborlan, Palawan

National Workshop on
Geographic Information Systems for
Coastal Area Management and Planning
Bauang, La Union, Philippines

13 December 1993 (Monday)

9:00 - 10:00	Registration
10:00 - 10:30	Opening Ceremony
10:30 - 10:45	Overview of the GISCAMP Project
10:45 - 11:25	Integrated Planning and CAM
11:25 - 11:45	Introduction to Remote Sensing GIS principles and applications
11:45 - 12:00	Open Forum
12:00 - 1:30	Lunch Break
1:30 - 2:00	Data Acquisition and Processing for GIS Operation
2:00 - 2:35	Assessing urban development using GIS
2:35 - 3:05	Zonation of Fishing areas and fry grounds
3:05 - 3:30	Marine Parks and Artificial reef siting using GIS
3:30 - 4:00	Tea Break
4:00 - 4:25	Assessing coastal tourism using GIS
4:25 - 5:00	Open Forum

14 December 1993 (Tuesday)

9:00 - 9:25	Site selection for mangrove reforestation using GIS
9:25 - 9:55	Assessing aquaculture development using GIS
9:55 - 10:25	Tea Break
10:25 - 11:10	A GIS study of the Agno River Basin
11:10 - 11:40	Zonation scheme for Lingayen Gulf
11:40 - 12:00	Briefing for the working group sessions
12:00 - 1:30	Lunch Break
1:30	Working group sessions

15 December 1993 (Wednesday)

9:00 - 10:30	Continuation of working group sessions
10:30	Tea Break
10:30 - 12:00	Finalize output for all working groups
12:00 - 1:00	Lunch Break
1:00 - 2:45	Plenary Session
2:45 - 3:15	Tea Break
3:15 - 4:00	Recapitulation/Closing

Address by
Dr. Laurence Stifel
Director General
International Center for Living
Aquatic Resources Management
13 December 1993
Bauang, La Union, Philippines

Mr. Leonardo Quitos, Director NEDA Region I
Distinguished guests, participants, ladies and gentlemen:

On behalf of the International Center for Living Aquatic Resources Management (ICLARM), it is my pleasure to welcome you to this National Workshop on Geographic Information Systems for Coastal Area Management and Planning.

It is increasingly being recognized that many coastal areas in the developing countries including the Philippines are facing intense demographic and economic pressures. Such pressures have resulted in unsustainable use of resources, social inequity, especially for the coastal fisherfolk, as well as pollution. The latter is exacerbated by unmanaged inland and upland activities. ICLARM's research focus is on fisheries but being cognizant of the impact of other sectors on it, its research approach must necessarily be integrated and within an ecosystem management framework. One of the pioneering efforts of ICLARM to integrated coastal area management was the implementation of the Association of Southeast Asian Nations (ASEAN)/United States (US) Coastal Resources Management Project (CRMP) during 1986 to 1992 which produced a coastal area management plan for Lingayen Gulf. This plan is aimed at the sustainable development of the coastal areas of La Union and Pangasinan including the Lingayen Gulf under a multisectoral environment.

The coastal management plan for Lingayen Gulf is expected to be implemented by the regional agencies with the National Economic and Development Authority Region I Office (NRO I) as the technical secretariat to oversee it. In order that the plan will be responsive to the changing needs of the region, periodic revision and updating of information are required. Information with spatial components are among the most difficult to revise but the availability of computer-assisted tools like geographic information systems (GIS) makes it easier to do so.

Apart from research, ICLARM recognizes the need to strengthen in-country institutions through training and transfer of appropriate approaches and methodologies. The importance of GIS as a planning and management tool has been recognized since the inception of the CRMP but requires pilot testing to determine its appropriateness. NRO I was identified as one of these institutions for GIS pilot testing with the objective of further refining the plan for implementation. Thus, as part of ICLARM's capability building program, it implemented the Geographic Information Systems for Coastal Area Management and Planning Project (GISCAMP Project) under its Coastal Area Management Program in late September 1991. Funding is provided by the International Development Research Center of Canada with counterpart contributions from ICLARM and NRO I.

This national workshop on GIS which starts today is a component of that program using the output of the project to demonstrate the wide range of applicability and flexibility of GIS for resource planning and management. We hope that this workshop will serve as an impetus towards systematic spatial information management as well as integrated planning and management of our common resources. I wish you all a productive workshop.

Thank you and good morning.

IDRC
CANADA

Certificate of Participation

This certifies that

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participated as delegate to the Workshop on

ICLARM

Geographic Information System for Coastal Area Management and Planning

held on December 13-15, 1993 at
Cresta del Mar, Bauang, La Union
jointly organized by the
International Center for Living Aquatic Resources Management
and the
National Economic and Development Authority Region 1
for the Geographic Information Systems for Coastal Area Management and Planning Project

James N. Paw
Project Manager
ICLARM

Dir. Leonardo N. Quitos, Jr.
Project Leader
NEDA, Region 1

Table 1

Workshop Group No. 1: PLANNING AND MANAGEMENT OF THE COASTAL ZONE

ISSUES/PROBLEMS	CAUSES & IMPLICATIONS/EFFECTS	RECOMMENDATIONS/ACTION MEASURE	TO WHOM ADDRESSED
Resource degradation/ depletion			
1. Excess fishing effort	- resource use conflict	- more explicit definition of municipal/commercial fishing grounds	- DA, DILG
	- low awareness/practice (ecosystem)	- information campaign	- DA, LGUs, NGOs
	- dynamite/illegal fishing	- intensified enforcement of fishery laws	- DA, PNP/CG, DOJ
	- ineffective law enforcement	- provision of alternative livelihood	- DA, LGUs, DTI, NGOs
	- overfishing		
2. Habitat and environmental degradation	- bottom trawling disturb habitat	- closure of LG to trawling for at least 5 years	- Bay Management Council, Pangasinan/La Union governments, LGUs
	- establishment of fish sanctuary		
	- improper waste disposal particularly in urban municipalities	- compliance to environmental laws	- DENR, DOJ, NGOs
	- deforestation of uplands	- compliance to environmental laws	- DENR, DOJ, NGOs
3. Coastal forest depletion	- mangrove deforestation	- compliance to environmental laws	- DENR, DOJ, NGOs
	- conversion of mangrove to ponds	- compliance to environmental laws	- LGUs, DA
4. Coastal erosion	- magnetite mining and water current	- shoredikes establishment in affected areas	- DPWH, LGUs
Proverty among fisher folks	- weak fisherfolks organization	- intensify formation of fisher folk cooperatives	- DA, CDA, LGUs, NGOs
	- declining return from capture fisheries	- diversification of activities i.e. land-based alternative livelihood	- DA, DTI
	- lack of alternative livelihood		
	- overpopulation	- family planning	- DOH, DSWD
Logistics support to coastal management	- lack of commitment/support to law enforcement agencies and judiciary	- creation of special courts	- DOJ
		- re-orientation of politicians to balanced development and management	- DILG
	- lack of political will		
	- lack of equipment of law enforcement agencies	- provision of basic equipment	- NGOs, LGUs
	- lack of inter-agency coordination	- execution of MOA	- LGUs, NGOs, NGAs
	- no baywide authority or council	- formation of bay management council	
Education, public awareness and participation	- poor/low environmental protection awareness	- information campaign and participatory planning	- DILG, DA, PIA, LGUs, NGOs
	- lack of environmental management focused curriculum	- integration of environment management-focused curriculum from pre-scholl to college level	- DECS

Table 1

Workshop Group No. 2: GEOGRAPHICAL INFORMATION SYSTEMS ON COASTAL AREA MANAGEMENT AND PLANNING

ISSUES/PROBLEMS	CAUSES & IMPLICATIONS/EFFEC	RECOMMENDATIONS/ACTION MEASURE	TO WHOM ADDRESSED
1. Pollution	- destruction of critical habitats - decreasing fish catch - endangered public health - foregone revenues/incomes	- institutionalization of zonation landuse plan - information drive on health impacts of pollution - citizen participation in monitoring compliance of ECC - ban non-biodegradable products - set up waste treatment facilities	- DENR, Congress, LGUs, NGOs, DECS, PIA, PCG
2. Inter-agency policy conflict	- no clear direction - low productivity - confusion - waste of government resources	- horizontal/vertical coordination between agencies - revert to mangrove all underdeveloped fishpond leases	- DENR, DA, LGUs
3. Resource-use conflict (land)	- conversion of mangrove to other us - unsustainable/wasteful use of resources - environmental degradation - irreversible environmental impacts	- implement/institutionalized TUR - implement community-based resource management programs - support pressure groups/NGOs to lobby for environmental concerns, zoning and landuse plans	- LGUs, NGOs, DENR
4. Conflict between municipal & commercial fisherman	- destruction of natural habitats, benthic species - reduced fish catch/income of municipal fisherman	- increase penalties/fines of violators - give incentives to commercial fisherman who fish on designated zone	- PCG, Congress, LGUs, PN
5. Lack/absence of relevan data/information	- lack of funds, expertise, environme related statistics/data gathering system - planning/decision making impaired by lack of reliable data/information	- upgrade research capabilities of agencies, LGUs - identify parameters/indicators for environmental information system - standardize methodologies of data	- BAR, NSO, Academe, research institutions, LGUs all government agencies

Table 1

Workshop Group No. 3: DATA ACQUISITION AND PROCESSING

ISSUES/PROBLEMS	CAUSES & IMPLICATIONS/EFFEC	RECOMMENDATIONS/ACTION MEASURE	TO WHOM ADDRESSED
1. Accuracy			
- georeferencing	- lack of technical skill of those who prepare the thematic map - different groups produce similar maps - precision of instruments used	- training of those involved in map preparation - use of more precise instruments	
- reproduction	- warping of reproduction machine	- proper positioning of materials being produced	
2. Timeliness	- some data/information are obsolete or not updated	- strengthen networking for data available	
3. Data format varies	- different methodology/purpose	- clearing house (NSCB)	
4. Availability	- not a priority of concerned agencies	- networking of all sectors	
5. Urgency of data acquisition	- unwillingness of concerned agencie to responds to request	- go directly to head of office - strengthen networking - use proxy data	
6. Propriety rights	- copyright law	- memorandum of agreement - proper referencing	
7. Expensive acquisition of remote sensed data	- imported	- use remote sening data only when absolutely necessary - access more inexpensive data	

Table 1

Workshop Group No. 4: INSTITUTIONAL ISSUES ON THE USE OF GIS TECHNOLOGY

ISSUES/PROBLEMS	CAUSES & IMPLICATIONS/EFFEC	RECOMMENDATIONS/ACTION MEASURE	TO WHOM ADDRESSED
1. Staffing			
- permanent	- additional cost - CS restriction	- creation would depend on agency priorities needs	- management
- adhoc	- competing activities - GIS not maximized - acquistion coast will not be justified	- at least one permanent for administration and at leasr one from each sectoral unit - part time	
2. Training			
- who will be trained - who will train - extent of training	- for coast effectivity and to maximize operation/utilization of GIS	- must be computer literate and preferably knows technical requirements - 1 or 2 intensive training followed by echo trainings - private agency with capability - appreciation course, 1 year OJT	
3. Cost			
- prohibitive acquisition cost - recurring expensive cos - funding	- software & hardware (P 1M minimu - to ensure sustainability of operation - GOP cannot shoulder out of regular funds the full requirement	- enhancement of existing capabilities to lower cost - program in regular budget - develop project proposal to support GIS acquisition and sustain operation	
4. Data sharing			
- different data forms - difficulty in accessing available data - determine which agenc should generate official data	- makes conversion difficult - level of confidentiality - legal impediment - data consistency	- technical working group to define: 1. networking guidelines among agencies 2. standardize	- NAMRIA (to lead)
- data security	- tampered data	- systems and procedures in data release	

SOME OF THE PAPERS PRESENTED

Geographic Information Systems for Coastal Area Management and Planning Project (GISCAMP): An Overview

James N. Paw[1]

Introduction

The coastal areas[2] in many developing countries are subjected to heavy economic and population pressures. Most of these countries depend heavily on the area's primary resources for economic development. Indiscriminate exploitation coupled with accelerated economic development have resulted in the degradation of the coastal environment, a situation which could have been avoided with adequate planning and management for sustainable development.

Most developing countries lack long-term, integrated coastal area planning and management. Where planning exits, it is usually sectoral in approach and uncoordinated in execution resulting in serious use conflicts.

To begin solving these problems, two conditions must be met: (1) policymakers and resource managers at all levels have to understand the basic principles of sustainable development, and (2) capabilities in integrated planning for long-term resource utilization have to be developed, particularly at the municipal (district) and provincial (state) levels.

The key to planning for long-term resource use is to make accurate and up-to-date information available to the planners and resource managers. This information is also important during the implementation of the coastal area management (CAM) plan. The information required to identify resource management options on which to base effective plans include demographic data, land and water usage, agriculture, forestry, mining, fishing tourism and legal and institutional structures. Appropriate tools to organize, process, store, update, analyze and interpret such information are also needed in order to make effective

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1 International Center for Living Aquatic Resources Management (ICLARM), MC P.O. Box 2631, Makati, Philippines.

2 Coastal area or coastal zone is broadly defined as the interface or transition space between two environmental domains, the land and the sea. The seaward boundary could stretch to the 200 nautical miles limit known as the Exclusive Economic Zone (EEZ) while the landward boundary could be 1 kilometer from the seashore to more than 50 kilometers inland.

decisions and plans. One such tool is the geographic information systems (GIS).

GIS has been applied in the management of watersheds, water resources and land use. Its application for the coastal area is relatively new and therefore, requires successful pilot testing to demonstrate its wide applicability, efficiency and relevance.

The pilot site: Lingayen Gulf, Philippines

The provinces of Pangasinan and La Union border the 2,100 km^2 Lingayen Gulf in northwestern Luzon, Philippines. The Lingayen Gulf area is one of the major fishing grounds of the country. The gulf is one of the intensely exploited waters and myriad social, economic and institutional problems have spawned brought about by economic and demographic pressures. The major management issues affecting the gulf are:

- overexploitation of fisheries resource which has exceeded the maximum sustainable yield, biological overfishing and conflict between trawlers and artisanal fishermen;

- destruction of critical habitats due to the use of explosives and poison as well as sediment loading from upland activities including mining and pollution;

- low aquaculture production due to poor farm management practice; and

- coastal erosion due to sand mining and other factors.

During 1986-1990, the Association of Southeast Asian Nations (ASEAN)/United States Coastal Resources Management Project (CRMP) executed by the International Center for Living Aquatic Resources Management (ICLARM) undertook several studies covering biogeographical, socioeconomic and institutional aspects in Lingayen Gulf areas. It is its first regional attempt to promote integrated coastal area management (ICAM). The output of the CRMP was a CAM plan aimed at the sustainable development of coastal resources in the Lingayen Gulf area with specific strategies to address the management issues facing the area. It was through the regional office of the National Economic and Development Authority (NEDA) that the plan was developed and completed. NEDA Region I Office (NRO) was identified as the lead agency to oversee the implementation of the CAM plan for the first two years.

The NEDA is responsible for the effective coordination of various social and economic plans, policies, programs and projects of the Philippines to ensure

cohesiveness in the country's economic development planning. There are 14 regional offices all over the country with NRO as the planning agency of Region I comprising four provinces including Pangasinan and La Union. It is the technical secretariat to the Regional Development Council (RDC). RDC coordinates the planning and implementation of development programs and projects at the regional level and composed of selected local government officials (governors and mayors), regional heads of departments and other government offices and representatives from nongovernment organizations in Region I.

It was recognized during the development of the management plan that spatial data management is important in the overall success of plan implementation, an aspect which was not adequately considered during the research phase of the CRMP. With the completion of the plan and its possible implementation in the next five years (i.e., after 1992), the need for spatial data management is critical. Furthermore, the region has been designated a potential industrial area, especially Pangasinan. Recently, the Lingayen Gulf has been declared as an environmentally critical area under Presidential Proclamation No. 156 dated 25 March 1993.

Existing spatial program or activity of Region I relies largely on manual efforts, especially spatial analysis. The use of GIS technology will greatly facilitate spatial data management in the region. The availability of GIS technology at NRO will be very useful in the CAM plan implementation, particularly in delineating a zonation scheme for the Lingayen Gulf area. The scheme could aim at minimizing conflicts in the multiple use of the gulf area and at ensuring sustainable development. GIS can also complement the current physical planning thrust for Region I by NRO.

It is with this background that a GIS project for NRO was initiated in early 1990 under the former Coastal Area Management Program of ICLARM, with the international Development Research Centre of Canada (IDRC) as the funding agency with counterpart contributions from ICLARM and NRO. The GISCAMP is a 2-year project with the ICLARM as the executing agency and NRO as the collaborating institution. Although the project is coordinated by NRO, ICLARM provides the overall technical and administrative supervision.

The GISCAMP Project

One of the recommended strategies of the CAM plan for the Lingayen Gulf is the development of a zonation scheme for both land use and water space utilization. On a broader context, the zonation scheme should consider the downstream impact of upland activities so that appropriate management options and policy actions can be formulated to deal with linked habitats such as forests. Indeed, the CAM plan has addressed such issue with a proposal to rehabilitate

the Upper Agno River System watershed.

The zonation scheme proposed in the CAM plan is essentially based on ecological and resource management considerations but more focus on the coastal waters component such aquaculture, mangrove rehabilitation, fisheries and marine critical habitats. The terrestrial component such as agriculture, forest land, industrial areas and tourism sites is not well defined. Impacts of development activities, both short- and long-term, for tourism, agriculture, industrialization and urban expansion remain to be assessed and incorporated into the zonation scheme.

The GISCAMP Project is formulating a zonation scheme in response to the recommendation of the CAM plan but the context has been expanded to include development programs (largely industrialization) which are not adequately considered by the plan. Also, the project looks into land use/cover and water space utilization in the Lingayen Gulf area and in the watershed to quantify impacts on the resources. The GISCAMP Project has the following objectives:

1. to evaluate coastal land use changes and marine space utilization with respect to fishing, commercial fry collection, marine parks, mangrove reforestation, aquaculture development, tourism, human settlements and artificial reef sites and their impacts using GIS;

2. to determine the sphere of influence of upland watershed activisms in terms of sediment and pollutant influx into coastal areas and their impacts thereof using GIS;

3. to differentiate between natural and anthropogenic changes in the coastal zone, where possible, to pinpoint areas of intense human activities so that appropriate management guidelines can be instituted and to delineate areas for conservation;

4. to develop a zonation scheme for the Lingayen Gulf areas that is consistent with the principles of sustainable development; and

5. to establish a databank on spatial and attribute information relevant to CAM and planning at the pilot site.

Approach

Ten tasks are established to meet the above objectives. The two core tasks are GIS data bank and GIS application. The latter consisted of 9 activities as follow:

Activity 1 — Impact of upland watershed and lowland land use activities on the coastal zone.

This activity assesses land use/cover changes and to quantify sediment loading using the Universal Soil Loss Equation.

Activity 2 — Impact of human settlement development and expansion on the coastal area.

This activity, attempt to document and assess land use changes with respect to settlement expansion in the coastal areas using GIS.

Activity 3 — Delineation of fishing zones in Lingayen Gulf.
Activity 4 — Delineation of fry grounds in Lingayen Gulf.

Activity 3 identifies and delineates fishing zones for conservation and management including assessment of dependence of some fishing communities on nearshore waters while Activity 4 identifies and delineates the fry grounds in the gulf.

Activity 5 — Identification and assessment of marine park and artificial reef zones.

This activity aims to demarcate an area in Santiago Island as a marine park using GIS. Also, artificial reef sites will be identified for the possible establishment of such structures to enhance the fisheries.

Activity 6 — Identification and assessment of coastal tourism areas.

This activity identifies and assesses existing and potential tourism areas and delineates tourism zones under an integrated planning framework.

Activity 7 Identification and assessment of mangrove reforestation areas.

This activity identifies suitable areas for mangrove reforestation and document mangrove conversion in the gulf area using GIS.

Activity 8 Identification and assessment of areas for aquaculture development.

Proper site selection is a very important requirement to ensure success in any aquaculture venture. With GIS, potential sites will be identified under a multiple resource use environment and thus, minimizes possible resource use conflicts.

Activity 9 Zonation scheme for the coastal zone of Lingayen Gulf.

Activity 9 is the integration of Activities 1 to 8 and the development programs for the Lingayen Gulf in the context of a 5-year (medium) term development strategy. Fig. 1 shows the flow of inputs into the GIS.

Methodology

Specific GIS procedures are designed for each activity using a GIS software called Spatial Analysis System (SPANS) developed by INTERA TYDAC Technologies of Canada (Version 5.22) for PC microcomputer. Spreadsheets, text editors and database management system (DBMS) are used for processing and analysis of attribute information prior to importation into the GIS. Remotely sensed data (March 1990 Landsat Thematic Mapper) were used to update topographic and thematic maps. Rectification was done by the National Mapping and Resource Information Authority (NAMRIA) using microBrian, an application-based image processing system developed by CSIRO and MPA International Pty Ltd of Australia. Ground truthing using Global Positioning System was conducted by the project staff and some information on coral reef cover was provided by the Marine Science Institute of the University of the Philippines. Photointerpretation of aerial photographs was also conducted by NAMRIA.

To facilitate GIS analysis, each activity follows a standard procedure:

1. Specific objective - defines an objective where GIS can be applied.

2. Information and data needs - define what data are needed in doing the GIS analysis and in what format the data should be collected

and processed.

3. Flow of processing tasks - defines the transformation of data for GIS analysis and the GIS functions to execute in order to meet the objective.

Information and data needs are of two types - map and attribute data. Maps include topographic maps, nautical charts and thematic maps (e.g., soils, slopes, physiography) as well as remotely sensed data. Maps including the aerial photographs are digitized using a digitizing package of SPANS called TYDIG (Version 4.3) while remotely sensed data are in digital format imported into SPANS as raster (grid) files. Digitizing was done using a 24" x 36" CALCOMP drawing board II model 33360 with 16 button cursor. Attribute data like population data, number of fishing boats and rainfall data, etc. are encoded in spreadsheets and DBMS following SPANS format and imported as table files. Many of the attribute data collected have to undergo preprocessing to ensure data consistency, detect and correct errors, aggregation and resampling. The latter are for large datasets. Most of the attribute data are point data. Point data are processed in SPANS either as surface maps, point maps or maps with some zone of influence/interest using the buffer function. These various map layers are then overlaid according to specific objectives according to the procedure enumerated above.

Other activities

In conjunction with GIS application is the development of GIS databank. The initial data input necessarily reflects the requirement of the 9 activities enumerated above. Long-term target will cover other provinces such as Ilocos Norte and Ilocos Sur as well as linkage of other databases with GIS. The database creation was undertaken with the assistance of a hired GIS consultant.

Aside from GIS databanking and application, the GISCAMP will conduct in-house training for selected staff in the use of GIS, particularly SPANS GIS. This is part of the capability building program of ICLARM to ensure that local expertize will be available. Workshops and short-term technical training from non-project staff will also be conducted to increase awareness of the use of GIS as planning and management tool.

Data Acquisition and Processing for GIS Operation

Introduction

Geographic information systems (GIS) have very exacting data requirement in terms of definition, format and integrity. One of the most important features that data for GIS analysis must have is geographical reference (i.e., coordinates) which allows such data to be located in space. Geographical data can represent real world phenomena in three modes - spatial, temporal and thematic. Spatial mode deals with places or locations, temporal mode considers variation in time while the thematic mode deals with variations from one characteristic (attribute) to another. Most commercial GIS cover only spatial and thematic modes. Temporal mode is typically embedded in attribute information and depicted as a "snap-shot" in time, e.g., 1986 land use or 1990 road network.

GIS are powerful spatial analytical tools but many institutions using GIS are not maximizing its functionalities. Most often, GIS are used for automatic mapping/facilities management (AM/FM) focusing on spatial inventory and query functions. Such functions are used to locate a facility, mapping resources and generate reports or maps regarding the condition of the resources/facility. This emphasis on AM/FM has severely underestimated the importance of GIS for spatial modelling. Depending on complexity, spatial modelling generally involves several datasets from disparate sources. Some could be point data like rainfall and salinity, area data such as land cover and line data like roads.

Types and sources of spatial data

Spatial data for GIS consist of two types - locational and attribute data. Locational data are entities or objects that can be located on the earth surface. Attribute data, on the other hand, refers to the characteristics of locational data such as name, condition and description (Table 1).

Spatial data can come from various sources through primary and secondary data collection. Primary data are those collected directly from the field such as in surveys or by remote sensing. Secondary data refers to data obtained from published and unpublished materials including other databases. In the latter, the methodologies used in data collection are sometimes difficult to obtain if not unavailable. This situation may lead to misinterpretation and false expectation regarding accuracy so that caution must be exercised when using such information.

Data for GIS can come from maps, remotely sensed data, technical

reports, census data and digital databases in varying formats and scales. Maps are the most common source of GIS data and usually classified into 3 types - nautical charts, topographic maps and thematic maps. Thematic maps are further classified into chloropleth map, area class map and isopleth map. Nautical charts are maps showing features of the marine environment such as depth, landforms found along the coast, coastline and navigational obstruction and spots. It is intended for navigation purpose and usually at 1:100,000 scales. Nautical charts are usually in Mercator Projection while topographic maps are in the Universal Transverse Mercator (UTM). Most GIS can accept data from different map projections but correction factors are required.

Topographic maps typically represent some features of the earth's land surface such as elevation, vegetation and roads. Such maps are of varying scales but commonly at 1:50,000 and 1:250,000. Thematic maps like soil maps, census maps and land use map follow the same format and scale as the topographic maps. For the GISCAMP Project, maps were purchased from different sources including cadastral maps (Table 1). Most thematic maps were secured with minimal fees usually for blue printing from various national and local agencies, particularly the Bureau of Soils and Water Management (BSWM).

Remotely sensed data from Landsat Thematic Mapper, both analogue and digital were purchased from the National Mapping and Resource Information Authority (NAMRIA) including aerial photographs. Maps are typically captured into GIS as vector while remotely sensed data are in raster.

Attribute data are usually extracted from technical reports, development plans and statistical reports such as water quality data, census, tourism sites and resorts, etc., including descriptions of locational data. Frequently, thematic maps have corresponding reports where attribute data can be extracted (e.g., soils/land resources evaluation project reports of BSWM). In cases, data can be obtained in semi-processed forms such as rainfall and water quality data. Attribute data can be numerical or categorical. The latter includes descriptions of entities. In GIS, categorical data refer to mathematical symbols that are used to identify an entity such as soil unit (e.g., class 1 = sandy clay loam, class 2 = loam) but which cannot be used in mathematical expressions. Numerical data refer to the measured value of an entity expressed in interval (e.g., temperature, elevation) or ratio (e.g., rainfall, wind speed) systems.

Before collecting data for GIS analysis, one must first established a procedure to identify data needs and in what form it should be processed so that it will meet one's study objectives. In GISCAMP, we have the following procedure:

1. Specific objective - defines an objective where GIS can be applied. The objective is usually a subset of the overall study objectives.

2. Information and data needs - define what data are needed in doing the GIS analysis and in what format the data should be collected and processed.

3. Flow of processing tasks - defines the transformation of data for GIS analysis and the GIS functions to execute in order to meet the objective.

The main concern of the succeeding sections will be item 2. An example of the procedure is illustrated in Fig. 2. The 3rd item can be depicted as a flow diagram showing the various transformation steps within GIS.

Preprocessing of data

Data obtained need some level of preprocessing before being captured into the GIS. Preprocessing must ensure that it meets the data requirement for GIS analysis. More importantly, the spatial elements (e.g., locations) should remain intact. Data preprocessing would ensure data consistency, error detection and rectification, aggregation and resampling. Raw or semi-processed data, particularly those obtained from surveys or observation records need processing and analysis outside of GIS. This is usually conducted using statistical packages. For example, rainfall data often show observational gaps due to lapses in recording or change in gauge location. A simple double mass analysis (normal ratio-proportion) can correct for such inconsistency. One can also subject time-series data using auto-regressive models to compute for missing data, especially for continuous phenomenon. Model results (e.g., ecological, biological, chemical) can be used in GIS as long as the coordinates are available. However, such sources often ignore spatial feedback.

Preprocessing can also eliminate or correct errors in the data. Maps such as those at 1:50,000 quadrangle when join together sometimes have mismatched edges, that is, some continuous features like elevation does not match the edge of the adjoining map. In smaller scale thematic maps (1:250,000), it is not unusual to discover that some polygons lack identification (e.g., land use map). Sometimes, even the coordinates are incorrect. In the case of cadastre, many of the redrawn maps which are ported down to smaller scales (from 1:4,000 to 1:50,000) lack coordinates. Thus, close examination of the data is important so

that appropriate corrections can be made. In the case of distorted map, it may be necessary to transfer some important information into a correctly scaled map.

Some data may be too large to handle in GIS so that aggregation or resampling may be necessary. In aggregation, similar features may be lumped together while resampling may involve random, systematic or stratified approaches. These can be done outside of GIS using spreadsheets and statistical packages.

For descriptive attribute information, depending on the objective, say assessing a tourist site, it must be converted into either nominal or ordinal scale. In nominal scale, numbers merely establish identify of the object (e.g., resort A is no. 3). In ordinal scale, numbers establish order (e.g., sandy area is better than mixed sand/stone area for siting resort A). This can be done using text editors and spreadsheets.

Data capture

Once the data have been preprocessed, point data like rainfall, temperature must be encoded into tabular form following the GIS format. This can be dome using text editors and spreadsheets. If the point data is to be appended into a map, the classes of the target map must be used as the reference field also called the key field so that the table matches the coordinates of the map (see Fig. 3).

For maps, several methods are employed to capture the required information.

1. Manual digitizing. This involves the use of digitizing tables. A map is usually positioned at the surface of the digitizer and using a cursor (usually a 16-botton hockey puck), pertinent information is traced. Generally, the program that runs the digitizer is a subset of the GIS software although some are external such as AutoCad. Data captured are in vector format which can be converted into raster inside the GIS. Although this method is labor intensive, it is so far the most reliable and simple to use.

2. Scanning. This uses scanners much like a photocopier. Maps are scanned in raster format. Scanners can be video or electromechanical. Both methods are expensive and with current technology, it is still not reliable.

3. On-screen digitizing. This method is embedded within GIS typically under the function of cut and paste or draw. Polygons, lines and point can be

drawn onscreen but this method requires a digital base map.

Data processing in GIS

Once spatial data are imported into GIS, some processing are required before analysis can be undertaken. For maps, the vector format is usually transformed into polygons and color-coded. Each polygon will assign some description based on the assigned attribute (e.g., polygon 1 is ricefield). For point data, some can be interpolated, especially numerical point data such as salinity, temperature and rainfall. Several interpolation methods are used such as the triangulated irregular network (TIN), Thiessen's polygon and moving average.