#151

Geographic Information System for Coastal Area Management and Planning Project

February 1994
ICLARM-IDRC-
NEDA Region I

ICLARM

IDRC
Canada

Report on the Training Courses Under the GISCAMP Project

GISCAMP Project 1994
ICLARM-IDRC-NEDA Region I

Introduction

Capability building in the use of geographic information systems (GIS) is one of the major objectives of the GISCAMP Project. This was achieved through training of NRO project staff and from other government agencies in Region I. Training was conducted in two phases. The first phase (Task 110) was conducted during the early stage of project implementation, mainly to training NRO project staff both in the operation of the GIS software called SPANS and applying GIS in resource allocation and management. Training was conducted on a sustained basis throughout the first year of implementation. The second phase (Task 120) was similar to the first phase but the schedule was compressed into one week. This report contains the summary of the two phase training courses conducted by the project.

First Phase

The first phase involved the training of NRO project staff (Task 110). It was basically an in-house program aimed at introducing the principles of GIS and hands-on operation of the GIS software called SPANS. Part of the training was conducted at ICLARM on February 26 to March 13, 1992 and attended by three NRO staff namely: Jonathan Guiang, Nestor Rillon and Agnes Grace Cargamento. Training topics covered overview and principles of remote sensing and GIS, functionalities and operation of SPANS GIS (version 5.22). Case studies on the application of GIS using SPANS on mangrove, aquaculture and settlements were included. Training was conducted by the System Analyst under the supervision of the Project Manager.

In mid-March 1992, training was conducted on site following the transfer of equipment and software which arrived in January 1992. Datasets used in the training included existing and newly acquired data. This way, the project was able to undertake two activities at the same time, that is, training and building the project databank. Training at NRO included other staff, particularly the subject specialists (e.g., sectoral representatives from NRO). It focused on lectures rather than hands-on.

Additional training in the form of lectures was provided by the consultant, Dr. Kam Suan Pheng during her visit in 28 February to 5 March 1993 and again in 27 June to 3 July 1993. Thereafter, intermittent meetings were conducted on site and at ICLARM but the focus was on data acquisition and processing. Data processing involved analysis and processing prior to importation into GIS. These meetings were undertaken in conjunction with the application studies under Task 220.

Recommendations

GIS applications are often multidisciplinary and require the inputs of subject specialists. Under the present setup at NRO, there is a need for close working rapport between the GIS operator and the subject specialist on a continuous basis. As the consultant, Dr. Kam Suan Pheng (1993[1]) noted, this will "enable them to appreciate why certain data are required, and in what format, so that they can assist more fruitfully in data acquisition." Although this statement speaks more of the project, it is nevertheless true for the sustained use of GIS within NRO. She recommended that "staff members who have the interest, aptitude, or whose work would benefit from GIS expertise, should be sent for courses on GIS within or outside of the country."

Overall, sustained utilization of GIS at NRO will require formal training for staff; funding allocation (i.e., for software subscription and updates, hardware maintenance, and data acquisition and processing); and interdivisional support (Paw and Cargamento 1993[2]).

Second Phase

The second phase dealt with the training of staff from other agencies, especially those involved in resource management and planning. This training was conducted on 19-24 January 1994 in San Fernando, La Union. The course was known as the Training Course on the use of GIS for Regional Planning in the Coastal Zone.

Objectives of the training course

The following were the training objectives:

1. to demonstrate the use of GIS as an integrative tool for coastal area management and planning;

2. to train regional planners and managers in the use of GIS; and

---

1 Kam Suan Pheng. 1993. Final report of the consultant for the GISCAMP Project.

2 Paw, J.N. and A.G.A Cargamento. 1993. Geographic information systems for coastal zone management in Lingayen Gulf, Philippines: relevance and constraints. Paper presented at the Environmental Management Conference for Enclosed Coastal Seas'93, Baltimore, Maryland, U.S.A., 13-15 November 1993.

3. to training regional planners and managers in data acquisition and processing relevant to GIS operation.

Participants

The training course was originally planned for agencies within Region I. Two agencies outside of Region I, however, requested to participate. These were the Southeast Asian Fisheries Development Center in Tigbauan, Iloilo (1 participant) and NEDA Central based in Metro Manila (2 participants). Total participants were twelve (Annex I).

Summary of the training course

The training course was conducted initially at the Miramonte Hotel in Poro Point, La Union (19 January 1994). The first day consisted of lectures on principles of GIS, data acquisition and processing including the various functions of SPANS GIS. The succeeding training schedules (20-23 January 1994) were conducted at the Regional Educational Learning Center about a kilometer from Miramonte Resort. The course timetable is in Annex (II).

Review and hands-on on SPANS GIS were programmed for the second day. Participants were taught how to digitize, import vector files and process then into map files. The trainees were grouped into four and each group was given a topic to undertake as a case study using GIS. The case studies were land suitability for cacao, land suitability for cotton, land suitability for coffee and site selection for artificial reefs. Although the original emphasis was on coastal area management and planning, the case studies (except for one) dealt with the terrestrial component largely because of the technical background of the trainees given the tight training schedule (less than a week). Only one participant (from SEAFDEC) has experience in coastal environment research. Each group was given a dataset consisting of vector files of the various map layers required in the overlay process. References were provided to the group wherein suitability criteria were defined. The trainees processed the vector files into maps, linked attributed information to maps and did overlay using the criteria required by their case studies. The project staff supervised the trainees throughout the preparation of their case studies. Some project staff were also assigned as technical advisors who advised the trainees in designing the GIS procedure for their case studies.

On the fourth day, the local distributor of SPANS (Project Consultants Group, Inc. or PCG) in the Philippines gave a presentation on new developments for SPANS as well as on their corporate GIS activities. The PCG lent two sets of SPANS GIS to the project which were used during the training. The last day was

the presentation of case studies. Each group presented their case study but the discussion was slanted towards the GIS procedure. The trainees' reports are in Annex III. Closing ceremony was conducted immediately after the presentation and a certificate of training was given to each participant (Annex IV).

Overall, the trainees were able to use GIS to a satisfactory level given their technical background. Their working knowledge on SPANS was also satisfactory. Due to their varied background, however, full appreciation and understanding of data processing and transformation prior to capture into the GIS were less satisfactory. The trainees are not expected to operate the GIS in their respective agencies even if they have one (currently, only NRO has SPANS GIS in the region) but that they can interact closely with NRO in terms of their GIS requirement as well as providing and/or preparing the materials needed for GIS analysis. The training conducted by the project is envisaged to provide an avenue towards closer collaboration among agencies in the region, especially with NRO in terms of data sharing and technical support and that the trainees would the link in attaining this goal.

Masterlist of Participantss to the Training Course
on the Use of GIS for Regional Planning in the Coastal Zone
Regional Educational Learning Center
San Vicente, San Fernando, La Union
January 19 - 24, 1994

Participants	Agency	Address
Group 1: Site Suitability for Artificial Reef		
Dr. Clarissa L. Marte	Southeast Asian Fisheris Development Center	Tigbauan, Iloilo City, Iloilo
Ms. Lilia RR. Nuesca	National Statistics Office	San Fernando, La Union
Group 2: Site suitability for Cotton		
Ms. Emma Molina	Phil. Human Resource Development Council	Bonuan, Dagupan City, Pangasinan
Ms. Erlinda Manipon	Department of Agriculture	Aguila Rd., San Fernando, La Union
Mr. Wilfredo Soriano	Pangasinan State University	Lingayen, Pangasinan
Group 3: Site suitability for Coffee		
Engr. Emil Ganaden	Dept. of Public Works & Highways	Aguila Road, San Fernando, La Union
Mr. Darius Cargamento	Provincial Planning & Development Office	San Fernando, La Union
Ms. Irma Devadeb	NEDA Region I	Guerrero Rd, San Fernando, La Union
Ms. Carolyn Mulato	NEDA Region I	Guerrero Rd, San Fernando, La Union
Group 4: Site suitability for Cacao		
Mr. Isidro Teleron	Management Information System Staff	NEDA sa Pasig, Metro Manila
Mr. Dennis del Rosario	Regional Development & Coordination Staff	NEDA sa Pasig, Metro MAnila
Mr. Roel Añonuevo	Provincial Planning & Development Office	Lingayen, Pangasinan
Ms. Joy Marie Tiongson	NEDA Region I	Guerrero Rd, San Fernando, La Union

Training Course on the Use of Geographic Information System for Regional Planning in the Coastal Zone
Regional Educational Learning Center
San Vicente, San Fernando, La Union
19 - 24 January 1994

19 January 1994 (Wednesday)

8:30 - 9:00	Registration
9:00 - 10:00	Introduction to Geographic Information Systems (Agnes Cargamento, James Paw)
10:00 - 10:30	Break
10:30 - 11:00	Data Acquisition and processing (James Paw)
11:00 - 12:00	SPANS GIS: File/Edit/Visualize (Zoraida Alojado)
12:00 - 1:30	Lunch break
1:30 - 3:00	SPANS GIS: Transform/Query/Analyze/Model (Zoraida Alojado)
3:00 - 3:30	Break
3:30 - 5:00	SPANS GIS: Model/Case Study (4 groups) (Zoraida Alojado)

20 January 1994 (Thursday)

10:00 - 12:00	Review of SPANS GIS with hands - on (Zoraida Alojado)
12:00 - 1:30	Lunch Break
1:30 - 5:00	TYDIG with hands - on (Alexis Fabunan, Jonathan Guiang)

21 January 1994 (Friday)

9:00 - 12:00	Hands - on/Case Study Site suitability for a. Cotton (Nestor Rillon) b. Cacao (Konifacio Casuga) c. Coffee (Josefino Tadifa) d. Artificial reef (Fe Domingo)
12:00 - 1:30	Lunch Break
1:30 - 5:00	Continuation of case study

22 January 1994 (Saturday)

9:00 - 10:30	SPANS GIS - the software (Gerry Gabuya)
10:30 - 12:00	Continuation of case study
12:00 - 1:30	Lunch Break
1:30 - 5:00	Continuation of case study

23 January 1994 (Sunday)

9:00 - 10:00	Group 1: Suitable sites for Artificial Reefs
10:00 - 11:00	Group 2: Suitable sites for Cotton
11:00 - 12:00	Group 3: Suitable sites for Coffee
12:00 - 1:30	Lunch Break
1:30 - 2:30	Group 4: Suitable sites for Cacao
2:30 - 3:00	Closing

Group 1 Potential sites for artificial reefs in Lingayen Gulf

Group Members: Lilia Nuesca - NSO, Region 1
Clarissa L. Marte - SEAFDEC

I. Introduction

Lingayen Gulf is a semicircular embayment located on the northwestern coast of Luzon. It is bounded on the southwest by Pangasinan province and on the northeast by La Union. The gulf encloses an area of approximately 2,100 km^2 and 160 km of coastline from Cape Bolinao to Poro Point (McManus et.al., 1990).

Lingayen Gulf is a major area for capture fisheries, aquaculture and coastal tourism in northwestern Luzon (McManus et.al., 1990). As such like other coastal areas in the Philippines, Lingayen Gulf is besieged with complex problems. Municipal fisherman resort to the use of explosives and other destructive fishing methods to increase their catch which has resulted in habitat degradation and diminishing fish stocks. Considering the use of the Gulf as the main income source of the coastal inhabitants, the government is challenged to plan and initiate programs and projects geared toward the conservation of marine resources.

Deployment of artificial reefs is an approach used to rehabilitate and conserve marine environments. These are structures that serve as shelter, habitat, feeding and breeding areas of fish and other marine organisms. These are also used for shoreline protection in areas exposed to strong waves. They are also used to prevent trawling in some areas.

This case study focuses on the suitable sites for artificial reefs in Lingayen Gulf. An attempt was made to identify the possible sites and compare these with existing artificial sites and those proposed by the Philippine Navy.

II. Objectives

The case study aims to identify suitable areas for siting artificial reefs in Lingayen Gulf by applying the methods of Geographic Information System (GIS).

III. Methodology

A. Site selection criteria used for establishing artificial reefs based on White et. al., 1990 are:

1 over 1 km away from natural reefs
2 constructed on a barren area of flat or gently sloping bottom of relatively good visibility
3. near an alternative food source (i.e. seagrass beds)
4. at depths of 15 to 25 km., protected from wave action and accessible to local fisherman

Additional criteria considered in selecting sites for this study area:

1. stable bottom substrate (e.g., rock, sand)
2. absence of blastfishing activities

B. Materials and information available:

1. Thematic maps of Lingayen Gulf
   a. Bathymetric map
   b. habitat map giving locations of marine habitats
   c. location of blastfishing areas

2. Analyzed maps
   a. 1 km buffer zone around coral reefs
   b. 6 km buffer zone near river mouth
   c. 3 km navigation area along the coast
   d. 7 and 15 km zones in the gulf

C. Activities undertaken

1. Maps with the required information were visualized and labels were attached to corresponding items in each map
2. Analysis of the available maps was done by:
   a. reclassifying classes or groups in the following maps:
      1. bathymetric map - reduced categories from 14 to 3 by reclassifying the first six categories to three and excluding the rest of the classes (model/ reclassification/make template). A new map was generated to show the reclassified areas (model/ reclassification/build map/ interactively)
      2. habitat map - reduced groups from nine to four following the procedure above.

   b. merging information in two or three maps using the model/overlay/stamp function
      1. reclassified habitat map and reclassified

bathymetric map (bodepth.map)

2. two-step merging of reclassified bathymetric map, coral buffer and river mouth buffer maps (test.map)

c. merging information in two maps using the model/overlay/matrix function to delimit areas with characteristics found in criteria used for site selection (715km.map overlain with bodepth.map)

d. merging information in several maps and giving appropriate weights to each map and ranks to classes within each map using site selection criteria as guide (model/overlay/index). the following maps were indexed: test.map, navig.map, 7hab.map, blastfis.map

From four indexed groups, two groups with the highest index categories were selected (model/ reclassify). These were classed as 1 - good site and 2- fair site for artificial reefs.

e. point data from previous tables were used to identify:
   1. municipalities along the Lingayen Coast;
   2. existing artificial reef sites;
   3. sites proposed by the Philippine Navy; and
   4. municipalities relying mainly on fishing (based on number of fisherman)

Using the query function of SPANS, characteristics of areas with existing ARs was retrieved and compared with those of sites selected in this case study.

IV. Results

The suitable sites selected using the methods of GIS have the following characteristics:

Good sites: 7-10 fathoms; firm to muddy bottom; within 3 km from the shoreline; outside blastfishing area; outside the buffer zones of existing coral reefs and river mouths

Fair sites: within 10-20 fathoms; firm-muddy bottom; within 7 km from shoreline; outside blastfishing area; outside the buffer zones of existing coral reefs and river mouths.

Good sites for artificial reefs are close to the municipalities of San Fernando, Caba, Santo Tomas, and Rosario in La Union and Dagupan, Labrador, Sual, Alaminos, Anda and Bolinao in Pangasinan. Fair sites are close to the municipalities of Binmaley, Lingayen, and Labrador in Pangasinan.

Based on the present GIS analysis, of the 17 existing artificial reef sites, three were located in good sites and two are located in fair sites while two of three proposed sites for AR deployment are in good sites located near San Fernando, La Union. Artificial reefs located in sites not suitable based on the

present criteria set are located in areas at buffer zones of river mouth (6/17), buffer zones for coral reefs (2/17), blastfishing areas (2/17) and at depths above seven fathoms (3/17).

```
:Indexing Overlay Input File
:-------------------------------------------------
:new mapid & title: arsite    Artificial reef site
:-------------------------------------------------
:no of input maps : 4
: Input Maps (Id Max Color)
: test1    5    blastfis    1    7hab    2    navig    1
:
: Format = Weight  Map ID    Title
:-------------------------------------------------

:-------------------------------------------------
:35.000   test1 : Bathy, river buff, coral buff
:-------------------------------------------------
:                 - 0:    0
:<1-7             - 1:    -1
:7-10             - 2:    5
:10-20            - 3:    3
:corbuff          - 4:    -1
:rivmouth         - 5:    -1
:-------------------------------------------------
:10.000   blastfis:
:-------------------------------------------------
:                 - 0:    0
:                 - 1:    -1
:-------------------------------------------------
:25.000   7hab : Coastal Habitats within 7 km
:-------------------------------------------------
:                 - 0:    0
:firmbot          - 1:    5
:muddy            - 2:    2
:-------------------------------------------------
:30.000   navig : Navigational Map of Lingayen Gulf
:-------------------------------------------------
:                 - 0:    0
:                 - 1:    5
:=================================================
```

Bathymet.rcl

```
:-------------------------------------------------
:bathymet      - Bathymetric Map
:-------------------------------------------------
:              :     0     0
:< 1           :     1     1
:1             :     2     1
:5             :     3     1
:7             :     4     2
:10            :     5     2
:20            :     6     3
:40            :     7     0
:60            :     8     0
:80            :     9     0
:100           :     10    0
:150           :     11    0
:200           :     12    0
:250           :     13    0
:300           :     14    0
```

Bohab.rcl

```
:-------------------------------------------------
:bohab         - Bohab
:-------------------------------------------------
:              :     0     0
:              :     1     0
:              :     2     1
:              :     3     2
:              :     4     0
:              :     5     3
:              :     6     0
:              :     7     4
:              :     8     0
:              :     9     0
:              :     10    0
:              :     11    0
:              :     12    0
:              :     13    0
:              :     14    0
:              :     15    0
:              :     16    0
:              :     17    0
```

TITLE OF THE STUDY: SUITABLE AREAS FOR CACAO PRODUCTION

Location: Pangasinan and La Union

I. Objective:

To determine areas suitable for cacao production in the provinces of Pangasinan and La Union.

II. Data needs and information

a. Base map
b. Municipal map
c. Land use map
d. Soil map
e. Slope map
f. Flood-prone map
g. Physigraphic map

Criteria setting

Land use - 45%
Soil suitability - 25%
Physiography - 15%
Slope - 10%
Flood prone areas - 5%

III. Methodology

1. Flowchart (refer to attached sheet)

2. Analyses

Based on the Annual Regional Development Report of CY 1993, cacao production in Region I is minimal. It is grown in small isolated areas primarily for family consumption. The Department of Agriculture recommends production of cacao in a wider scale because of its potential as source of fuel (oil) and raw material for chocolates.

The above set of criteria was selected and the SPANS GIS function called indexing (weighted map overlay) was used to determine areas suitable for cacao production. Land use criterion was given a greater weight (45%) due to its significance in the existing land utilization such as a) built-up areas, irrigated ricefields, fishponds and forest; b) its consistency with the municipal zoning ordinance. In terms of soil types, cacao is best grown in areas with alluvial and deep well-drained soils.

Cacao can be grown in areas with physiographic characteristics of alluvial plains, minor alluvial plains and hilly landforms with slopes ranging from 0-18%. For commercial purposes, it should be best planted in areas with slope of 8-18% considering that slope of 0-3% are susceptible to land conversion for settlements as well as flooding. Unfortunately, the slope map did not have slope of 18%. Hence, the cut off interval was 25% so

that part of the lands between 18-25% were included. Ideally, however, areas with slope above 18% are considered public lands.

Rainfall was not included as a criterion although relevant factor in planting of the seedlings. It is recommended that perennial crop such as cacao should be planted at the start of the wet season to provide the necessary moisture at the early stages of crop propagation.

Using the above criteria for the two provinces, four suitability classifications were derived:

a. Highly suitable areas. This refers to areas that are 70-90% dominant grasslands with hilly landforms as well as areas planted with coconut due to shade requirement of the crop during the early stages of propagation.

b. Moderately suitable areas. This refers to marginal areas with standing crop (i.e., corn, sugar cane, cassava, ipil-ipil, etc.) which are located in minor alluvial plains. This also include those areas that are newly cleared (kaingin), but should be subjected to fallowing to reduce soil acidity.

c. Suitable areas. This refers to conditional areas (e.g., paddy rice, built-up areas, vegetable, banana) and brushland.

d. Not suitable areas. This refers to areas that do not qualify with the set criteria. These are fishponds, swamp areas, orchards and forested areas.

3. Findings

Total areas suitable for cacao production in the study area is recorded at 3,490 km^2 or 54% of the total area being considered. However, highly suitable areas represent only 7.64% while moderate and suitable areas were 24.04% and 22.09%, respectively.

Areas that are highly suitable for cacao are mostly found in Pangasinan which accounted for about 44 km^2. These are in Dasol, Sual and Burgos with 88, 75 and 39 km^2, respectively. On the other hand, La Union accounted only 2.13 km^2 with Rosario registering the highest suitable areas at 0.67 km^2. For moderate and suitable areas, there were about 2,543 for Pangasinan and 451 km^2 for La Union.

The current cacao production areas are minimal. Due to non-assurance of the marketability of the produce, most farmers are reluctant to venture into commercial cacao production.

IV. Recommendations

a. Actual field validation should be conducted to support the derived suitability classification.

b. A feasibility study on cacao production should also be conducted to determine its viability and profitability.

Case Study: Areas Suitable for Coffee in La Union and Pangasinan

Group Members:	Engr. Emil Ganaden	-	DPWH
	Engr. Darius Leo A. Cargamento	-	PPDO - La Union
	Ms. Irma C. Devadeb	-	NEDA - I
	Ms. Carolyn E. Mulato	-	NEDA - I
	Mr. Josefino B. Tafida	-	NEDA - I(Facilitator)

I. Objective

The study aims to determine the areas suitable for coffee in the southern provinces of Region I, namely, La Union and Pangasinan. The areas to be identified will be up to the municipal level.

II. Methodology/Flow of Activity

Five maps were identified by the group, (slope, soil classification, erosion, existing land use and flooding map) which could be needed for the case study. These were based on the result of the group discussion and the suggestion of Mr. James Paw on the ecologic suitability for coffee as follows:

slope	-	between 0 - 25%
soil texture	-	loamy, silty loam, silty clay loam
erosion	-	no to moderate erosion
land use	-	grassland, shrubs, coffee
flooding	-	no to moderate flooding

The maps were then weighed according to their level of importance, the result of which are as follows:

	CRITERIA DATA	RANK	WEIGHT
1.	soil texture	1	35%
2.	land use	2	20%
3.	erosion	3	15%
4.	slope	3	15%
5.	flooding	3	15%

With the different weights given to the various criteria data, the study group made use of index overlay.

Maps were reclassified to conform with the ecological suitability criteria for coffee except for flooding and landuse map. These were then overlaid through the use of indexing. An index template was edited using the weight and score per map and map class based on ecological suitability criteria for coffee. A maps showing suitable area for coffee was generated.

As a result of the indexing method, 11 classes were identified. The group agreed to reclass these making classes 7 to 9 as the most suitable, classes 3 to 6 as suitable and classes -1 to 2 as not suitable. A final map was established.

To determine the specific municipalities where the areas most suitable to coffee are located, cross-tabulation of the final map with the municipal map of Pangasinan and La Union was made.

III. Data Analysis

To come up with an analysis of the data, the group uses cross tabulation area analysis of the final map and various maps used.

Of the total study area (6,475.39 km^2), 118.75 km^2 or 1.83% is considered the most suitable for coffee while 1,585.01 km^2 or 24.48% is suitable and the rest as not suitable.

Compared with the existing landuse, most suitable area for coffee are found in grassland area, 74.55%, and 23.64% are found in shrub area. Suitable areas on the other hand are also found in grassland area, 58.3% and in shrub area, 41.68%.

Of the total area of Pangasinan, 5,040.77 km^2, 108.30 km^2 or 2.15% was found to be most suitable for coffee while 1,166.99 km^2 or 23.15% were suitable. Municipalities were most suitable area can be found are in Agno, 17.22 km^2, Mabini, 14.05 km^2, Dasol, 23.79 km^2, Bugallon, 4.82 km^2, Aguilar, 6.66 km^2, Mangatarem, 13.53 km^2, Malasiqui, 5.43 km^2, and Villasis, 5.13 km^2

In La Union, 0.73% or 10.46 km^2 are found to be most suitable and 29.10% or 415.24 km^2 are suitable. Most suitable areas are usually found in the municipalities of Luna, 1.44 km^2, Balaoan, 1.44 km^2, Bacnotan, 2.26 km^2, San Juan 2.87 km^2, and Tubao, 1.03 km^2.

IV. Results of the Study

Municipalities found to be most suitable for coffee in Pangasinan and La Union with their corresponding ranks and areas are the following:

Pangasinan	1.	Dasol	-	23.79 km^2
	2.	Agno	-	17.22
	3.	Mabini	-	14.05
	4.	Mangatarem	-	13.53
	5.	Sual	-	7.83
La Union	1.	San Juan	-	2.87 km^2
	2.	Bacnotan	-	2.26
	3.	Balaoan	-	1.44
	4.	Luna	-	1.44
	5.	Tubao	-	1.03

Municipalities found to be suitable for coffee in Pangasinan and La Union

with their corresponding ranks and areas are:

Pangasinan	1.	Bolinao	-	122.62 km^2
	2.	Dasol	-	104.51
	3.	Bani	-	101.60
	4.	Sual	-	84.23
	5.	Mabini	-	79.86
La Union	1.	San Gabriel	-	83.65 km^2
	2.	Bagulin	-	56.18
	3.	San Fernando	-	27.16
	4.	Burgos	-	26.26
	5.	Bacnotan	-	24.91

V. Conclusion

The required output could further be analyzed to come up with potential areas for coffee considering the settlement areas, road networks and population density.

CRITERIA AND THEIR CORRESPONDING RANK AND WEIGHT DISTRIBUTION

RANK	CRITERIA	WEIGHT (%)	SCORE
1	Soil texture	35	
	- loam		10
	- silty loam		9
	- silty clay loam		8
	- riverwash		3
2	Landuse	20	
	- grasslands		7
	- shrubs		10
	- coffee		10
	- vegetable terrace		7
	- all other landuses		-1
3	Slope	15	
	- 0 - 3%		2
	- 3 - 18%		3
	- 8 - 15%		10
	- 15 - 25%		8
4	Erosion	15	
	- none		10
	- none to slight		9
	- slight		8
	- moderate		7
5	Flood	15	
	- moderate		4
	- severe		-1
	- very severe		-1

DISTRIBUTION OF SUITABLE AREAS FOR COFFEE ACROSS LANDUSES OF PANGASINAN AND LA UNION

Total %
Row %
Col %

Landuse	Most Suitable	Suitable	Not Suitable	Total
Forest with associated landuses	0.00	0.00	523.62	523.62
	0.00	0.00	8.09	8.09
	0.00	0.00	100.00	
	0.00	0.00	10.97	
Grassland (90% dominant	0.92	104.46	182.81	288.19
	0.01	1.61	2.82	4.45
	0.32	36.25	63.43	
	0.78	6.59	3.83	
Paddy rice irrigated	0.00	0.00	2,404.79	2,404.79
	0.00	0.00	37.14	37.14
	0.00	0.00	100.00	
	0.00	0.00	50.40	
Grassland (70% dominant	87.60	819.64	657.03	1,564.27
	1.35	12.66	10.15	24.16
	5.60	52.40	42.00	
	73.77	51.71	13.77	
Shrubs	28.08	660.61	127.59	816.28
	0.43	10.20	1.97	12.61
	3.44	80.93	15.63	
	23.64	41.68	2.67	
Coconut	0.00	0.00	128.58	128.58
	0.00	0.00	1.99	1.99
	0.00	0.00	100.00	
	0.00	0.00	2.69	
Built-up	0.00	0.00	330.68	330.68
	0.00	0.00	5.11	5.11
	0.00	0.00	100.00	
	0.00	0.00	6.93	
Coffee	2.15	0.31	0.00	2.46
	0.03	0.00	0.00	0.04
	87.50	12.50	0.00	
	1.81	0.02	0.00	

Landuse	Most Suitable	Suitable	Not Suitable	Total
Cassava	0.00	0.00	10.56	10.56
	0.00	0.00	0.16	0.16
	0.00	0.00	100.00	
	0.00	0.00	0.22	
Sugarcane	0.00	0.00	45.11	45.11
	0.00	0.00	0.70	0.70
	0.00	0.00	100.00	
	0.00	0.00	0.95	
Corn (>70% dominant)	0.00	0.00	17.53	17.53
	0.00	0.00	0.27	0.27
	0.00	0.00	100.00	
	0.00	0.00	0.37	
Fishpond	0.00	0.00	141.32	141.23
	0.00	0.00	2.18	2.18
	0.00	0.00	100.00	
	0.00	0.00	2.96	
Bamboo	0.00	0.00	0.92	0.92
	0.00	0.00	0.01	0.01
	0.00	0.00	100.00	
	0.00	0.00	0.02	
Upland rice	0.00	0.00	6.66	6.66
	0.00	0.00	0.10	0.10
	0.00	0.00	100.00	
	0.00	0.00	0.14	
Saltbed	0.00	0.00	7.07	7.07
	0.00	0.00	0.11	0.11
	0.00	0.00	100.00	
	0.00	0.00	0.15	
Beachsand	0.00	0.00	7.09	7.09
	0.00	0.00	0.11	0.11
	0.00	0.00	100.00	
	0.00	0.00	0.15	
Ipil-ipil	0.00	0.00	1.19	1.19
	0.00	0.00	0.02	0.02
	0.00	0.00	100.00	
	0.00	0.00	0.02	
Riverwash	0.00	0.00	18.77	18.77
	0.00	0.00	0.29	0.29
	0.00	0.00	100.00	
	0.00	0.00	0.39	

Landuse	Most Suitable	Suitable	Not Suitable	Total
Grapes	0.00	0.00	1.23	1.23
	0.00	0.00	0.02	0.02
	0.00	0.00	100.00	
	0.00	0.00	0.03	
Mango	0.00	0.00	4.92	4.92
	0.00	0.00	0.08	0.08
	0.00	0.00	100.00	
	0.00	0.00	0.10	
Maguey	0.00	0.00	3.49	3.49
	0.00	0.00	0.05	0.05
	0.00	0.00	100.00	
	0.00	0.00	0.07	
Swamp	0.00	0.00	18.08	18.08
	0.00	0.00	0.28	0.28
	0.00	0.00	100.00	
	0.00	0.00	0.38	
Kaingin	0.00	0.00	0.47	0.47
	0.00	0.00	0.01	0.01
	0.00	0.00	100.00	
	0.00	0.00	0.01	
Vegetable, lowland	0.00	0.00	11.51	11.51
	0.00	0.00	0.18	0.18
	0.00	0.00	100.00	
	0.00	0.00	0.24	
Total	118.75	1,585.01	4,771.63	6,475.39
	1.83	24.48	73.69	

DISTRIBUTION OF SUITABLE AREA FOR COFFEE ACROSS MUNICIPALITIES OF PANGASINAN

Total %
Row %
Col %

MUNICIPALITIES	MOST SUITABLE	SUITABL	NOT SUITABLE	TOTAL
San Fabian	0.00	10.76	63.67	74.43
	0.00	0.21	1.26	1.48
	0.00	14.46	85.54	
	0.00	0.92	1.69	
Mangaldan	0.00	0.00	45.52	45.52
	0.00	0.00	0.90	0.90
	0.00	0.00	100.00	
	0.00	0.00	1.21	
Dagupan	0.00	0.19	49.98	50.17
	0.00	0.00	0.99	1.00
	0.00	0.37	99.63	
	0.00	0.02	1.33	
Calasiao	0.00	0.00	52.90	52.90
	0.00	0.00	1.05	1.05
	0.00	0.00	100.00	
	0.00	0.00	1.40	
Binmaley	0.00	0.00	47.52	47.52
	0.00	0.00	0.94	0.94
	0.00	0.00	100.00	
	0.00	0.00	1.26	
San Carlos	0.00	0.00	178.49	178.49
	0.00	0.00	3.54	3.54
	0.00	0.00	100.00	
	0.00	0.00	4.74	
Lingayen	0.00	0.06	59.15	59.21
	0.00	0.00	1.17	1.17
	0.00	0.10	99.90	
	0.00	0.00	1.57	
Labrador	0.31	41.28	72.36	113.95
	0.01	0.82	1.44	2.26
	0.27	36.23	63.50	
	0.28	3.54	1.92	

MUNICIPALITIES	MOST SUITABLE	SUITABL	NOT SUITABLE	TOTAL
Sual	7.83	84.23	51.95	144.01
	0.16	1.67	1.03	2.86
	5.44	58.49	36.07	
	7.23	7.22	1.38	
Alaminos	3.18	47.93	108.24	159.34
	0.06	0.95	2.15	3.16
	1.99	30.08	67.93	
	2.93	4.11	2.87	
Bani	0.00	101.60	113.86	215.46
	0.00	2.02	2.26	4.27
	0.00	47.15	52.85	
	0.00	8.71	3.02	
Bolinao	0.00	122.62	38.71	161.33
	0.00	2.43	0.77	3.20
	0.00	76.00	24.00	
	0.00	10.51	1.03	
Anda	0.00	24.15	46.91	71.06
	0.00	0.48	0.93	1.41
	0.00	33.99	66.01	
	0.00	2.07	1.25	
Silaqui	0.00	0.00	0.10	0.10
	0.00	0.00	0.00	0.00
	0.00	0.00	100.00	
	0.00	0.00	0.00	
Santiago Island	0.00	6.89	13.14	20.02
	0.00	0.14	0.26	0.40
	0.00	34.40	65.60	
	0.00	0.59	0.35	
Siapar	0.00	1.61	0.15	1.76
	0.00	0.03	0.00	0.03
	0.00	91.27	8.73	
	0.00	0.14	0.00	
Hundred Islands	0.00	0.33	0.27	0.60
	0.00	0.01	0.01	0.01
	0.00	55.32	44.68	
	0.00	0.03	0.01	
Cabalitian Island	0.00	0.00	1.35	1.35
	0.00	0.00	0.03	0.03
	0.00	0.00	100.00	
	0.00	0.00	0.04	

MUNICIPALITIES	MOST SUITABLE	SUITABL	NOT SUITABLE	TOTAL
Agno	17.22	71.60	49.35	138.16
	0.34	1.42	0.98	2.74
	12.46	51.82	35.72	
	15.90	6.14	1.31	
Burgos	0.00	71.74	50.38	122.12
	0.00	1.42	1.00	2.42
	0.00	58.75	41.25	
	0.00	6.15	1.34	
Mabini	14.05	79.86	132.87	226.78
	0.28	1.58	2.64	4.50
	6.19	35.22	58.59	
	12.97	6.84	3.53	
Dasol	23.79	104.51	41.92	170.22
	0.47	2.07	0.83	3.38
	13.97	61.40	24.63	
	21.96	8.96	1.11	
Infanta	0.00	69.27	164.00	233.27
	0.00	1.37	3.25	4.63
	0.00	29.70	70.30	
	0.00	5.94	4.36	
Bugallon	4.82	30.12	118.53	153.48
	0.10	0.60	2.35	3.04
	3.14	19.63	77.23	
	4.45	2.58	3.15	
Aguilar	6.66	37.32	99.98	143.97
	0.13	0.74	1.98	2.86
	4.63	25.92	69.45	
	6.15	3.20	2.66	
Mangatarem	13.53	21.66	248.81	284.00
	0.27	0.43	4.94	5.63
	4.77	7.63	87.61	
	12.50	1.86	6.61	
Urbiztondo	0.00	0.00	53.00	53.00
	0.00	0.00	1.05	1.05
	0.00	0.00	100.00	
	0.00	0.00	1.41	
Basista	0.00	0.00	29.94	29.94
	0.00	0.00	0.59	0.59
	0.00	0.00	100.00	
	0.00	0.00	0.80	

MUNICIPALITIES	MOST SUITABLE	SUITABL	NOT SUITABLE	TOTAL
Malasiqui	5.43	20.40	94.32	120.16
	0.11	0.40	1.87	2.38
	4.52	16.98	78.50	
	5.02	1.75	2.50	
Santa Barbara	0.00	0.10	68.89	69.00
	0.00	0.00	1.37	1.37
	0.00	0.15	99.85	
	0.00	0.01	1.83	
Mapandan	0.00	0.00	21.73	21.73
	0.00	0.00	0.43	0.43
	0.00	0.00	100.00	
	0.00	0.00	0.58	
San Jacinto	0.00	7.48	23.38	30.86
	0.00	0.15	0.46	0.61
	0.00	24.25	75.75	
	0.00	0.64	0.62	
Manaoag	2.46	6.56	36.50	45.52
	0.05	0.13	0.72	0.90
	5.41	14.41	80.18	
	2.27	0.56	0.97	
Laoac	0.00	0.00	31.78	31.78
	0.00	0.00	0.63	0.63
	0.00	0.00	100.00	
	0.00	0.00	0.84	
Pozzorubio	0.10	14.05	65.31	79.45
	0.00	0.28	1.30	1.58
	0.13	17.68	82.19	
	0.09	1.20	1.73	
Sison	0.00	18.63	92.28	110.91
	0.00	0.37	1.83	2.20
	0.00	16.79	83.21	
	0.00	1.60	2.45	
Binalonan	0.00	1.95	63.15	65.10
	0.00	0.04	1.25	1.29
	0.00	2.99	97.01	
	0.00	0.17	1.68	
Urdaneta	0.31	3.28	123.74	127.33
	0.01	0.07	2.45	2.53
	0.24	2.58	97.18	
	0.28	0.28	3.29	

MUNICIPALITIES	MOST SUITABLE	SUITABL	NOT SUITABLE	TOTAL
Asingan	1.44	0.00	74.33	75.76
	0.03	0.00	1.47	1.50
	1.89	0.00	98.11	
	1.33	0.00	1.97	
San Manuel	1.33	12.30	100.47	114.11
	0.03	0.24	1.99	2.26
	1.17	10.78	88.05	
	1.23	1.05	2.67	
San Nicolas	0.00	17.72	194.30	212.03
	0.00	0.35	3.85	4.21
	0.00	8.36	91.64	
	0.00	1.52	5.16	
Tayug	0.00	0.00	43.57	43.57
	0.00	0.00	0.86	0.86
	0.00	0.00	100.00	
	0.00	0.00	1.16	
Natividad	0.00	9.74	76.03	85.77
	0.00	0.19	1.51	1.70
	0.00	11.36	88.64	
	0.00	0.83	2.02	
San Quintin	0.10	15.99	96.55	112.65
	0.00	0.32	1.92	2.23
	0.09	14.20	85.71	
	0.09	1.37	2.56	
Santa Maria	0.00	0.00	48.70	48.70
	0.00	0.00	0.97	0.97
	0.00	0.00	100.00	
	0.00	0.00	1.29	
Umingan	0.00	65.47	192.34	257.81
	0.00	1.30	3.82	5.11
	0.00	25.39	74.61	
	0.00	5.61	5.11	
Balungao	0.00	22.86	52.87	75.73
	0.00	0.45	1.05	1.50
	0.00	30.19	69.81	
	0.00	1.96	1.40	
Rosales	0.00	9.28	55.08	64.36
	0.00	0.18	1.09	1.28
	0.00	14.42	85.58	
	0.00	0.80	1.46	

MUNICIPALITIES	MOST SUITABLE	SUITABL	NOT SUITABLE	TOTAL
Villasis	5.13	8.61	65.10	78.84
	0.10	0.17	1.29	1.56
	6.50	10.92	82.57	
	4.73	0.74	1.73	
Santo Tomas	0.00	0.00	13.01	13.01
	0.00	0.00	0.26	0.26
	0.00	0.00	100.00	
	0.00	0.00	0.35	
Alcala	0.00	0.00	44.51	44.51
	0.00	0.00	0.88	0.88
	0.00	0.00	100.00	
	0.00	0.00	1.18	
Bautista	0.00	0.00	66.95	66.95
	0.00	0.00	1.33	1.33
	0.00	0.00	100.00	
	0.00	0.00	1.78	
Bayambang	0.62	4.82	87.54	92.97
	0.01	0.10	1.74	1.84
	0.66	5.18	94.16	
	0.57	0.41	2.32	
Total	108.30	1,166.99	3,765.49	5,040.77
	2.15	23.15	74.70	

DISTRIBUTION OF SUITABLE AREAS FOR COFFEE ACROSS MUNICIPALITIES OF LA UNION

Total %
Row %
Col %

MUNICIPALITIES	MOST SUITABLE	SUITABLE	NOT SUITABLE	TOTAL
Bangar	0.21	2.26	38.26	40.72
	0.01	0.16	2.68	2.85
	0.50	5.54	93.96	
	1.96	0.54	3.82	
Luna	1.44	4.71	33.93	40.08
	0.10	0.33	2.38	2.81
	3.58	11.75	84.67	
	13.73	1.13	3.39	
Balaoan	1.44	14.96	52.74	69.14
	0.10	1.05	3.70	4.85
	2.08	21.64	76.28	
	13.73	3.60	5.27	
San Juan	2.87	13.94	43.53	60.35
	0.20	0.98	3.05	4.23
	4.76	23.10	72.14	
	27.45	3.36	4.35	
San Fernando	0.00	27.16	71.27	98.42
	0.00	1.90	4.99	6.90
	0.00	27.59	72.41	
	0.00	6.54	7.12	
Bauang	0.00	15.99	59.57	75.57
	0.00	1.12	4.17	5.30
	0.00	21.17	78.83	
	0.00	3.85	5.95	
Caba	0.00	10.25	38.74	48.99
	0.00	0.72	2.71	3.43
	0.00	20.93	79.07	
	0.00	2.47	3.87	
Aringay	0.51	21.85	75.84	98.20
	0.04	1.53	5.31	6.88
	0.52	22.25	77.23	
	4.90	5.26	7.57	
Agoo	0.00	11.69	27.21	38.90
	0.00	0.82	1.91	2.73
	0.00	30.04	69.96	
	0.00	2.81	2.72	

MUNICIPALITIES	MOST SUITABLE	SUITABLE	NOT SUITABLE	TOTAL
Santo Tomas	0.00	15.28	45.79	61.06
	0.00	1.07	3.21	4.28
	0.00	25.02	74.98	
	0.00	3.68	4.57	
Rosario	0.00	16.10	51.80	67.90
	0.00	1.13	3.63	4.76
	0.00	23.71	76.29	
	0.00	3.88	5.17	
Pugo	0.00	16.13	27.18	43.32
	0.00	1.13	1.90	3.04
	0.00	37.25	62.75	
	0.00	3.89	2.71	
Tubao	1.03	10.97	44.60	56.59
	0.07	0.77	3.13	3.97
	1.81	19.38	78.80	
	9.80	2.64	4.45	
Naguilian	0.72	17.94	76.07	94.73
	0.05	1.26	5.33	6.64
	0.76	18.94	80.30	
	6.86	4.32	7.60	
Burgos	0.00	26.26	35.28	61.54
	0.00	1.84	2.47	4.31
	0.00	42.67	57.33	
	0.00	6.32	3.52	
Bagulin	0.00	56.18	15.28	71.46
	0.00	3.94	1.07	5.01
	0.00	78.62	21.38	
	0.00	13.53	1.53	
San Gabriel	0.00	83.65	70.99	154.64
	0.00	5.86	4.97	10.84
	0.00	54.09	45.91	
	0.00	20.14	7.09	
Santol	0.00	15.58	96.68	112.27
	0.00	1.09	6.78	7.87
	0.00	13.88	86.12	
	0.00	3.75	9.66	
Sudipen	0.00	9.43	58.51	67.95
	0.00	0.66	4.10	4.76
	0.00	13.88	86.12	
	0.00	2.27	5.84	
Total	10.46	415.24	1,001.26	1,426.96
	0.73	29.10	70.17	

LAND SUITABILITY STUDY FOR COTTON

OBJECTIVE

To identify suitable areas for cotton in the provinces of Pangasinan and La Union through the use of geographic information systems (GIS).

DATA AND INFORMATION NEEDS

1. Pangasinan-La Union base map
2. Municipal boundary maps for Pangasinan and La Union
3. Soil map
4. Land use map
5. Physiography map
6. Slope map
7. Flood-prone areas map
8. Average monthly rainfall map

METHODOLOGY

(See flowchart)

RESULTS/ANALYSIS

As a result of the reclassification, majority of the areas which did not qualify under the criteria set were excluded. This gave a total of 310.18 km^2 considered for the study area.

Based from the overlayed maps, the total area suitable for cotton production is 307,93 km^2 or only about 47% of the total land area of the two provinces. Of the total suitable areas, 2.59% (7.97 km^2) falls under the most suitable category, 73.71% (226.99 km^2) under suitable and 23.68% (72.97 km^2) under moderately suitable.

Area cross tabulation analysis with Pangasinan municipalities showed that the most suitable area for cottom is largest in Dasol with 1.84 km^2 (0.04%) followed by Bolinao with 1.02 km^2 (0.02%). Likewise, suitable areas are dominant in Bolinao and Umingan, both with 28.72 km^2 (0.57%). Moderately suitable areas are found largely in Bolinao with 31.17 km^2 (0.62%) and Bani with 23.61 km^2 (0.47%).

In the province of La Union, Rosario registered the largest area under most suitable category at 0.61 km^2 (0.04%) of total land area. The municipalities of Pugo, Rosario and Agoo showed large areas suitable for cotton with 1.74 km^2 and 1.33 km^2, respectively. Moderately suitable areas are found mostly in Sto. Tomas at 0.61 km^2 (0.04%).

Result of the area cross tabulation with the land use map showed that areas which are not traditionally planted with cotton but which pass the requirements for cotton production came out as either most suitable or suitable. It further showed that possible conversion may be made under the most suitable and suitable areas categories for shrublands with areal extent of 6.85 km^2 and 60.30 km^2, respectively. The largest land area under the 3rd category (moderately suitable) are grasslands with 70% cover at 36.48 km^2.

From the result of the area analysis with slope, category 1 and 2 are found with 0-3% slope with areal extent of 7.05 km^2 and 132.04 km^2, respectively. For the 3rd category, largest areas (46.95 km^2) are found with 8-15% slope.

RECOMMENDATIONS

The marginal areas of grasslands and shrubs are highly recommended for conversion for cotton production. Given the financial viability of cotton production, this may be recommended in the municipalities of Dasol and Bolinao in Pangasinan and in Rosario, La Union which are not traditionally cotton growers.

Data on rainfall distribution in La Union for cotton suitability should be included to make the result more precise.

LIMITATIONS OF THE STUDY

1. No rainfall information for La Union for cotton suitability requirement.

2. Physico-chemical data on soil texture description were not available, hence, scoring was at best, rather arbitrary.

IDRC
CANADA

Certificate of Training

This certifies that

---

participated as

Support Staff

in the

Training Course on the
Geographic Information System for Regional Planning
in the Coastal Zone

held on January 19-24, 1994 at
Regional Educational Learning Center, San Fernando, 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