CHARACTERIZATION OF LAND-BASED AND COASTAL FEATURES OF REGION VIII, EASTERN VISAYAS

Final Report of the
GIS Component of the Comprehensive, Coastal-Resource Management Plan for Eastern Visayas 1997-2007

Cybersoft Information Technologies, Inc.
6/F Triumph Building
1610 Quezon Ave.
Quezon City
Tel. No. 02-426-3321

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Chapter
1

Introduction

1.1 Background

The Regional Development Council (RDC) of Eastern Visayas through its technical arm, the National Economic and Development Authority (NEDA) Regional Office No. 8, and with financial support from the United States Agency for International Development (USAID) is implementing a project to provide for a Comprehensive, Coastal Resource Management Plan (CRMP) for Eastern Visayas for 1997-2007.

The project aims to provide a wholesome direction in the sustainable use of coastal resources in the islands of Leyte and Samar. The project calls for several activities to accomplish its aim. One of these activities is the establishment of a Geographic Information System (GIS). This part of the project is called the 'GIS Component of the Comprehensive, Coastal Resource Management Plan (CRMP) for Eastern Visayas 1997-2007'.

1.2 Aim of the GIS Component

The main aim of the GIS component is to establish a GIS database of digital maps that represent the location of the following: indicative areas of coastal resources, or more specifically coastal habitats (i.e. mangroves, coral reefs and land cover) for aquatic life; and important physiographic, coastal and human-made features that may impact on the management plan that would be prepared for the coastal resources of Eastern Visayas or Region VIII.

The output for this GIS component would devolve into a physical characterisation and description of the study area. This report contains such material that is essential in the preparation of a comprehensive plan for coastal management. This report, therefore, provides the baseline information about the state of the land and coastal resources as well as the indicative situation within the study area in a visual form through maps. This is an ideal situation wherein the capability of a GIS could be utilised and put into full advantage.

Through a GIS, we could readily present data in a map form that would provide us a visual information of the existing or prevailing situation in the coastal areas of Eastern Visayas. Composition of these maps were made possible through digitisation of paper maps and processing these through a GIS. The geographic features represented in the digital form in the GIS database are then labelled with their attributes or characteristics.

By integrating both attribute or descriptive and spatial data in a GIS, one is given a comprehensive overview of the resource situation where map-based analysis could be easily performed to reflect an existing situation as well as view future scenarios. Overall, these information will be useful in strategic action planning, policy decision making and in the determination of priorities for development.

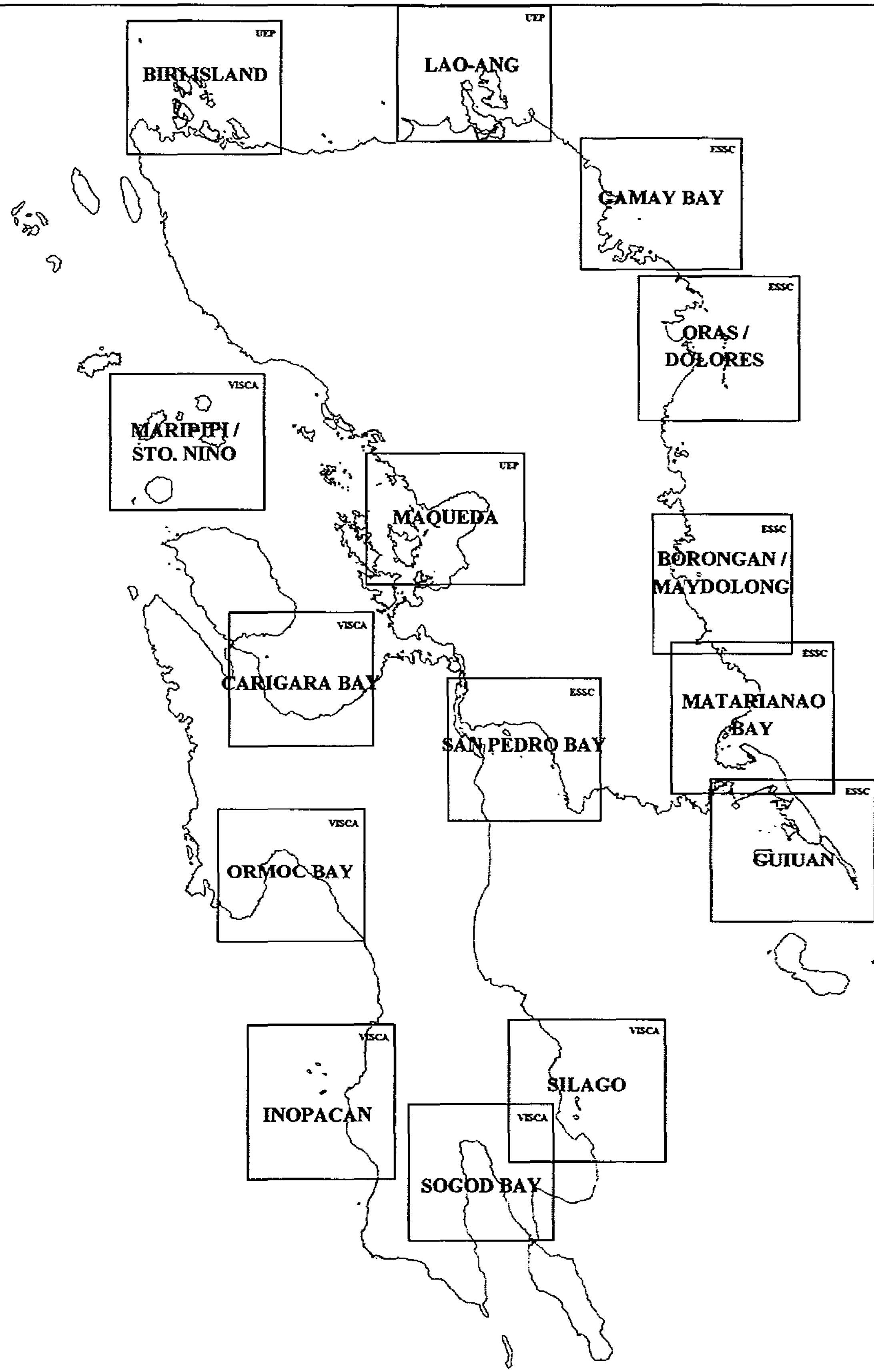
1 .3 Contents of this Report

This document, which is a GIS-assisted characterisation of land-based and coastal features of Region VIII, is presented into four parts. These are Chapters 2 to 5.

Chapter 2 describes the regional physical characteristics of the land features surrounded by the coastal areas of Eastern Visayas, specifically, those of Leyte and Samar. Chapter 3 presents a characterisation and description of the regional geology and coastal features of Eastern Visayas. Chapter 4 provides a general picture of coastal pollution in selected coastal areas, delineated as pilot areas for the Coastal Resources Management Plan (CRMP) Project for Region VIII. Lastly, Chapter 5 describes the spatial features of the coastal resources, specifically, the three main coastal habitats, namely, mangroves, coral reefs, and seagrasses, located in the pilot areas.

The mapping of coastal features and resources has been confined to the fifteen (15) pilot areas (Figure 1.1) because of the constraint limiting intensive inventory and assessment by CRMP project teams. Other information that has been mapped by the National Mapping and Resource Information Authority (NAMRIA) and those derived from aerial survey and photography are not a hundred percent accurate, but they form the set of materials that are useful for planning. The reader is, however, advised about the caveats in using these mapped information and must exercise discretion about weighing the usefulness of the information against their need for accuracy. The information provided in this final report can be best used for strategic planning of land and coastal resources.

Figure 1.1 Pilot Sites for the CRMP Project



Chapter 2

The Regional Physical Characteristics

2 .1 Introduction

The objective of this chapter is to describe the regional physical characteristics of Eastern Visayas that is comprised mainly of the major islands of Leyte and Samar. This will provide a visual composition of the land-based features of Region VIII and their relative location to the coastline of the region. The information available in this chapter is a supporting material to the concept that the inland features have an impact on the coastal zones. This exhibits the interrelationship between the inland environment and the coastal environment.

We provide the information material on the land-based physical characteristics of Region VIII to familiarise our readers of its surface features and for them to establish their 'link' to coastal features.

2 .2 Location and Land Area

Region VIII is situated off the southern tip of the island of Luzon. On the western side it is bounded by the Visayan Sea, on the south by the Bohol Sea, and on the east and north by the Philippine Sea (see Maps 1a and 1b).

It is composed of two (2) major islands, Samar and Leyte, separated by the San Juanico Strait. The total land area of Eastern Visayas is 2.16 M hectares (Forestry Statistics Report 1992). The region is composed of six (6) provinces namely: Leyte, Southern Leyte, Eastern

Samar, Northern Samar, Western Samar and Biliran. Three (3) major cities belong to the Region. These are Tacloban and Ormoc in the province of Leyte and Calbayog in the province of Samar.

2.3 Topography

The region's terrain is relatively flat near and along the coasts. The mountainous areas of the region are mostly located in the middle portion of both Samar and Leyte islands (Map 1a and Map 1b).

Mountainous terrain in the island of Leyte dominates the southern and south western portion. The northern portion is extensively a level area. Scattered coastal flat lands are located at the northwest.

On the other hand, the island of Samar is characterized by mountainous ranges with forest and deep valleys. It has four (4) major river basins, namely, Gandara, Catubig, Dolores and Ulot.

2.4 Slope

The regional slope map (Map 2) presents the prevailing inclination of land within provinces and municipalities. It does not present the contours of landforms but does give a general impression of the repose of the land.

An important indication of potential land use is the natural land slope of the region. Accordingly, there are six (6) slope categories and ranges in Region VIII (BSWM 1992). The first category (Table 2.1), which is 0-3% slope (flat lands), constitutes about 18% of the total land area or about 386,000 hectares. This area is irrigable and highly suitable for agriculture, urban and industrial purposes.

The 3% to 8% slope is characterized as gently sloping to undulating and is also highly suitable for agricultural and non-agricultural development. This covers an area of some 15,000 hectares or about 7% of the total regional land area. The slope ranging from 8% to 18% which is about 15% of the total area or an equivalent of 321,000 hectares, offer a wide variety of land uses with option ranging from seasonal to permanent crops.

Table 2.1 Slope classes in Region VIII

SLOPE CLASS	AREA (ha)	% SHARE
0-3%	382,000	18
3-8%	136,663	7
8-18%	317,584	15
18-30%	514,002	25
30-50%	521,166	25
>50%	205,487	10

Source: Map data from BSWM (1992), but area size were determined through GIS calculations.

Hilly or mountainous areas, which are categorically within the 18% to 30% slope, comprised a total of 535,000 hectares or 25% of Eastern Visayas. The 30% to 50% slope range category covers another

25% of the land area or some 535,000 hectares. Slopes above 50%,of which there are 214,000 hectares, are characterized to be very steep and extremely rough mountainous areas. These areas are considered protection forest in view of their high slope of 50%.

2 .5 Legal Land Classification

Of the total land area of Region VIII, a total of 797,000 hectares (Map 3 and Table 2.2) are classified as forest land or about 38% of the total land area, while a total of 1.27 M hectares are considered alienable and disposable lands (A and D) comprising about 62% of the total land area (BSWM 1992).

Current land classification policies require that a land above 18% slope, which is the maximum angle of repose for soils, are to be retained for forest purposes. Those below 18% in slope are to be classified as A and D, provided these have not been previously proclaimed as conservation or reserve areas.

Table 2.2 Land classification status in Region VIII

PARTICULAR/S	AREA (ha)	% SHARE
A and D	1,273,142	62
Forestland	796,868	38

Source: Map data from BSWM (1992), but area size were determined through GIS calculations.

2 .6 Land Use/Land Cover

The Eastern Visayas region has three(3) major land use classifications (Map 4): agricultural lands (A and D areas); forestlands; and miscellaneous or other lands. Each classification could be further sub-classified into: agricultural areas and grasslands or shrublands under agriculture; woodland and wetland under forestlands; built up or urban areas, beach sand, industrial estates and other land uses under miscellaneous.

Table 2.3 Land use/vegetation of Region VIII

PARTICULAR/S	AREA (HA)	% SHARE
Agriculture	916,473	44
Wetland	28,878	1
Woodland	492,630	24
Grassland/Shrubland	628,524	30
Special/Miscellaneous	17,545	1
Total	2,084050	100

Source: Map data from BSWM (1992), but area size were determined through GIS calculations.

Data from BSWM (1992) shows that about 916,000 hectares or 44% (Table 2.3) of the total land area of Region VIII is devoted to agriculture or cropland. Included in this land use are areas planted to rice, corn, sugarcane, coconut and other crops. Apparently, this is the dominant land use in Eastern Visayas.

Following agriculture is grassland/shrubland comprising some 629,000 hectares or roughly 30% of the land area. A total of 493,000 hectares or 24% of the land area is under woodland. A minimum of 1% of the land area is devoted to wetlands and miscellaneous or special land uses.

Table 2.4 Soil erosion in Region VIII

DEGREE OF EROSION	AREA (HA)	% SHARE
Moderate Erosion	411,037	20
No Erosion	374,493	18
Severe Erosion	383,539	19
Slight Erosion	897,573	43

Source: Map data from BSWM (1992), but area size were determined by GIS calculations.

2 .7 Soil Erosion

As reflected in the soil erosion map (Map 5), erosion is being experienced within the region in varying degrees. Of the total land area, some 384,000 hectares were considered to be under severe erosion or roughly 19 % (Table 2.4).

Another 411,000 hectares experienced moderate erosion or 20 % of the land area while a total of 898,000 hectares were described as having slight erosion. There are some 374,000 hectares of land with no perceived erosion occurrence or 18 % of the land area.

2 .8 Pedo-Ecological Zone

Pedo ecological zones (PEZs) are broad ecological resource management units derived from an association of soils and their environment based on several factors. These PEZs represents the broad environmental gradients, which recur as landscape strips with well-defined attributes, viz, the soil systems, slope and elevation.

Based on the map (Map 6), there are five (5) broad categories of PEZ namely cool highlands, warm cool hilly land, warm lowlands, warm cool uplands and miscellaneous. As reflected in the map, 6% of the total land area (Table 2.5) of Eastern Visayas falls within cool highlands. These zones are principally comprised of mountainous area that are highly elevated, extremely steep and precipitous.

However, there are also relatively small plain areas that occur in these zones. A total of 35 % of the land area are within the warm-cool-hilly land zones. These encompasses all hills and mountains within 500 meters elevation, generally with slopes greater than 18%.

Table 2.5 Pedo-ecological zones in Region VIII

PARTICULAR/S	AREA (HA)	% SHARE
Cool Highland	118,513	6
Warm-cool hilly land	728,138	35
Warm lowland	562,409	27
Warm-cool upland	663,082	32
Miscellaneous	3,419	0
Unclassified	6,089	0

Source: Map data from BSWM (1992), but area size were determined by GIS calculations.

Warm lowland zones cover about 27% of the region. This zone is characterized by low elevation with level to undulating physiography. About 32% of the land area are considered under warm cool uplands. These zones include areas mostly under residual terrace, footslopes and plateus with relatively small areas of low hills.

The fifth category is miscellaneous of which there is a minimal area under this particular category. These units represents the built up areas, body of water and barren lands.

2 .9 Watershed Reserves and Drainage

There are 24 watershed reserves (Map 7) delineated in Eastern Visayas with a combined total area coverage of 273,000 hectares. The individual area coverage of these watershed reserves ranged from 308 hectares to 61,000 hectares with Busay Falls Forest Reserve having the smallest area and Catubig Watershed Forest Reserve having the largest area.

Of the 24 watersheds, five (5) namely Pan-as Falls Hay-Ban Watershed, Palompon Watershed Forest Reserve, Jicontal Watershed Forest Reserve, Bulasao Watershed Forest Reserve, and Hinablan-Lawigan Watershed Forest Reserve are proclaimed watersheds covering a total of 28,875 hectares (Phil. Forestry Statistics 1992). An additional two watersheds are awaiting proclamation . These are the Catbalogan and the Hinablan-Lawigan Watershed Forest Reserves.

Drainage for the region is provided mainly through average sized-streams with catchment area ranging from 100-900 sq. kms. The average run-off is about 161 million cubic meters (MCM) (1987 Natural Resources Atlas). The largest river basin in the region is the Ulot River Basin with a drainage area of 1,903 sq. km. and an estimated annual run-off of 1,716 MCM.

2 .10 Recommendations for Using the Different Thematic Maps

Topographic Map

This map shows useful information on the terrain of the regions. It serves as guide in macro planning for the development of the region by giving the planner a birds eye view of the overall physical feature. It is useful for location planning and infrastructure development considering that topography is a major factor in any development undertaking.

Slope

Very much related to topography is the slope map. It yields information as to the prevailing inclination of lands within provinces and municipalities. It should be noted that a slope map is derived from a topographic map. As such, it gives a general impression of the slope of the land. The slope map could be used to give indications of the potential land uses of an area. With a slope map, one can easily locate infrastructures, support facilities which influence land use. Directions of potential development efforts could be dictated and highly influenced by slope.

Legal Land Classification

This particular map shows distinct categories of the legal status of the region: the alienable and disposable areas and forestlands. Again slope has a direct effect on the legal status of an area. Accordingly, areas 18% and below in slope are classified as A and D lands. These areas are open for distribution and could be titled.

On the other hand, areas above the 18% are considered forestland and could not be alienated. For planning purposes, this map gives guidance as to the areas that could be open for development and those where certain activities are being controlled or prohibited. In land use and physical planning, this yield information that would certainly affect development priorities.

Land Use/Land Cover

From a macro planning perspective, this map gives current land use and the overall vegetative conditions of an area. As such, it is useful in planning land use rationalization policies and programs for development purposes. In short, it gives information necessary for determining the manner of utilization of land including its allocation, development and management. It also facilitates monitoring of land use changes or changes in the vegetation pattern by comparing different land use or vegetation cover maps taken from different times.

Soil Erosion

This map gives information on extent of soil erosion as a function of geological, natural and man-induced processes. It is useful in the formulation of soil conservation measures to prevent further soil losses and arrest soil-related problems. This is also necessary in the identification of priority areas for soil conservation and rehabilitation activities which may be undertaken.

Watershed Reserves and Drainage

This map gives a complete picture of the boundaries of proclaimed watersheds including the areas drained by such watershed. It also yields information on drainage and as such could be useful in determining surface water run-off as a source of water for domestic, agriculture and industrial uses.

Pedo-Ecological Zone

This map gives information on the broad environmental gradients which recur as landscape strips with well defined attributes. This is useful for planning cropping systems and for expansion of areas to be planted with certain crops, because his yield information on soil systems, slope and elevation. This also gives planners suitability rating of different crops and land uses wherein each suitability class can be further related to specific management inputs and requirements.

2 .11 Conclusion

We have shown maps that characterize the surface physical make-up of Region VIII. All of these maps have been digitally converted from analog sources obtained from the Bureau of Soils and Water Management (BSWM) of the Department of Agriculture. The entire effort of composing these maps from field surveys and remotely sensed data took about 15 years to finish. The analog sources were then published in 1992.

These are the most recent data we can obtain from secondary sources. It is not cheap to come up with very recent data. We need to justify the cost of obtaining current information against the value and accuracy of the output we desire and the urgency of our need for information. We will find in the succeeding chapters that most of these physiographic features would not have changed drastically over the years, except for geographic features, which are under constant intervention by people such as settlement areas, mangrove sites and woodlands.

We can verify the status of these dynamic features using rapid assessment techniques, one of which have been applied to obtain information for the other chapters of this report. At the micro-level of data collection, we cannot ignore the usefulness of foot work, but this becomes very taxing when applied in large scale reconnaissance and data gathering activities. In this case, we cannot undervalue the usefulness of the data we have in conjunction with some form of a practical method for rapid assessment.

2 .12 References

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Chapter 3

Regional Geology and Coastal Features

3 .1 Introduction

The coastal zone is one of the most important areas for ecology, economics and recreation. As such, coastal zones all over the world are being subjected to active exploitation. With the increasing population pressure on the coastal areas and its resources, the need for protection and management has become a top priority.

As learned from past experiences on coastal management, a basic requirement for management is an understanding of not only the biological environment of the coastal zone, but also the physical environment as well. It is for this purpose that this coastal geomorphological study is being conducted as part of the coastal management planning project for Eastern Visayas.

Physically, the coastal zones are regions where active changes in the landscape is taking place. Geology and tectonics play important roles in the development of the coastal zones. Coastal features are constructed and destroyed by processes operating at different scales in time and space (Fox and Davis 1976). Tectonic processes influence large scale features, like mountain ranges, deltas and continental shelves. Sea level changes, on the other hand, play important roles in intermediate features, like estuaries, spits and barrier islands. Additionally, small scale features like beaches, nearshore bars and ridge and runnels are controlled by waves, longshore currents and tidal currents. Waves and currents that influence beach and nearshore topography are likewise strongly influenced by local meteorological conditions (Fox and Davies 1976).

This chapter deals in general with the geology of Region VIII and in particular on the coastal geomorphology and coastal features of pilot sites of the CRMP study in

Region VIII, otherwise known as the Eastern Visayas. It is composed of the islands of Samar, Leyte and Biliran and other smaller islands. This aims to yield a useful set of data that for coastal land-use planning and resources conservation and development. These outputs will also be supplemented by other data sourced from other working groups involved in the preparation of the Coastal Resources Management Plan (CRMP) for Eastern Visayas.

The objectives of this chapter is to present the regional geology of Leyte and Samar and their coastal features with focus on these coastal zones. We provide a general description of the geology of Eastern Visayas to provide a picture of the underlying rocks and lithological structure supporting the major islands of Samar and Leyte. It will give an idea of what mineral resources are available and the region's potential to geological hazards. The characterisation of the coastal features will provide a picture of the coastline that may influence management plans. We also provide a description of the geologic and coastal processes active in Eastern Visayas.

3 .2 Methods and Limitations

The general approach to this chapter is the characterisation of the coastline of the pilot areas for Eastern Visayas. This characterisation is essential for the planning exercise. The physical characterisation of the coastline combined with the regional biological and social characterisation of the study area being done by the other CRMP teams will allow the planners to identify and focus on issues and concerns that need to be addressed by the coastal resource management plan. Through this procedure, we can classify and prioritise coastal zones needing immediate protection and management.

The geomorphologic characterisation and description of the coastal features in the study area were based on secondary sources and recent data obtained from the aerial survey of the pilot sites. One of the major sources of baseline information on the coastal geomorphology is the 1957-1960 1:50,000 NAMRIA topographic maps. These maps were interpreted for landforms and coastal features. The results of the aerial survey provided current information on the condition of the coastal regions of Eastern Visayas. Features interpreted from the older maps were updated and/or confirmed by the recent data acquired through the aerial survey. The aerial survey improved the quality of information on the coastal features of the pilot sites. One major general observation that can be made from the aerial survey recently conducted is that no substantial physiographic changes have occurred over the years. The most notable changes are those for land use, which are confined in areas where there is rapid urban expansion.

Delineation of coastal features was done on the 1:50,000 photocopy of the maps, which were later digitised. Generally, the use of coastal zones is highly dependent on the type of coastlines, as such the coastline of Eastern Visayas were categorised according to three main features, the inland feature, the beach type and the nearshore feature. Further subdivision of this classification is enumerated in Table 3.1.

Table 3.1 Categories of coastline features used in this chapter

Inland Features	Beaches	Nearshore features
Coastal Plains	Rocky	Intertidal Region
	Sandy	Rocky
	Mangroves/Swamps	Sandy
	Rocky/Sea Cliffs	

The coastal features are generally classified into six types. These are: (1) the coastal plains; (2) mangrove/swamps; (3) rocky cliffs; (4) rocky beaches; (5) sandy beaches; and (6) intertidal regions. Note that because of the approach taken in this chapter the mangrove area and its extent may vary with those provided in Chapter 5, which were provided through the ground surveys by the CRMP study teams. The data available in this chapter and in Chapter 5 provide an opportunity for us to reconcile our methods. This will bring us to a healthy rethinking of our strategies for future work on the CRMP Project.

The *coastal plains,* whose color code on the map is brown, denotes the flatlands, floodplains and other low-lying places found along the coasts. They are a short distance inland, away from the immediate shoreline. These plains consist mainly of alluvium (soil) and unconsolidated (loose) sediments and in some places by young uplifted coral reef platforms. They are the result of accumulated sediments eroded from inland regions, higher areas (like highlands near the plains themselves) or transported by inland rivers and even by longshore currents carrying sediments from the open sea. These places are usually developed into cultivated lands and human settlements.

Coastal plains are subject to various geomorphologic processes such as erosion, deposition, storm surges and sea level rise, and are important in the study because human populations inhabiting these regions are directly affected by these phenomena. Fishing village's coastal towns and cities are usually developed and built within these areas. Land-based port facilities and other structures are built at these places that is why their importance cannot be discounted.

Mangroves and swamps, whose colour code is green, is separated into two more sub-groups, but otherwise marked on the map as one for convention. One of the sub-groups is the mangrove, which are woody, shallow-water plants that commonly occur in patches or forests. They thrive in places where open-sea currents are minimal and the shallow-water substrates (bottom sediments) are plenty in supply. The shallow marine environment setting is also the same for the subgroup of nipa vegetation's, small plants related to palms that occur in patches in areas influenced or intruded by saltwater.

Mangroves serve as habitat for various species of fishes and other small marine animals. The woody structure of mangrove plants is locally used for firewood and certain wood-based products. Nipa plants, on the other hand, also serve as habitats for small animals and have a variety of uses. Their economic, as well as ecological and environmental importance qualifies them into a separate group.

Their setting, which is generally a swampy environment, is one of the transitional to shallow marine regions. They commonly thrive in places where saltwater and inland fresh water mixes, and the sediment is usually fine-grained and rich in organic materials. This only occurs in calm bodies of water that is not much affected by the longshore currents and open sea waves (usually in the far end of bays where the effect of the circular-moving longshore currents from the bay opening dies down).

Sea cliffs are features characterised by a high relief with rectilinear slope with respect to the mean water level or a low-lying area, such as a beach. These are coded by the violet colour on the worksheets. These are commonly composed of bedrocks and sometimes by thick piles of stratified (layered) sediments. Sea cliffs are commonly produced by the active, parallel retreat of the slope due to wave erosion.

They are subject to a high degree of erosion caused by natural as well as man-induced surface runoff, and by wave action at their base, which results in wave-cut rock exposures. These two main processes leads the cliffs into its collapse, either by slumping, landsliding, debris flow, mass wasting (much like landslides) or the more common rock falls. The erosion of these cliffs is also controlled by the resistance of the rocks to the processes. Highly resistant rocks are usually igneous, while sedimentary rocks and stratified sediments (and even loose sediments) are more prone to erosion.

Eroded materials from these rocky cliffs accumulate at their surrounding bases. These materials are then subject to intense pounding of waves, which reduces their size through time. Accumulated materials of these kinds form the *rocky beaches* that are commonly associated to these rocky cliffs. Rocky beaches, coded by the orange colour, is differentiated into two sub-units, those beaches composed of shingles and those composed of boulders.

Rocky beaches made up of shingles are beaches that are subject to a lesser degree of sea wave erosion. These regions usually have accumulated small chunks of rocks and have formed small beach platforms that extend towards the sea. These platforms reduce the strength of the incoming waves beyond the shore.

Rocky beaches composed of boulders commonly denote a high-energy environment. This type is strongly associated to rocky cliffs because the boulders are sourced from the falling large rocks of eroding cliffs. Wave action is stronger because the brunt of its energy is directed onto the boulders, and any beach platforms that were made by the boulder accumulation are not well-formed and stratified. These platforms are not efficient enough to reduce the strength of the incoming waves.

Mapping of these features are important for land use planning and conservation. Stable cliffs and well-developed rock formations can be good sites for tourism development. Shingle-based beaches can provide a source for aggregate needs, especially if this is composed of colourful and decorative rock shingles. These environments also provide a different habitat for some other plant and marine life. Coral reefs sometimes favour these kind of geomorphologic setting which provides stable substrate.

Sandy beaches, coded on the worksheets as yellow, is one of the more transitional geomorphologic environments. They commonly occur in small strips that are lining the immediate contact between the sea and the land. Some coastlines have thicker and wider sandy beaches and some even have extensions or protrusions into the body of water near it. These are products of the accumulation of transported sediments brought along by longshore currents from major sediment sources like rivers. It sometimes result from the breaking down of eroded rocks within the beach vicinity itself.

Beaches are strongly subject to geomorphologic processes such as shoreline retreat, progression and erosion. These are caused by a host of natural factors like rising sea level and changes in sediment supply. These are among the things to consider in determining the best use of each particular beach area.

Intertidal regions, marked by red colour on the worksheets, define another of the transitional coastal environment feature. These places are strongly influenced by the changing tidal levels, and as such define a different habitat for marine plants and animals. Marine sedimentary processes are quite different and variable, because it can source its sediments from the sea itself (through currents), as well as from inland sources. The waters in this places are usually calm (especially in lagoons and inner regions of coral reefs), but these can sometimes be microenvironments only, because the intertidal region can exist within a high-energy wave environment. Intertidal regions usually form in association with coral formations, and also at places where there is a balance between erosion and sediment deposition. These can also be old beach platforms that were submerged due to a rising sea level or isostatic adjustment. Mapping of these zones will be crucial in determining the usage of these features, whether for conservation, tourism or for massive developments. It can be composed of either rocky or sandy sediments veneered by algae or seagrass meadows.

The coral reef areas were not included in the classification but are noted and defined at certain points. All of the coastal plains and inland limits were projected inland at a maximum contour elevation of 10 meters. This is to facilitate modelling for physical constraints such as flooding.

3 .3 Definition of Terms

Terms used in this chapter and are defined below:

Indentations are cuts or notches on a generally continuous or uniform area, structure, or material. It is usually applied to rocks, and even to the coast or shore as features.

Irregular coasts/shores denote the generally varying physiographic appearance of a described area based on the different coastal features that may exist. The irregularity of an area is exhibited by the presence of segments of different coastal features, such as rocky cliffs or beaches alongside sandy beaches or swampy portions in that same area.

The features does not occur singly in irregular areas, but the coast or shore is rather heterogenous. The physical appearance, such as the presence of jagged shores or alternating headlands and coves or bays, also denote the irregularity.

Karst/ Karstic Topography denotes an uneven type of topography characterized by limestone areas. This occurs when surface and ground waters percolate through the small cracks and crevices of the limestone rocks. These percolating waters slowly dissolves the rock, especially if the waters have acidic behavior and thus results in the formation of large cracks and underground caves below the formation, as the water moves out or be accumulated in water aquifers. The large opening or "holes" make the overall foundation of the limestone formation weaker, which results in the collapse of the upper limestone ceiling. The collapsed features are characterized by a rolling terrain of rocky protrusions, short cliffs and small depressions.

Headlands are coastal features usually occurring in a form of protruding landmass composed of rocks and sometimes by consolidated sediments that fronts the open sea. These features bear the initial impact of the main strength of the incoming waves coming from the open sea and are highly subject to wave erosion. The degree of erosion being experienced depends on the resistance of rocks that are exposed to the waves, and serves as the source of sedimentary materials by small bays and coves that normally occur near the headlands.

Shoreline is the line of contact in which the land meets the sea. This contact changes due to the effect of changing tides and other coastal processes that affects the water level, and can migrate landward or seaward, depending on the existing conditions.

The *Shore* is a region on the coast denoted by the lowest tide mark and the highest point reached by waves or tides. This region can have different characteristics, depending on the coastal setting (i.e. topographic/physiographic form, type of rock or sediment existing in the area, in an open sea, etc.) and the prevailing conditions (i.e., strong waves, erosional or depositional process for sediments, etc.).

The *Coast* or *coastline* is the part of the land that is next to the sea and on which waves have a direct effect.

Scallops are features represented by deep cuts or facets on the side of a mountain slope, ridge or cliffs.

Bays/embayments are recesses in the shores or inlets of a sea or lake between two capes or headlands, though not large as a gulf, but larger than a cove.

Channels are the deepest portions of a stream, bay or a strait. It is the part of a body of water which is deep enough to be used for navigation.

Coves are small sheltered bays or inlets in a coast, with normally tranquil waters that allow anchorage for small sea crafts. They usually occur sandwiched in between headlands and are normally composed of pocket rocky or sandy beach along the shore.

Fringing reefs are inorganic reefs attached to or bordering the shores of an island or continent, having a rough, table-like surface that is exposed at low tide. It can be more than one kilometer wide and its seaward edges slope sharply down to the seafloor. There may be a shallow channel or lagoon between the reef and adjacent mainland.

Intertidal regions pertain to the benthic environment or depth zone between high water and low water.

A *marsh* is a saturated, poorly-drained area that is intermittently or permanently submerged underwater, having aquatic and grass-like vegetation, but essentially without the formation of peat.

A *swamp* is an area that is intermittently or permanently submerged underwater with shrubs and trees, but essentially without the accumulation of peat.

A *rocky cliff* or headland is a high steep face of a rock onland, which borders the sea.

Sea stacks are isolated, pillar-like rocky islands, detached from a headland by wave erosion.

Tombolos are bars or barriers of accumulated sediments that connect an island with the mainland or with another island.

Harbors are natural or artificially, protected bodies of water where ships can find refuge during storms or be anchored during repair.

Ports are developed harbors with built facilities like wharves, warehouses and other structures intended for handling ships and cargoes.

Beaches are zones of accumulation of unconsolidated sediments which covers a part or all of the shore. This is limited by low tide on the seaward margin and by the limit of storm wave action on the landward side.

Rocky beaches are the result of erosion of resistant rocks and are common on regions where erosional wave action is predominant.

Sandy beaches result when depositional wave action predominates and there is a source of easily and readily transportable sediments such as fine sand.

Faults are tectonic structures in the form of large lines observed on top of the earth's surface. These structures form planes of weakness extending along and through the earth's crust. It is along these faults where earthquakes are mostly generated, when built-up tectonic pressure caused by the moving plates of rocks (commonly termed as crustal plates) is suddenly released, resulting to strong ground shaking.

Terranes are small, fault-bounded tectonic structural units, which are popularly known as small crustal plates or chunks of rocks that were probably transported from a far region into its present location because of geologic processes.

Strike-slip Faults is a type of fault which has a crustal motion that occurs parallel (lengthwise) along the fault line itself as observed above the earth's surface.

Trenches (also known as Deeps) are tectonic structures that are much like the faults, which are boundaries of crustal plates of rocks. The difference is that most of these are located offshore. Earthquakes are also generated in this areas, which is caused by the subduction (i.e. "sinking") plate beneath the other.

Splays are lineaments that are usually denoted by the alignment of some physiographic features like mountains, river patterns and ridges. These can be observed from aerial photographs of certain regions. Splays are usually inferred as minor faults that are possibly associated to a bigger fault structure that can be nearby.

Mya is a short term for Million Years Ago, applied to rock units to denote their relative ages from the present time.

Intercalated Lavas/Limestones means that the aforementioned rocks are in contact with another rock unit in 'intertoungin' (i.e. admixed, distinguishing layer or squeezed sheets of the rock within the other rock) form.

Breccias are applied to rock deposits composed of angular fragments and a matrix of mixed composition of possibly the same, or different, material.

Pyroclastics are rock units formed because of the accumulated ejecta of a violently erupting volcano (ie. Mt. Pinatubo). It has the appearance of medium to fine-grained rock and usually has a lighter color.

Ultramafic Complexes are rocks that is usually composed of one or more of a succession of serpentine, gabbro and other igneous rocks which are sourced deep beneath the crust. It is being thought that these rocks are associated with the mantle layer of the earth, exposed only at the earth's surface by tectonic processes. Minerals such as serpentinite, asbestos, chromite and sometimes precious metals like platinum and gold are associated with these types of rocks.

Schists are metamorphic rocks that is a product of tectonic processes like thrusting and folding. These rocks form under extreme regional crustal pressure applied to them.

Metamorphosed means that the denoted rock has been altered or changed into a new form, with different mineral and physical characteristics distinct from its original form.

3 .4 Regional Geology

The islands of Samar and Leyte lie in the eastern periphery of the Visayan Region. They are located within the immediate vicinity of the Philippine Fault Zone (PFZ) and the Philippine Trench (PT), two major structures that strongly influence Philippine geology. The main tectonic line of the PFZ, a strike-slip fault system, extends through the entire length of the island of Leyte, with its splays and smaller tensional faults occurring in Samar (Figure 3.1). The Philippine Trench, where an oceanic plate plunges westward beneath the Central Philippine Arc Terrane (CPAT) (McCabe et al. 1985), closely follows the eastern coast of Samar island and extends southward to the eastern coast of Mindanao.

The Philippine Fault Zone (PFZ), which is a complex strike-slip fault system, traverses through the entire length of the island of Leyte (Pilac et al. 1965). Northwest-trending splays and tensional faults associated to the PFZ also occur in Samar. One of these minor faults is the Catbalogan Fault which runs parallel along the western coastline of Samar. The Philippine Trench (PT), on the other hand, is located east of Samar, and the related subduction of an oceanic plate in this trench may have resulted to the uplift of the island itself and other islands north and south of it. The age of the PFZ is suggested to be between 4 and 2 mya, which is late Pliocene (Barrier 1991).

The following sections will describe the geology of the two major islands of Eastern Visayas, Samar and Leyte. A visual perspective of their geology is shown in Map 16 of Appendix B.

Samar Island Geology (Adapted from BMG, 1981)

The dominant rock units have been mapped in Samar and are arranged from youngest to the oldest as shown in Table 3.2.

Table 3.2 Dominant rock units in Samar

Geologic Period	Rock Unit
Late Pliocene to Pleistocene	Calicoan Limestore Taclaon Clay
Middle Miocene to Early Pliocene	Catbalogan Formation
Early to Middle Miocene	Loquilocon Limestone Daram Formation Mawo Volcanics
Paleogene	Diorite Intrusives Felsic Volcanic Rocks
Cretaceous	Ultramafic Complex Basement

The Cretaceous (135 mya to 65 mya) rocks in the island consist of a sequence of thinly bedded shale, chert and mudstone with some manganiferous beds, overlying the agglomerates and lavas intercalated with sedimentary rocks (Balce and Esguerra 1974). The most common rock type is made up of intercalated lavas, volcanic breccias and pyroclastics. These are overlain by rocks composed of graywacke, sandstone, mudstone and chert beds, and lenticular masses of marbleised limestone. The limestone lenses are of particular interest due to the occurrence of manganese deposits.

An ultramafic complex was delineated along the southeastern portion of Samar. These are found as discontinuous bodies along northwest trending thrust faults and also as thrusted sheets overriding the massive spilitic basalts and locally, the metamorphosed sedimentary rocks. As a consequence of thrust faulting, the chert and mudstone became schistoid (Santos-Ynigo et al 1951). These ultramafic complexes can be potentially mined for the chromite mineral, which occurs in association with the rock.

The Paleogene (65 mya to 23 mya) rocks, consisting of a thick series of interlayered dacitic lavas, volcanic breccia and lapilli tuff is probably the most widespread rock type mapped in central Samar. Observed outcrops are characterized by alternating layers of lava flows of varying compositions, some of which showing various degrees of alteration. The felsic volcanic rocks and related volcanic breccias occur as massive flows and sometimes interlayered with tuffaceous sandy shale. By and large, central Samar is conspicuously underlain by thick series of old, felsic volcanic rock flows probably deposited under various geologic environments. This means that the central Samar region has a relatively good foundation bedrock which is important to infrastructure development.

The diorite exposures occur as a 'dark, grenish, granular rock' (Kinkel 1956), and sometimes as a "light-colored, coarse-grained rock" in a dike-like body (Santos-Ynigo 1950), with varying degrees of alteration. It is usually darker colored and relatively finer-grained near its contact with the volcanics (Santos-Ynigo 1950). These kinds of rocks may be a potential source of valuable metals such as gold, silver and copper. The widespread volcanic rocks, on the other hand, serve as a good foundation bedrock for developed areas like cities in Samar.

The Early to Middle Miocene (23 mya to 11 mya) rocks are composed of the younger Loquilocon Limestone and the older Mawo Volcanics and Daram Formation, said to be a facies of the previous formation. The Mawo Volcanics consist of a series of andesite and basalt with intercalated pyroclastics. Minor limestone lenses are found interbedded with the volcanics. Some of these volcanics shows some degree of alteration.

This alteration translates to a possibility for the affected rocks to have formed potentially mineable metallic minerals like copper. The compact and well-bedded tuffite, as well as the other well-formed volcanics can also serve as a good foundation bedrock.

The sedimentary rocks are made up of a clastic member and the so-called Loquilocon limestone. The clastics overlies the basement rocks in most areas of Samar, conformably overlain by the limestone. It is made up of highly folded series of sandstone, siltstone and shale with minor conglomerate. The siltstone consists of thin, lenticular and fossiliferous clastic beds, and carbonaceous shale with intercalated coal seams that grades upward into marly limestone. These sedimentary rocks can be potentially tapped as a groundwater resource because of their relatively good porosity and permeability, which is suitable for natural aquifer development, although these rocks are not good foundation bedrocks to speak of, due to a smaller density and weaker induration (compactness and natural compressive strength of rock).

The conglomerate components are angular to sub-rounded, pebble-sized fragments of igneous rocks in a sandy-clayey matrix. A dark gray, carbonaceous shale with minor low-rank coal form a distinct layer between the conglomerate and shale. Iron-copper sulfide mineralization usually occur in the rock and their oxidation results in yellowish brown and greenish spots on the surface. The coal beds are normally black, shiny lenses exhibiting fractures and at times, retaining its woody texture. The coal deposits have a low economic value because of its poor quality, although there some good potential for these rocks to have accumulated metallic mineral deposits that can be extracted.

A thick and extensive coralline limestone conformably overlies the sandstone-shale series, usually with a thin layer of highly fossiliferous marl at its base. It grades upward to a horizon of bedded, fragmental, coralline limestone and massive reef limestone. This limestone, varying from buff to pink, attained a considerable thickness, thus indicating a slow but continuous subsidence at an optimum depth favorable for the growth of corals. Very well developed karst landforms characterize it (Travaglia 1979), which are good features for tourism development. Fossil fuel deposits, such as oil and, gas, might also be found in this rock but these can better be utilized for cement manufacture.

The Late Miocene to Early Pliocene (11 mya to 3.3 mya) Catbalogan Formation is an extensive, gently folded sequence of interbedded sandstones, siltstones with minor conglomerates, deposited in a marine basin surrounding the nucleus of mainland Samar. In Eastern Samar, it unconformably rests on basement rocks while in western and northern Samar, it is either in fault contact or abuts against the uplifted lower to middle Miocene (23 mya to 11 mya) limestone. Graded bedding can be observed in the formation. The gentle folding and kind of the rock sequence, as well as its relative age, can be studied for potential oil and gas deposits. These rocks may also be natural aquifers and can be a good source for extracting groundwater.

This formation is characterized by sedimentary facies consisting of well-rounded fragments of volcanics and some metamorphosed sedimentary rocks embedded in a sandy matrix. A sandstone-shale-calcarenite sequence is also observed in other places. The sandstone is coarse-grained, the shale exhibits conchoidal fracturing, and the calcarenite is whitish and thinly bedded. The presence of shale itself suggests that there is a possibility for oil or gas to exist in the previously described folded series, because these fossil fuel deposits originate from the shales and then be transported to a more permeable rock unit like sandstones. These sequences can also be tapped as a natural water aquifer.

The late Pliocene to Pleistocene (3.3 mya to 0.01 mya) rock units are composed of the Taclaon Clay and the Calicoan Limestone. The Taclaon Clay consists of poorly compacted sandy beds with alternating clayey layers, normally found as soil mantle along creeks and steep road cuts. This clay, deposited in a shallow marine basin, is believed to form the base of the Calicoan limestone. Places with clay layers are sites where groundwater development is met with some degree of difficulty because these layers are poor aquifers for groundwater extraction. On the other hand, clay materials have a variety of uses, like pottery and finishing tiles, so areas with these type of material can also be economically important.

The coralline Calicoan Limestone, dated as late Pliocene to Pleistocene (3.3 mya to 0.01 mya), occur scattered along the eastern coast of Samar between Sulat and the southern tip of Calicoan Island and the Guiuan Peninsula. This limestone is usually buff to pinkish and varies into dirty white to dark gray. It is soft, porous, and contains well-preserved corals, shells and algal structures. Moderate karst landforms and underground drainages cut through this formation. These sites are good places to be developed for tourism purposes, for limited groundwater source, and as a good source of limestone used for cement manufacture.

Leyte Island Geology (Adapted from BMG 1981)

The succession of rocks observed in Leyte is shown in Table 3.3.

Table 3.3 Dominant rock units in Leyte

Geologic Period	Rock Unit
Quaternary	Quaternary Volcanics
Late Pliocene to Pleistocene	Hubay Limestone Dolores Formation
Middle Miocene to Early Pliocene	Northwest Volcanics Bata Formation Pangasugan Formation Bagahupi Formation Central Highland Volcanics
Early to Middle Miocene	Diorite Intrusives Calubian Limestone Kadlum Conglomerate

Geologic Period	Rock Unit
	Tagnocot Formation San Ricardo Formation Taog Formation San Jose Formation
Cretaceous	Gabbro Intrusives Serpentine Rocks Tacloban Volcanics
Pre-Cretaceous	Babatngon Schist

The Pre-Cretaceous (135 mya) basement of Leyte Island is characterized by the extensive exposures of schist bodies which is probably a product of low-grade metamorphism of some basic rocks. Evident close folding and crenulation of schistosity planes indicate a strong compressive force directed in an east-west direction. These rocks are intruded by serpentinized peridotite and gabbro, ultramafic igneous rocks which are potential sources of chromite minerals that are economically important in extracting chromite metal. The indication of compressive stresses also suggest that the area may be prone to tectonic hazards (ie. groundshaking due to earthquakes).

The Cretaceous (135 mya to 65 mya) rocks of Leyte consist of the Tacloban Volcanics, the Serpentine Rocks and Gabbro Intrusives. The Tacloban Volcanics, being the oldest of the three, are predominantly andesitic, with slight sulfide mineralization as observed southwest of Tacloban City. The mineralization may suggest a possible existence of metallic ore deposits in this site that can be extracted. This rock unit is fault-bounded at the eastern and southern margins, converting it to cataclasite in places. In western Leyte, spilitic, basic and intermediate flows with intercalated metamorphosed graywacke, shale and minor cherty sediments occur. It generally forms rugged ridges with irregular slopes. The existence of these rocks shows that the area underlain by these sequences has a very good foundation bedrock, which is important for infrastructures.

The younger Serpentine Rocks occur along major fault zones. In cross-section, it occurs deeper in northern Leyte and becomes shallower towards the southern portion, until they become topographically prominent in Dinagat island and Surigao. The gabbro bodies are generally light gray, medium to coarse-grained, with chilled borders occuring along their contact with the serpentine. It has a very pronounced gradation from fine-grained at the contact to coarse-grained at the center. These two types of rocks are the commonly associated with the occurrence of significant amounts of serpentinite and chromite minerals which are economically important.

The Early to Middle Miocene (23 mya to 11 mya) rocks generally consist of conglomerates, sandstones and shales, while light to medium gray volcanics occur in the highland areas. All of the units are overlain by the Calubian Limestone to the west. The Central Highland volcanics are composed of andesites extruded (i.e. "erupted") during early to middle Miocene (23 mya to 11 mya) time, with a violent late phase resulting in the deposition of agglomerates and explosive breccia along the slopes of the ridges. The northwest trending major rifting that affected these rocks can be associated to the deposition of economically important minerals, and the rift can also pose some earthquake hazards as well.

The sandstone and conglomerate beds are mostly made up of well-rounded fragments of volcanic rocks. Intense folding and faulting probably occured during the end of Miocene, which produced tight folding and some cases of bed overturning. Occassional lenses of limestones and coal stringers occur within this unit and fossils collected from these lenses were dated as Early Miocene (23 mya to 16.2 mya). Local metamorphism has affected the rocks in San Jose area (Stratigraphy, 1981), which could be associated to tectonism. The formation of folds and the sedimentary nature of these rocks may suggest a possibility of oil and gas formation and accumulation.

These rocks are unconformably overlain by a coralline limestone with marly facies at the western side of the island. It exhibits its topographic prominence in the form of north-northwest trending ridges. Solution channels and extensive caves are common features at the Palompon and Mt. Buga-buga areas. These limestone formations are good sites that can be developed for eco-tourism and bird sanctuaries.

The only known diorite body crops out south of Albuera town and East-Southeast of Plaridel town. It is elongated and coarse along the west slope of the central range, mostly blanketed by the Pangasugan clastics. This fine to medium-grained diorite is encased within altered ultramafic rocks and the altered diorite stock intruded the metamorphosed wacke and shale sequence. (Compilation Team 1977). This rock unit can be prospected for valuable metallic mineral deposits like gold and copper.

Middle Miocene to Early Pliocene (16.2 mya to 3.3 mya) rocks in general are composed of tuffaceous clastics greatly folded and intruded by volcanic flows and dikes. Light-colored shales and sandstones predominate with occassional lenses of conglomerate and thinly-bedded limestone. The conglomerate lenses mainly consist of sub-rounded andesitic fragments cemented by a tuffaceous and clayey material. Some relic bedding structures are exhibited by the basic volcanic flows and dikes found at northwestern Samar. Around the Balite area at the western coast, tar sands mark the base of the unit (Corby, 1951), which contain the only rock asphalt deposit in the country.

Clastic rocks and limestone comprise the Late Pliocene to Pleistocene (3.3 mya to 0.01 mya) units, both unconformably overlying the late Miocene to early Pliocene (11 mya to 3.3 mya) clastic rocks. The clastics are chiefly composed of pyroclastic materials and a sequence of low dipping beds of conglomerate, sandstone and shale with limestone. Conglomerate clasts consist of andesitic pebbles, loosely cemented by sand and at times by tuffaceous materials. Limy, tuffaceous shale with thin lenses of dirty limestone form the base of the unit. This unit occurs along the eastern and western slopes of the central highlands and generally well-bedded and low-dipping although steeply dipping beds are found near major structures. These clastic rocks may not be comparable to igneous rocks in terms of efficiency as foundation bedrock, but these rocks can be good aquifers that are crucial sources of extractable groundwater.

The overlying limestone contains minor facies of conglomerate, sandstone and shale at its base. The limestone is white, porous, coralline and is poorly bedded to massive. The sandstone-shale beds are calcareous and exhibits cross-bedding. This limestones can be sources of groundwater because of its porosity, but is not a strong potential fossil fuel source because these rocks are still young.

Quaternary (1.6 mya to recent time) volcanics consist of the volcanic cones and associated flows found along a northwest-trending belt controlled by a major fault structure running parallel to the Philippine Fault Zone (PFZ). The volcanics are composed of andesite characterized by a porphyritic texture with trachytic groundmass. These are possibly contemporaneous with the extensive volcanism that occured during the quaternary, and the evolution of Biliran Island possibly related to this period of volcanism. These volcanic chains strongly emphasize the vast geothermal energy resources of the areas found in the islands of Biliran and Leyte that lies along the PFZ. This is extremely important in developing indigenous sources of renewable energy that can be used for the production of electricity, especially in regions where massive development is being done, such as that in Tacloban, Leyte.

3 .5 Dominant Coastal Processes

The Philippine Sea is the largest body of water which borders eastern Philippines. Waves crashing towards the entire coastal length of the region mainly derives its energy from this open sea. These waves travel in a West-Northwest general direction, owing from the general trade winds direction coming from the east (Gonzales 1994). This is specially dominant during the late summer up to the end of the rainy season (May-October). This region also experiences the brunt of the force of storms and thypoons which passes along Region 8. Samar is known to belong to the Visayan typhoon belt.

Most of the processes on the east side is dominated by erosion, as well as bioturbation. Portions of the coastline of the region (e.g. Salcedo-Matarinao Bay, Homonhon) is rimmed by rocky outcrops of varying composition and varying susceptibility to erosion. As observed from the aerial survey open coves and small bays seems to be conducive to coral reef growths. This is apparently due to factors favorable to coral growths such as shallow clear water, ideal warm temperature and constant water movement.

Partly to well-protected bays, as well as developed shallow deltaic plains has numerous mangrove swamps and forests, mainly because of the high amount of depositing substrates, as well as the natural tidal changes. While sandy beaches are well-developed in coastal areas that are favorable for deposition.

On the western side of Samar, the coast is protected and as such part of it can be classified as low energy shoreline. This is shown by the presence of high, weakly eroded seacliffs from Calbayog City all the way up to the northern coast, as well as those found along the coast of Catbalogan. Headland erosion is also minimal due to the smaller intensity of refracting waves. The dominant presence of swamps and mangrove forests along these areas, such as those found at Cambatutay, Sogod and Silangan Bays, along the coasts of Daram and Zumarraga Islands, and along the coasts surrounding the San Juanico Strait strongly support a relatively calm water and a geologic environment that is dominated by depositional process. The sedimentation rate is quite average, as shown by these well-developed swamps that mainly source their substrates inland.

Similarly, northern Leyte is characterized by relatively calm water. Coastal feature in this part of the study area is dominated by swamps, mangrove forests and developed coastal plains as observed in the Carigara Bay, and north of San Juanico Strait. The high coastal hills and thin, sandy beaches surrounding Biliran island also attest to this kind of current patterns, which means a minimal headland erosion. The coastal process in this region is dominantly depositional, mainly because of the high amount of substrate that sustains this kind of environment. The substrate is mainly sourced from the highlands north of Leyte and possibly through longshore drift of the sediments from other sources.

At Leyte Gulf, a circular pattern of wave motion in a clockwise manner possibly exists, which directly affect the manner of sediment deposition due to longshore drift and may be linked to the formation of the Tacloban sandspit (Torres 1994). This pattern is possibly caused by the incoming large, open sea waves from the Philippine Sea, south of Samar and southeast of Leyte. As the waves hit southern Leyte, these waves are deflected to move towards the north, thereby inducing headland erosion at the impact area and then allows sediment transport to the north. This deflection continues all the way up to Palo and Tacloban City, where it results to the formation of another longshore drift and circular wave pattern cell at San Pedro and San Pablo Bays. The bigger circular cell at Leyte Gulf still continues to affect the southern portion of Samar and the smaller bays near Balangiga because of continuous deflection up to Calicoan and Homonhon islands.

The sandspit located in Tacloban City, where the airport is built, is possibly formed by the build-up of longshore sediments transported from the south. The cuspic form of the coast north and south of MacArthur defines an erosional region caused by the longshore currents. Well-formed beaches on eastern Leyte are mainly due to this process of sediment transport, and may also be sustained by sediments from inland sources.

At Sogod Bay south of Leyte, the coastal process is dominantly depositional, characterized by relatively calm waters lightly influenced by open water waves. The sediments are mainly sourced inland, as well as from eroded coral reefs that are being deposited at the innermost embayment pocket. This region is bounded by high cliffs and hills at the mainland, after the coastal plains, protecting it from the effects of strong winds. A splay of the Philippine Fault is suspected to lie along this bay, with a parallel splay running along the coast of St. Bernard Bay. This structure might be a strong control with regards to the formation of these features.

To the west of Leyte, the coastal process is a mixture of depositional and erosional. This is mainly because of a relatively weaker wave energy that affects the western coast. Ormoc Bay, for example, is a site of strong sedimentation, sourcing their sediments from the inland rivers and longshore drift. Small bays with pocket beaches also occur to the north, with associated headlands that usually have small cliffs and hills. Mangroves and swamps have a relatively lesser occurrence, as compared to northern Leyte and Sogod Bay, with exception to northern Ormoc, which has a relative abundance of swamps and mangrove formaton at the north-western side of embayment.

3 .6 Coastal Features

The coasts of the three major groups of islands in Eastern Visayas, consisting of the islands of Leyte, Samar and Biliran, extends for hundreds of kilometers. Considering the budgetary and time constraints, it would not be possible to get an update of the characteristic features of the entire coast of Eastern Visayas. We, therefore, limit the descriptions of the coastline features to the fifteen pilot sites selected for a closer study by the Coastal Resources Management Plan (CRMP) research teams. These are Carigara Bay, Cuatro Islas, Maripipi-Sto. Nino, Ormoc Bay, Sogod Bay, Silago Bay, Borongan-maydolong, Gamay Bay, Guiuan, Matarinao Bay, Oras-Dolores, San Pedro Bay, Biri Group of Islands, Laoang Bay and Maqueda Bay.

The following sections will describe the predominant coastal features existing in the pilot sites according to the six types of features as given in Section 3.2 (Method and Limitations). Important landmark towns and islands have been cited for easy reference to the accompanying maps. These maps are shown in Appendix B for the specific pilot sites. Table 3.5 provides area estimates covered by the coastal features per pilot site.

Table 3.5a Aerial extent of the coastal features for each pilot site

	Area in Hectares		
Classification	**Carigara**	**Inopacan**	**Maripipi**
Coastal Plain	6,242	5,606	
Intertidal Flats	1,219	472	221
Rocky Beach	14		54
Rocky Cliff	554		88
Sandy Beach		346	268
Major Built-Up Areas	88	28	76
Fish Pond	678	21	
Mangrove	1,371	151	

Table 3.5b Aerial extent of the coastal features for each pilot site

	Area in Hectares		
Classification	**Ormoc**	**Silago**	**Sogod**
Coastal Plain	5,437	4,053	4,214
Intertidal Flats	568	359	402
Rocky Beach			194
Rocky Cliff			23
Sandy Beach (total)	526	747	1,457
White Beach			64
Major Built-Up Areas	729	169	318
Fish Pond	262		16
Mangrove	1,334	84	94
Quarry	24	4	

Table 3.5c Aerial extent of the coastal features for each pilot site

	Area in Hectares		
Classification	**Borongan**	**Guiuan**	**Matarinao**
Coastal Plain	4230	3826	2886
Coral Plain		47	
Intertidal Flats	1,176	4,717	1,188
Rocky Beach	38	77	174
Rocky Cliff	5	110	57
Unclassified			72
Sandy Beach (total)	525	1,502	285
White Beach	11	84	49
Major Built-Up Areas	192	137	179
Fish Pond		3	2
Mangrove	862	844	1,170
Quarry		38	6
Wet Land	15	71	72

Table 3.5d Aerial extent of the coastal features for each pilot site

	Area in Hectares		
Classification	**Oras**	**San Pedro**	**Biri**
Coastal Plain		28,080	3,738
Coral Plain		240	
Intertidal Flats		30	2,319
Rocky Beach		16	12
Rocky Cliff		753	
Sandy Beach (total)			770
White Beach	8		
Major Built-Up Areas	101	1,330	72
Fish Pond		237	536
Mangrove	747	1,647	3,855
Quarry	44		
Wet Land		183	

Table 3.5e Aerial extent of the coastal features for each pilot site

	Area in Hectares		
Classification	**Lao-ang**	**Maqueda**	**Gamay**
Coastal Plain	11,865	5,609	3,493
Coral Plain	1,788		
Intertidal Flats		2,510	1,884
Rocky Beach		160	21
Rocky Cliff		66	
Sandy Beach (total)	915	791	701
White Beach	5		
Major Built-Up Areas	125	27	*
Fish Pond		498	*
Mangrove	2029	3,854	*
Quarry		6	*

*No aerial survey was done over this pilot site because of flight problems.

Carigara Bay Pilot Site

Carigara Bay (Map 1 of Appendix B) is located north of Leyte Island. Its coast is moderately irregular, predominantly outlined by long stretches of grayish to slightly white sandy beaches, especially along the towns of Carigara, Guindapunan, Barugo and Capoocan at Leyte. There are also sandy portions at the coast of Biliran.

Rocky beaches and cliffs occur at the western and eastern coastal areas of Carigara and at Biliran, near Biliran Strait. Mangroves and swamps occur as patches with varying area sizes, usually located close to the shore or along the banks of estuaries and rivers. Some of the mangroves have been converted into fishponds like those found in Carigara, Guinapundan and Barugo, while other portions appear to be damaged or degraded, probably due to harvesting and clearing.

The intertidal is dominantly sandy and wide, such as those located at Carigara, but there are parts that are narrow and rocky, like those found near rocky beaches and cliffs at Biliran and the eastern and western sides of the bay. The coastal plains have a wide coverage at the area around the town of Carigara. Smaller deltaic plains occur at the east and west areas of Carigara and Biliran.

The major draining rivers of Carigara Bay are Himonglos, Canomontag, Carigara and Sangputan rivers. Moderate to heavy siltation is suspected to occur at Canomontag river. The shallow area behind the sand bar near the groin structure of Carigara town had been reclaimed and might be modified or developed into a port area.

Cuatro Islas–Inopacan Pilot Site

The Inopacan area (Map 2 of Appendix B) is located at the Southwestern side of Leyte Island. It consists of the islands of Cuatro islas, namely, Mahaba, Himokilan, Apid and Digyo, and the coastal towns of Baybay, Maitom, Inopacan, Guadalupe, Plaridel, Gabas, Lagolago, Hindang, Hilongos and Bato at Leyte. The coast varies from moderately uniform, which is noted by long and continuous stretches of the coast, to moderately irregular, marked by coves and indentations.

The coastal area is mainly characterized by grayish sandy beaches that are extensive in many places within the site, covering about forty percent (40%) of the area. The whole coast is mostly outlined by the narrow stretch of these kinds of beaches from north to south, and most especially at Hindang and Hilongos. Small, discontinuous segments occur at Inopacan and at the foot of hills that abruptly abuts in places. On the other hand, rocky beaches and scalloped small cliffs characterize the most of coastal areas of Cuatro Islas.

The mangrove and swamp areas, commonly occuring in the form of long and narrow stretches and patches. Sizeable mangrove areas occur at Inopacan and long, narrow stretches are present at Baybay. However, portions at Baybay had been converted into fishponds and there are traces of degradation to the vegetation.

The intertidal region is marked by sandy to rocky, corralline-related intertidal flats. Short, narrow sandy segments are prevalent along the areas of Hindang and Hilongos. Coral-related, small, narrow and fringing intertidal zones commonly occur at Inopacan at the coastal areas of Cuatro Islas. Most of this feature exists parallel to the shoreline, especially along sandy beaches.

The coastal plains commonly occur as narrow strips and segments that are discontinuous but extensive in many places. Wider areas also occur at the areas near Baybay, Gabas, Hindang and Hilongos. Deltaic plains wedged between hills and small mountains that abuts the land occur in places, such as those in Bato. Low mountains and hills commonly abuts the plains in certain places like Plaridel in Baybay.

The major river systems draining into Camotes Sea are Pagbangan, Ha, Cablason, Punpunan, Macahila and Iliga. Migration of the rivermouths of Macahila and Iliga at the coast had been observed. There are also reclaimed portions near Baybay.

Maripipi-Santo Niño Pilot Site

The area of Maripipi and Santo Nino (Map 3 of Appendix B) are located north of Biliran Island and west of Samar Island. These island group have a general appearance of volcanic edifices, especially Maripipi island. The shorelines of the islands of Almagro, Maripipi, Sto Nino, Kirikite, Camandag and Limbangcaran are generally irregular. The coastal area is dominated by scalloped rocky cliffs and ridges that rise up above the shoreline areas. The headlands of the islands appear to be fingers of solidified lava. Short, narrow segments of rocky and sandy beaches occur mostly in small coves, bays, indentations and pocket areas at the islands. The intertidal zones are usually narrow, rocky to sandy.

Very short and narrow coastal plains also occur in few places of the island group. The settlement areas are commonly located at the pocket beaches, scattered at the islands. There are highland areas above the cliffs and are inhabited.

Ormoc Bay Pilot Site

The Ormoc Bay area (Map 4 of Appendix B) consists of the coastal towns of Puerto Bello, Merida, Isabel, Albuera, Ipil, San Antonio, Caridad, Calunangan and Matlang along Leyte. The coast varies from moderately to highly irregular, but there are portions that are slightly uniform. The town of Isabel was the location of the PASAR and other heavy industries owned by the government, and thus contribute to the industrial development of Ormoc Bay.

Grayish sandy beaches characterize the whole coast of Ormoc Bay. They commonly occur as narrow, discontinuous segments such as those located in Isabel. Longer stretches of sandy beach is noted along the coast of Albuera and in places on the eastern coastal margin of Ormoc.

Mangrove and swamp areas predominate whole western coastal margin areas of Ormoc. They commonly occur as wide patches in places, especially near Puerto Bello and Isabel, Merida, and also as narrow, discontinuous stretches. Mangroves also occur at the nearby Dupon and Matlang Bays at Isabel.

Mangroves previously existed in portions near Albuera, but these may have been destroyed through time possibly because of human activities and exploitation. Most of the mangroves in Isabel appear undisturbed, although there are smal portions that have been cleared for industrial development, such as those located along the PASAR site. Mangrove stands are mostly intact near Merida although there is an observed prevalence in the conversion of some of these mangrove areas into fishponds and some have been degraded.

The intertidal region generally occur as narrow, discontinuous segments, which is mainly sandy although there are some fringing portions that are reef-related. Most of the intertidal zone are located along the western coastal stretch of Ormoc Bay.

Narrow coastal plains commonly occur along the western marginal coast of Ormoc. Wide plains also occur at the stretch from Ormoc City towards Albuera and extends to the southeast. Wide plains are also prevalent at the area near Isabel, Merida and Matlang.

Karstic hills are noted in places, such as those located near Calunangan, but these hills are not too spectacular.

The draining rivers are Pupon, Matlang Shapon, Macatol, Bagocos, Pagsangahan, Bawood, Bagongbong, Banalahong, and Panilahan. Pagsangahan River mouth which drains into Port Bello, Ormoc Bay is heavily silted. Most of the rivers in Albuera are braided and mature already. There are also changes in their river mouths, such as migration of the nearshore sandbars. Moderate siltation was obsserved on the bay.

Other river systems include Talisayan, Sibugay, Calingatngan, Tabgas, Palunas, Baean, Kagnonoc, and Macahila Rivers. Of these, Talisayan, Sibugan, Palunas, and Macahila Rivers have notable changes in the rivermouth opening, such as the migration of the offshore bar to a new position.

Quarries had been observed in few places at Isabel and Albuera. These quarries may be contributing to the siltation of the waters of Ormoc Bay. The heavy industries located along the coast may also be contributing to the degradation of the bay.

Silago Pilot Site

The Silago area (Map 5 of Appendix B) is located at the southeastern side of the Leyte Island. It consists of the islands of San Pedro and San Pablo, and the coastal towns of Silago, Sabang, Hinunangan and Hinundayan at Leyte. The coast is moderately irregular, characterized by small coves and indentations at the hilly headland area. It becomes uniform towards Hinunangan Bay.

The coast is predominantly outlined by white to slightly gray sandy beaches, commonly occurring in wide and long stretches. The whole coast of Hinunangan Bay and Hinundayan Cove, the shores surrounding the lesser islands, and in places at Silago are outlined by these white, prolific beaches. Shorter, narrow and discontinuous segments also exist in portions of Silago and in pocket beaches wedged between headland areas.

The rocky beaches, occurring at the foot of mountains and karstic hills that abuts the coast. Sometimes they occur as short, narrow stretches and as small pocket beaches at the headland areas. These features are common north of Silago and the headland area of Hinundayan.

The rocky, karstic cliffs and hills are mostly located at the headland area between Hinunangan and Hinundayan, although there are hills located north of Silago. The Anan Hills are the most noted of these features, although its natural vegetation cover has some portions that have been denuded.

The mangrove and swamp areas have limited occurrence, mostly as very short segments at the rivermouths of small rivers and as small patches along the coastal area. These vegetation appear to be intact.

The intertidal zone is dominantly sandy, and occurs as narrow to wide stretches beside the sandy beach. There are also portions that are rocky, which is mostly limited at the headland and corralline platform regions. These features also occur as narrow fringes and sometimes as sizeable intertidal flats.

Sizeable coastal plains exist in the area near Hinunangan and Hinundayan. Smaller deltaic plains also occur scattered in between hillsides, and sometimes as narrow and short stretches in places near Silago and Sabang. The lesser islands also have smaller coastal plains.

Bato River drain its waters into Hinundayan Cove and Bisay River drains into Hinunangan Bay.

Sogod Bay Pilot Site

The Sogod Bay area (Map 6 of Appendix B) is located at the southern end of Leyte Island. It is comprised of portions of Panaon Island at Panaon Strait, and the towns of Sogod, Bontoc, Banday, San Isidro, Malitbog, San Roque, Burgos, Himayangan, Liloan and Culian at Leyte. The Bay is quite narrow and elongated, landlocked at the eastern and western coasts, with its main opening towards the open sea located at the southern area. The coast is moderately uniform, marked by long beaches but there are limited portions that are irregular, marked by indentations. The bay appears to be a deep basin, because the intertidal area offshore appears to be scalloped, too narrow and is limited along the basin margin.

The coastal area is dominated by white to slightly grayish sandy beach. The sandy beaches occur as wide and almost continuous stretches, which narrow down in places near hilly areas. This continuity is noted especially along the coastal area from San Roque all the way towards the western coast near Panaon Island, although the beach width varies from wide to very narrow. Segments are commonly observed in places along the eastern coast of Sogod.

Mangrove and swamp areas have very scant existence in the area, possibly because of the nearly closed basin setting of Sogod Bay. These features usually occur as small patches scattered in few places Bontoc, Burgos and Liloan, where it is quite wider.

Narrow rocky to sandy intertidal flats commonly occurs in places along the coast at either sides of the bay. Narrow, discontinuous fringing reefs with rocky to sandy platforms is common at the eastern coasts, while the western coast is marked by narrow and long rocky intertidal area.

The coastal plains commonly occur as deltas of varying sizes, limited by the bounding hillsides that appears scalloped and rise abruptly. The widest coastal plain is located at Sogod, while the eastern and western coasts of the bay have smaller deltaic plains. Narrow stretches also occur in places near the scalloped sides of mountains facing the water. Many low mountains rise abruptly near Liloan.

The major river systems draining into the bay are Malitbog, the Consolacion-Pandan River System and the Salog rivers. The Consolacion-Pandan River appears to be heavily silted. Malitbog river also shows signs of siltation.

Borongan-Maydolong

The Borongan and Maydolong site (Map 7 of Appendix B) is located at the eastern side of Samar, covering Port Borongan and Napla Bay and facing the Philippine Sea. It is composed of the lesser islands of Menananod, Andis, Divinubo, and the coastal towns of Borongan, Maydolong, Llorente, Balangkayan, Maypangdan and San Buenaventura. The coast varies from moderately to highly irregular, denoted by alternating segments of coastal features such as rocky to sandy beaches and coves and indentations.

White and extensive sandy beaches characterize the coastal span from Llorente to Borongan. These features commonly occur as wide to narrow segments and are almost continuous, interrupted only by short and alternating segments of rocky beaches. Rocky beaches also occur in places, usually alternating with the sandy beaches but in short segments and are limited. These features are commonly observed at the hilly areas of Maydolong and Balangkayan towards Llorente.

The mangroves areas are quite small, usually limited along the rivermouth and in narrow and short segments along the coast. These are commonly located in few places at Borongan, San Buenaventura and Maydolong. Most of these appear undisturbed, with exception to certain portions at Maydolong where bare areas within the mangroves are observed.

The intertidal zone is generally rocky, oftenly occurring as wide flats and as fringing platforms associated to coral reefs. This is observed in almost all of the parallel stretches of sandy beaches.

The coastal plains commonly occur as deltaic platforms of varying areas, and also as narrow plains along the immediate coast. This manner of occurrence is prevalent along the whole coastal stretch, from Llorente to Borongan. In few places, hills and low mountains abuts behind the coastal plains. This is especially noted near Maydolong.

Karst topography can be noted along the stretch of Llorente to Borongan, the landscape of which is very similar to Chocolate Hills in Bohol. Natural vegetation still covers these areas.

Major river systems include Canoving, Lo-om and Borongan Rivers in Port Borongan, Maypangdan and Tabunan in Napla Bay, and Tongkip, Llorente, and Suribao Rivers at the Phil. Sea.

Gamay Bay Pilot Site

The Gamay Bay area (Map 8 of Appendix B) covers the whole of Gamay Bay, which includes the towns of Gamay, Cagamotan, Patong, Lapinig and San Ramon and portions of Sacamalig Bay. It is located at the northeast portion of Samar, facing the Philippine Sea. The coast is highly irregular, because of the strong contrasts in the existing features.

The coastal areas are dominated by mangrove vegetation. These vegetated portions occur as fringing patches near the open shores and also as inland swamps, most of which are located south of Gamay. Stretches of white sandy beaches occur. This is observable in the open-water areas near Gamay and around Sacamalig Bay.

The intertidal zone are mostly sandy and rocky, corralline areas. This is dominant in the areas south of Gamay Bay near the towns of Lapinig and San Ramon. The coastal plains are generally narrow in places, with exception to the floodplain near Gamay. The draining river for the area is Gamay river.

(NOTE: This area had not been covered by the aerial video due to unforeseen constraints encountered during the survey. The data in this portion were mainly based from the older maps, although a higher confidence can still be given for the older data to apply to the recent case of the site. Other pilot site that has a setting much like Gamay Bay generally has an intact geomorphological setting. Example of this are the sites of Oras and Matarinao, which still retains some of its features found from older maps whose source are the 1957-1960 aerial photos.)

Guiuan Pilot Site

The Guiuan area (Map 9 of Appendix B) is located at the southeasternmost portion of Samar Island. It is bounded to the east by the Philippine Sea and the Leyte Gulf to the west. The Guian peninsula is narrow and elongated sliver which is oriented along the northwest direction, parallel to the preferred orientation of the topographic features in this part of Samar. Immediately southeast of the Guiuam Peninsula are a series of small islands (Calicoan, Leleboon and Candulo) which appear to be disjointed part of the peninsula. The pronounce linearity of the eastern shoreline of this peninsula is strongly suggesting the influence of a geologic structure (e.g fault) in its formation. West of this peninsula, leeward side, are a number of small islands. Theses are the islands of Balinatio, Manicani, Botig and Tubabao. As viewed from a map, the offshore reef platform west of the Guiuan Peninsula and the Guiuan Peninsula form a somewhat triangular block which tapers to the south. Near the tip of this triangular block is Homonhon island.

The shoreline of the eastern side of the peninsula strongly contrasts the western shoreline. The eastern shoreline is very regular, strongly linear, while the western shoreline is very irregular.

The coastal area is dominated by extensive, white sandy beaches. The whole eastern stretch of the shore from Calicoan to the north beyond Guiuan is dominated by continuous, white sandy beaches, which varies from wide to narrow. This is also observed in many of the lesser islands and along the shores of Leyte Gulf, from Balinatio towards Salcedo all the way to Guiuan and Calicoan. The sandy beaches mainly outline almost all of the lesser islands and sometimes occur in shorter, narrow segments in places with cliffs, like Manicani and Homonhon.

The most dominant shoreline features of Manicani, Homonhon and Suluan Islands are rocky beaches and sea cliff. Beaches and abrasion platforms are typically narrow apparently due to the resistant nature of the rocks to erosion and weathering.

The mangrove and swamp areas are generally limited along the coastal area facing Leyte Gulf. These features commonly occur as short and narrow stretches along the shores of Balinatio, Salcedo, Botig, Tubabao and near Guiuan.

The intertidal zone commonly occurs as narrow to partly widening, fringing platforms and as small to wide, separate tidal flats. They are commonly veneered by what appears to be coralline sand and rubble. Narrow but extensive fringing coral reefs with sandy reef flats have also been delineated along the eastern coast. It is observed in places at Homonhon, Suluan, Manicani and Tubabao islands.

The coastal plains are commonly narrow, short and discontinuous on the islands as well as on the mainland. It sometimes occur as deltaic platforms in between hills that abuts near the coast. Narrow plains commonly bound the smaller islands as well as the areas located at the eastern coast facing the Phil. Sea. Deltaic plains are common at the areas around Leyte Gulf.

A high limestone cliff parallel to the shoreline seems to isolate the eastern shoreline from the western shoreline. This limestone cliff is elongated along the northwest-southeast direction and is traceable from Calicoan island to the Guiuan Peninsula. From the air, vegetation cover of the limestone area appears to natural vegetation with trees and brush.

Much of the islands and the peninsula are now devoted to agricultural use. But it seems that some natural areas still remain. As gathered from the aerial survey, the most serious problems besetting this study area is the mining activity in Manicani and Homonhon. Numerous bare areas have been identified in these islands. Most of these are attributed apparently to small-scale chromite mining. Large barren areas have been noted in areas being worked on by organized mining operations. Access roads have been cut in the island of Homonhon and are considered among the sources of siltation. Needless to say, mining operations in these islands have caused denudation and serious erosion and siltation problems.

Matarinao Bay Pilot Site

The Matarinao Bay area (Map 10 of Appendix B) is located at the southeasternmost coast of Samar, facing the Philippine Sea. It is comprised of the lesser islands of Anahao, Masisighi, Lalawigan and Capogpecana and the coastal towns of Hernani, San Miguel, Matarinao, General Mac Arthur, Buenavista, Abijao and Burac at Samar. The coastal pattern is variable, depending on its location. It varies from moderately to highly irregular at Matarinao Bay proper but becomes uniform along the coast facing the open sea.

The coast is mainly characterized by wide and extensive stretches of white sandy beaches along the area of the open sea. This is especially notable at the shores near Matarinao and Hernani. Short, narrow segments of these features are scattered in places at the bay proper.

Mangroves are widespread and dominant at the Matarinao Bay proper, mostly in the form of patches and narrow segments. These features are mostly found at the lesser islands, near General MacArthur, and along the coast of Abijao. There are also short, narrow segments of the vegetation at Hernani towards Llorente. Most of the mangroves appear undisturbed, with exception to very few portions where harvesting and fishpond conversion is being done.

The intertidal region is mainly characterized by sandy intertidal flats, especially at the headland sides near the mouth of Matarinao Bay. These features commonly occur as wide platforms and as narrow fringing zones that are associated with reefs. Narrow intertidal flats are common along Asgad and at the inner bay. Wider platforms are prevalent at Matarinao, San Miguel, Hernain and at Capogpecana island.

The coastal plains commonly exist as narrow stretches and as pocket deltas in between cliffs. The wider plains occur at General MacArthur, while most of the areas have smaller plains. The major river systems draining into the bay are Opong, Bigan and Sol-og River.

Limestone cliffs occur near the coastal area, just behind the plains of Matarinao and Asgad. The spectacular rock formation are covered with natural vegetation and resembles a similar structure at Guiuan. Behind these features are the karstic hills located in places near Abijao and Hernani.

Oras-Dolores Pilot Site

The Oras and Dolores area (Map 11 of Appendix B) lies on the eastern side of Samar island and faces the Philippine Sea. The area consists of Oras Bay, the lesser islands of Tubabao, Anahao, Catalaban and Hilaban to the east, and the major coastal towns of Can-awid, Dolores, Taft, Dapdap and Oras. The coast is highly irregular, marked by coves and inlets. The coast of Oras Bay, on the other hand, appears uniform.

The coast is predominated by wide grayish sandy beaches especially along the whole stretch of Oras Bay and around the lesser islands. Narrow and short, discontinuous segments of sandy beaches occur at Dolores, Dapdap, and Taft.

The intertidal zone commonly occurs as wide tidal flats or as narrow fringing platforms associated with coral reefs. This area is dominantly sandy, with some portions that are rocky due to the corralline nature of the platforms. Wide tracts of coastal plains exist in the area, especially near the major towns. The plains are more or less continuous from north to south.

Swampy areas, mostly covered with mangrove vegetation, commonly occur as patches and as segments along the riverbanks of certain rivers like Ulot and Dolores, and along Oras Bay. Mangrove patches also occur in places bordering the coast, such as those found at Dolores and Canawid. Most of the mangroves are undisturbed except for some small portions that appear to have been destroyed.

The major rivers draining into the area are Ulot, Oras, Dolores and Taft. The Dolores and Oras rivers show signs of moderate siltation.

San Pedro Bay Pilot Site

The San Pedro Bay area (Map 12 of Appendix B) is located at the northeastern side of Leyte and at the southwestern side of Samar. It covers the coastal areas of the southern portion of San Juanico Strait, the city of Tacloban, the towns of Santa Fe, Palo, San Jose, San Joaquin, Tanauan and Tolosa at the coastal side of Leyte, and the towns of San Antonio, Basey, Salvacion, Magollanes, Burgos, Osemena and Marabut along the coast of Samar. The lesser islands of Jinamoc and Capunluran are also covered by the study area. The coast varies from uniform to moderately irregular, characterized by long and continuous beaches, coves and indentations.

Grayish to white sandy beaches predominate the coastal area. The beaches occur in wide and long stretches from Tacloban City towards Tolosa in Leyte, and along the area of Basey and Salvacion. Numerous sand bars and spits are common along the coastal side of Leyte. The Tacloban City airport itself is located in a wide sandspit. These beaches also occur in small, narrow segments and sometimes in pockets wedged between headlands in places at San Juanico Strait and Marabut.

The occurrence of rocky beaches is very limited, mostly in the form of short and narrow segments at the foothills of cliffs or as narrow stretches. This features are mostly located at the area of Marabut and Osemena, and also in few, scattered places along San Juanico Strait.

The intertidal zone generally consists of sandy and rocky, corralline components. Rocky intertidal flats commonly occur as fringes along the coast, such as those located in few places of San Juanico Strait and Osemena. The sandy intertidal commonly occur as narrow stretches and flats beside the long beaches, such as those located along the coastal stretch of Tacloban City at the smaller bays to Tolosa and along Basey and Salvacion. There are portions in Tacloban, however, that are muddy, which is probably due to pollution.

Karst topography characterize the rocky cliffs and mountains that abuts along the coast located at Osemena, Marabut, Cabugao and Basey in Samar. Some of these cliffs occur as tower karsts similar to El Nido, Palawan and has a high aesthetic value. Pocket beaches are oftenly found between the tower karsts. These features exhibit well-formed limestone rock formations covered with natural vegetation that abuts the sea.

Mangrove vegetation is very abundant and widespread along the swamps and coastal stretch of Samar side of San Juanico and as narrow strips and patches at Leyte side along San Juanico. They also occur as small patches along the coast from San Jose to Tolosa, sometimes along the rivermouths, and as sizeable portions at Basey.

The mangroves apparently appear undisturbed at the side of Basey. At the eastern coast of Leyte, however, the mangrove patches were either highly disturbed or have been subjected to conversion into fishponds. This fishpond conversion is also rampant along the coastal sides of San Juanico Strait. Some of the mangrove areas have been badly degraded. Even portions of the Cancabato bay in Tacloban had been built up with fishpens.

The coastal plains occur as wide tracts of land, as pocket deltas, and as narrow stretches in certain portions. Some of the wider plains project inland, like the area located in Basey. The wide plains generally occur on both sides of San Juanico Strait, the whole coastal stretch from Tacloban to Tolosa at Leyte and the stretch from San Antonio to Burgos at Samar. Pocket deltas and narrow plains exist at Marabut, Osemena, and Samar sides of San Juanico Strait. Some of the coastal plains have isolated small hills located near the shore.

The major rivers draining into the bay at Samar are the Basey and Legaspi rivers. Heavy siltation had been observed at Basey. The draining rivers at Leyte are the Daguitan and the moderately silted Palo river. The rivers draining into San Juanico Strait are Tigbao at Leyte and Silaga and Apolagon at Samar. Varying degrees of siltation had been observed at the smaller bays around Tacloban City.

The area around and within Tacloban City is moderately urbanized, and there are presences of different industries in the area which can contribute to coastal degradation of critical areas.

Biri Islands Pilot Site

The Biri pilot site (Map 13 of Appendix B) is generally located at the northwestern side of Samar Island. The area is composed of the islands of Biri, Talisay, Cagnipa, Tingyao, Balicuatro, Bani, San Juan, Gilbert and Cabaongon Islands and the coastal towns of Lavezares, Borobayba, Rosario and San Jose on the side of Samar Island. The coastal areas of these places are highly irregular. The coast is dominantly composed of mangrove areas followed by sandy beaches.

The mangroves occur as wide patches and as narrowing stretches along the estuaries and open water areas beside the beaches. More than fifty percent 50% of the mangroves located along the shores of Lavezares have been converted into fishponds while remaining portions show various degrees of disturbance and damage. Near Rosario, most of the mangrove areas have been converted into fishponds and about fifty percent 50% in San Jose underwent conversion. At the minor islands, however, only small portions of the vegetation experienced slight disturbance and fishpond development.

The narrow sandy beaches are widely dominant at the minor islands, especially at Balicuatro and Biri. At Lavezares and portions along Samar island coast, these sandy beaches occur as narrow and short, discontinuous segments. The sandy to rocky corralline intertidal area, which varies from narrow flats to wide platforms. There are intertidal portions with presence of seaweeds and grasses.

The coastal plains generally occur in small pocket deltas and as narrow segments along the coastal area. These features only occur at the smaller islands and mainland Samar areas south of Biri Channel. Some of the mangrove wedge through the plains and most of the coastal towns are located in these areas.

Lao-ang Bay Pilot Site

The Lao-ang Bay pilot site (Map 14 of Appendix B) consists of the islands of Batag, Cahayan, Lao-ang, Binay, and the areas near the town of Pambujan and Palapag and portions of Bantayan and Laoangan at Samar. It is located at the northeast end of Samar. The coastline is moderately irregular at the Samar side, but becomes highly irregular along the coasts of the islands, like Batag. The coastal area islands are generally composed of white sandy beaches and mangrove- vegetated areas.

The white beaches commonly outlines most of the coast and sometimes as short segments in between the headland areas. This is observed especially at the coastal side of Pambujan and Bantayan. The mangroves on the other hand, oftenly occur as wide patches, covering the swampland areas, or as strips along certain parts of the coast, small rivers and estuaries like those near Pambujan. Some of the mangrove stands in certain areas show some degree of disturbance due to harvesting.

The intertidal area generally occurs as wide platforms like those in Batag, or as narrow bars along the shores of Pambujan. This is generally sandy, sometimes with the occurrence of sea grasses, but there are portions that are rocky which may be corraline platforms. Offshore sandbars and spits are commonly found within the shorelines of Laoang Island and Pambujan Bay.

The coastal plains are generally wide in extent, especially in areas around the towns of Palapag, Pambujan, Laoangan and Bantayan. The smaller islands also has sizeable areas of coastal plains, like Batag, but sometimes, they occur as narrow regions in rolling to highland areas.

The major river systems affecting these areas are the Catubig and Bobolgusan rivers which drain towards Laoang Bay, Pambukhan and Mondragon riveres draining into the Philippine Sea, and Balud, Bantayan and Bugko rivers that drain towards Bantayan Bay. The Pambukhan river mouth is showing signs of slight to moderate siltation.

Maqueda Bay Pilot Site

The Maqueda Bay area (Map 15 of Appendix B) is located at the middle section of western Samar and includes the Bays of Maqueda and Villareal. It comprises the islands of Zumarraga, Guimarcan and Daram and the coastal towns of Villareal, Wright, Hinabangan, San Sebastian, Calbiga, Camaisi and San Agustin at Samar. The coast is moderately irregular, characterized by a mosaic of various features located in different places.

Mangrove and swamp areas predominantly cover the region which is especially widespread around the Maqueda Bay and the coastal areas north of it. They occur as wide patches, independent islands, as vegetative margins along the inland estuaries and riverbanks, and as wide and long stretches at the waterfront sides of the coast. Characteristic sites include Villareal, Wright, Calbiga, areas around Catbalogan, in portions of the lesser islands, and in many places of Maqueda and Villareal Bays.

However, many of these mangrove areas have been extensively degraded or destroyed. Conversion of the mangrove to fishpond is noted to be prevalent in this pilot site, i.e. Maqueda and Villareal Bays, and in areas near Catbalogan.

Sandy beaches are commonly observed at the shores of the lesser islands that are located farther from the inner bay area and at the northeasternmost portion of Catbalogan. Portions of Daram, Guitarcan, and Zumarraga islands are outlined with grayish sandy beaches. Rocky beaches, commonly occur alternately with the sandy beaches and at the foot of small cliffs that abuts the coast. These features are also located at the areas of the lesser islands and in few places south of Villareal Bay and northwest of Catbalogan.

Few areas have scalloped rocky cliffs and most of these are located at the mountainous and hilly coastal areas of Catbalogan, at portions of the smaller islands, and in few places of Villareal Bay.

The intertidal area is dominantly sandy, but there are portions that are rocky. These features occur as narrow, fringing flats or as wide platforms that are common at the waterfront side of the mangrove areas. These features are commonly found in places along the bay and the narrow flats are common at the smaller islands..

The coastal plains generally exist as narrow stretches or as small deltaic platforms scattered in places of the site. The largest coastal plain is located at Wright and it projects inland. Portions of the plains at Villareal are commonly occupied by the swamps.

Unique karstic hills were noted at the northeastern side of Wright, which appears to be untouched. These hills look much like the Chocolate Hills of Bohol, and their natural vegetative cover is still intact.

The major rivers draining into Villareal Bay are Santo Nino, Obayan, Libonio and Calbiga. Some of these meander inland. Major rivers draining into Maqueda are Inabangan, San Sebastian and Wagao, but there are other smaller estuaries that extend inland through the mangrove area. Varying degrees of siltation can be observed at the mouths of rivers and estuaries that drain the swamplands. There are areas where the water at the coast is murky, and may be attributed to the heavy siltation.

3 .7 Potential Physical Constraints

Earthquake Related

Central eastern Philippines is considered highly susceptible to earthquake related hazards. This region is traversed by a parallel geologic structure, which are known earthquake generators. These are the Philippine Fault Zone and the Philippine Trench. The Philippine Fault Zone is an active lateral fault, which is traceable from northern Luzon to eastern Mindanao. In the eastern Visayas Region, it traverses the central region of Leyte, from Sogod Bay to the Biliran Strait to the north. While the Philippine Trench is a subduction zone marking the collision boundary between the Philippine Sea Plate and the lesser Central Philippine Plate. Figure 3.1 shows a regional geohazard map of Eastern Visayas.

Active movement along this fault caused the destructive Central Luzon earthquake of 1990. Numerous destructive earthquakes that affected Leyte in the past are attributed to the Philippine Fault Zone. While a number of destructive earthquakes with epicenter in northern Samar are presumed to be due to activities along the Philippine Trench.

The following table enumerates the destructive earthquake that has affected Samar and Leyte.

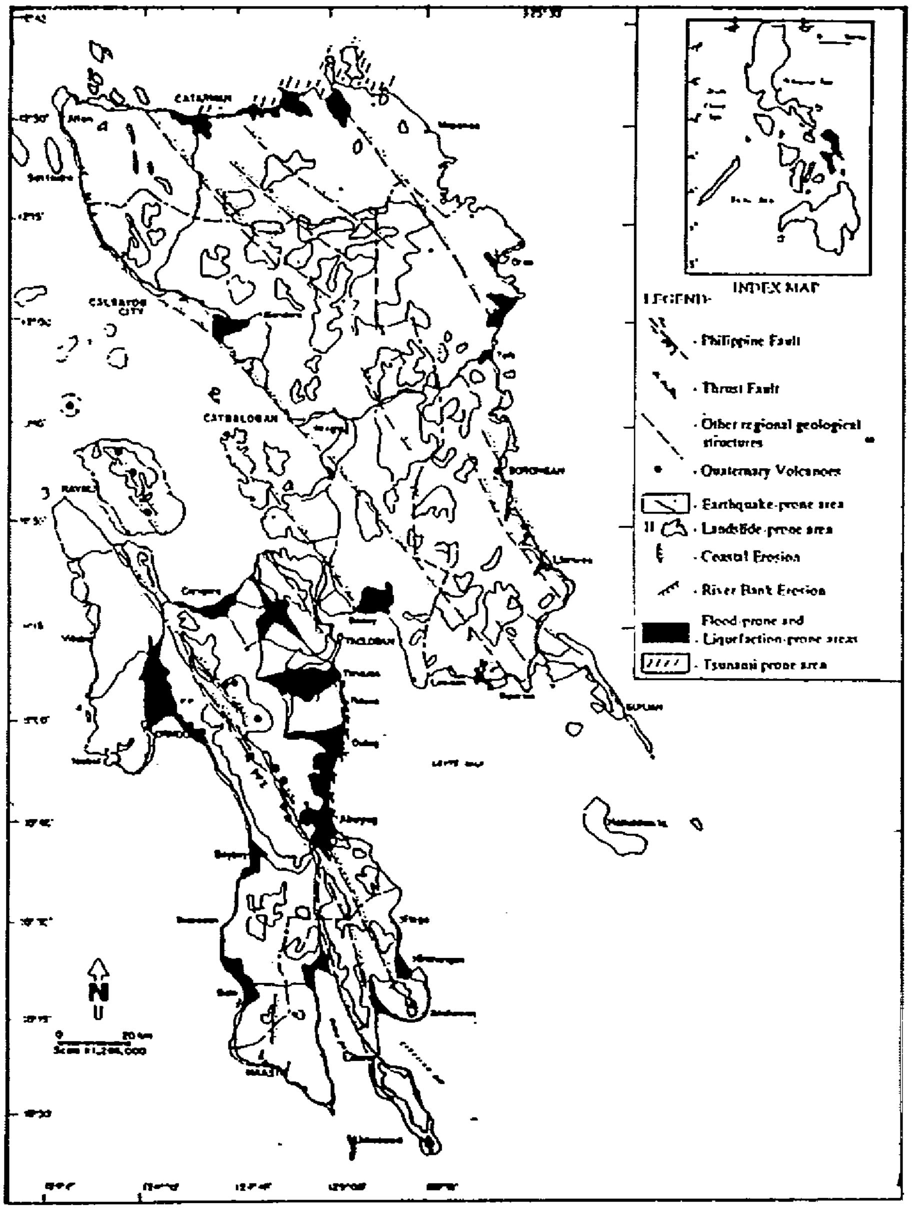

Figure 3.1 Regional geohazard map of Eastern Visayas or Region VIII

Source: Domasig et. al., 1994, from Natural Disaster Mitigation in the Philippines, DOST-PHIVOLCS, p. 142.

Table 3.4 Destructive earthquakes in Region VIII (Eastern Visayas)

Date	Place	Intensity*	Remarks
Dec 3, 1608	Ormoc and Central Leyte	Ms=7.4	Tremendous earthquake felt in the island of Leyte.
Mar 25, 1665	Catarman, Northern Samar	Ms=6.9	Felt in Northern Samar and Southern Bicol.
1743	Central Leyte	Ms=6.9	Tremendous earthquake felt in the island of Leyte.
Sept 27, 1863	Catbalogan, Samar	Ms=7.4	Felt at Leyte, Masbate and Samar islands.
Oct 19, 1865	San Bernardino Strait	Ms=7.9	Felt over areas of Bicol and Samar.
Aug 16, 1869	Masbate	M=7.4	Animals were terrified, domesticated birds flew around in an unusual manner and the sea was disturbed; the motion of the earth was E-W and so strong that all were frightened and threw themselves out of the houses though the houses were built of wood, bamboo and palm thatch and hence posed no danger. The few masonry buildings were considerably damaged and the others were tilted; the statues in the church turned on their pedestals, and in private houses nearly everything was jolted out of place. Large trees fell; cracks of great width opened in the south of the island of Masbate, and there were slides in the hills and on the steep sea-coast. A small island, among the many in the north end of Ticao, is said to have disappeared.
	Tacloban,		Shaking was felt in this capital with N-S

Date	Place	Intensity*	Remarks
	Leyte		oscillations lasting about 20 seconds.
	Samar		Strong shaking lasted for about 16 seconds.
Feb 7, 1890	Biliran and Calubian Peninsula	M=7.4	Felt over areas of Masbate, Leyte, Samar and Biliran.
Oct 19, 1897	Masbate	Ms=7.4	In Biliran Island, for two days, successive earthquakes were felt continuously, too strong to allow sleep, alarming everyone and preventing ordinary work. Fear was exacerbated by the fact that the island of Biliran is a place where there are mines of sulfur, iron and pitch.
Oct 19, 1897	Oras, Samar	Ms=8.1	The facade of the church, rectory, schoolhouse, courthouse and bridges were destroyed.
	Calbayog, Samar		On the 19th and 20th of the month, four violent, two strong and about 38 light earthquakes occured, all NE-SW except that on the 20th which is NNE-SSW.
	Catbalogan, Samar		Many feared that the houses would collapse. An hour later there was an aftershock and more followed for 24 hours, keeping everyone in a state of tension.
Nov 13, 1925	Samar	Ms=7.3	Perceptible within a radius of 600 kilometers comprising SE and S Luzon, all the Visayas Islands and NE Mindanao
	Coast of Samar		Some substantial infrastructures including native houses suffered considerable damage. Many persons were injured.

Date	Place	Intensity*	Remarks
	Masbate, Northern Cebu and Leyte	Int V-VI	at a distance of 300 kms from the center
Nov 17, 1988	Catarman, Samar	Ms=6.1 RF=VII	Most buildings suffered damages.
	Catbalogan	RF=V	
Jul 5, 1994	Southern Leyte	Ms=6.2	Hypocentral determination placed the epicenter NE of Libagon or SW of Hinunangan in Southern Leyte Province. Prior to the main shock, at least 765 seimic swarms were recorded from March to April 1994. Fairly strong aftershocks occured for several weeks after the mainshock. Small volume of landslides occured at Mt. Cabalian and nearby areas.
	Hinunangan, Hinundayan, Anahawan, St. Bernard	RF=VII	Minor liquefaction occurred
	Libagon, Silago	RF=VI	
	Sogod	RF=V	
	Palo	RF=III	

Source: Natural Disaster Mitigation, DOST-PHIVOLCS, 1994

* M = magnitude; Ms = magnitude scale; RF = Rossi-Forrel

Hazards associated with earthquakes are ground shaking, liquefaction, rupturing and Tsunami. Due to the lack of field verification and detailed study, susceptibility of the coastal areas of Samar-Leyte to ground shaking can only be discussed in general terms.

Groundshaking

Damages due to strong vibration during and earthquake are dependent upon the magnitude of the earthquake, distance of the site from the earthquake generator and the modifying effects of substrate soil condition. Hence, the shallower the earthquake source and the closer to the epicentral area the stronger is the intensity felt (Daligdig and Besana 1993). In general, areas along the trace of the Philippine Fault and its splays and other active structures are relatively more susceptible to groundshaking.

However, susceptibility of areas along the Philippine Fault to earthquake hazards varies. Some areas are considered less susceptible while other areas can be considered more prone to earthquake related hazards. According to recent studies on the Philippine Fault segment in northern Leyte, i.e. Northern Leyte Geothermal Area, creeping movement characterises the Philippine Fault in this part of Leyte. Because of the continued release of stress, the probability of the occurrence of large earthquake is reduced. Records of destructive earthquakes which occurred from 1589 to 1994 supports this interpretation. Epicenters of major destructive earthquakes in Leyte are located in the southern half of the island.

In addition, epicentral plot of earthquakes from 1900 to 1994 shows that occurrence of earthquakes in the Samar-Leyte region is most prevalent in southeastern Leyte. This is the area of Mt Cabalian and Silago.

In the island of Samar, based on distribution of epicenters of historical earthquakes, the eastern coastal zone of Samar is considered prone to groundshaking in the event of strong earthquakes originating from the Central Visayas segment of the Philippine Trench. There are three recorded events of destructive earthquakes in Samar and epicenters of two of these are located in northern Samar and one is located in the central western side of the island, east of Maqueda Bay.

Liquefaction

Areas susceptible to liquefaction are areas underlain by loosely compacted, water-saturated fine sediments such as sands. Physiographically, these are alluvial plains, floodplains and coastal plains.

Due to the rugged and mountainous terrain of the Samar-Leyte area, there are very few places which are susceptible to liquefaction based on the cited criteria. Inspection of the maps showing the distribution of coastal plains will indicate the areas susceptible to liquefaction. Significant coastal plains in Leyte are Ormoc, Tabontabon, Hinunangan, parts of Tacloban, Baybay, Carigara and other lesser coastal plain areas.

In Samar, among the possible areas susceptible to liquifaction are coastal areas around Maqueda, Villareal, Sogod and San Pedro Bays, Catarman, Gamay and Lao-ang, and Catbalogan.

Surface Rupturing

Areas susceptible to rupturing are those traversed by active faults and pre-existing faults. Again areas in Leyte cut by the Philippine fault and other structures are susceptible to surface rupturing during an earthquake. Some of these areas are the coasts of Leyte, Calubian, Biliran and Naval to the north, the eastern coastal boundary of Sogod Bay where Libagon and Lilo-an lies, and the coasts of Cabalian Bay, all located south of Leyte.

Tsunami

The eastern side of the Philippines can be considered as highly susceptible to Tsunami. Historical records show the occurrence of Tsunami along the eastern seaboard, from eastern Luzon down south to Mindanao. Susceptibility of the region to Tsunami is due to the convergence of several factors. One is the presence of earthquake generator in eastern Philippines, the Philippine Trench; second, the eastern coast of the Philippine is exposed to elements from the Pacific side. There are no offshore islands or reef to dissipate wave energy before it reaches the mainland.

A historical event of Tsunami in northeastern Samar has been reported in 1925.

Because of this event, Domasig et al 1994, classified the northeastern side of Samar as a Tsunami-prone area. This area includes the coastal towns of Catarman, Mondragon, San Roque, Pambujan and the northwestern islands of Batag, Binay, Cahayan and Laoang.

Sea Level Rise

Sea level rise is another important consideration in coastal management. Recent results of studies on sea level rise are indicating a worldwide shoreline migration as sea level rises (AAPG, 1997). Contrary to previous pronouncements, there is general agreement among the experts that sea level rise will be less dramatic (Viles and Spencer 1995).

As suggested by experts, sea level rise is attributed to numerous factors, among of which are isostatic adjustment, global warming, ocean thermal expansion, increased amount of water returned to the sea due to reduced water holding capability of the soil and subsidence due to water and petroleum extraction.

A recent estimate of the sea level rise for the period 1900-2100 is 46 cm (Wigley and Raper, 1993). This is equivalent to a rise 0.23 cm per annum. Major developments along the coastal zone should take into account this projected rise in sea level.

Storm Surges

Regions that are potentially susceptible to storm surges are the regions that are directly fronting the open sea or a wide body of water. Surges commonly occur during heavy monsoons or when a very strong typhoon passes by a coastal area that is directly open to the sea. It translates to heavy downpour accompanied by a rise in the sea level which inundates an affected area.

Historical data shows that Tacloban City, Leyte and Catarman, Samar was once affected by storm surges. The other areas that can be susceptible to this hazard are the northern and eastern coasts of Samar, and the eastern coast of Leyte.

3 .8 Recommendations

Recommended general management strategies for the coastal zone of Samar and Leyte are categorized into four (4) categories. These are :

- Environmental Rehabilitation
- Biodiversity Conservation
- Sustainable Development
- Hazard Mitigation

Environmental Rehabilitation

Areas that should be prioritized for rehabilitation are Manicani Island and Homonhon Island. Rehabilitation should include reforestation of bare areas, stabilization of bare slopes and strict implementation of mining laws and environmental laws that applies to mining activities.

Rehabilitation of the coastal areas near Merida, Ormoc Bay and Albuera should be a top priority in western Leyte. Regular monitoring of industrial areas should be implemented. For urban areas and settlements, LGU should enforce land use zoning regulation. Provisions of the Philippine Water Code should be implemented to guide development along coastlines.

The coasts of Carigara Bay in northern Leyte and Maqueda Bay in western Samar should be prioritised for rehabilitation and management of remaining mangrove stand. The same is recommended for the mangrove areas of Biri and Lao-ang.

Biodiversity Conservation

The mangrove areas of eastern Samar should be prioritised for conservation. Areas worth preserving should be identified and managed as a protected area.

Sustainable Development

Recognising the importance of mining and aquaculture in the economy of Samar and Leyte, responsible mining operations should be encouraged. This will mean stricter implementation of mining laws and pollution laws and compliance of the mining operators to all its environmental obligations. Some of which are rehabilitation of mined our area, provision of environmental guarantee fund, regular environmental monitoring.

Existing aquaculture farms should be supported with the aim of optimizing productivity. Optimum production of existing fishponds is necessary to prevent conversion of remaining mangrove stands in Carigara, Ormoc and Maqueda Bay.

Finally, tourism development should also be encouraged.

Development of coastal areas should be guided by best practices. A set of rules prepared by the American Association of Petroleum Geologists, Division of Environmental Geosciences to guide coastal development are as follows:

a) Coastal zone is unique and requires unique management strategies.

b) Coastal physical processes must be identified and understood from a whole island perspective.

c) Property damage potential is site-specific and each site is different

d) Property damage mitigation must be from a whole-island perspective.

e) Relative risk areas can be recognized on the basis of well-defined criteria.

f) All coastal hazard evaluation and mitigation must consider a rising sea level.

g) Repair alterations due to development

h) Conserve sand.

i) Conserve vegetation cover.

j) Conserve landform.

Hazard Reduction and Disaster Preparedness

Being susceptible to geologic hazards, management plan of the Samar Leyte coastal zone will not be complete without programs for hazard reduction and disaster mitigation. As part of this program a detailed risk assessment should be carried out in areas of the region that are identified to be prone to natural hazards. Some of the areas identified are northern Leyte and southern Leyte, i.e. areas traversed by the Philippine Fault and eastern Samar which is prone to meteorologic and oceanographic hazards.

The result of this study should be used as one of the criteria in the physical planning of the different municipalities of Region VIII.

The developers should adhere to guidelines and best practice for developing coastal areas.

3 .9 Conclusions

Potential of Coastal Areas for Development

Physically, only a small proportion of the coastal zone of Samar and Leyte are favourable for large-scale land development. There are very few coastal plains which can be host to large land development. Most of these areas are now occupied by settlements, which makes up the major cities and municipalities of Samar and Leyte. The only location with a sizable hectarage of contiguous flat lands is the area from Tacloban going south to MacArthur. In Samar, coastal plains are very limited in land area.

In addition, there are physical constraints which should be considered when planning the development of the region. There are two general areas in the region which are relatively more susceptible to natural hazards. These areas as Eastern Samar and Central Leyte. Of the entire region, Eastern Samar is classified to be susceptible to Tsunami and storm surge. While Central Leyte is susceptible to hazards associated with active fault, the Philippine Fault. It is imperative that developments in these areas be anteceded by risk assessment study.

Overall Physical Environmental Condition

There are three identified major stressors of the physical environment of the coastal zone of Samar and Leyte. Although these are not prevalent, they are considered major because of the magnitudes of their impacts in a particular bay or area rather than their impacts on the region in general. These stressors are: (a) settlements and urban development; (b) mining and industrialisation; (c) agriculture and aquaculture; and (d) tourism.

Settlements and Urban Development

Coastal settlements and urban areas such Ormoc City and Tacloban City have serious implication on the geomorphology of coastal areas. One of the most evident is alteration of shoreline configuration. Reclamation and construction of offshore structures such as sea walls, piers and groins alter shoreline configuration. Construction of protective walls such as in the airport of Tacloban interferes with the natural process of nearshore sediment transport. While piers and jetties obstruct longshore drift, sometimes with destructive effects on adjoining beaches. Settlements and urban development also encroaches on other important coastal features, the mangroves. Mangroves are reclaimed and built on. Lost of mangrove stands translates to loss of natural sedimentation basins. Mangrove areas being areas of low energy are depositional areas. Silt carried by surface runoff are intercepted by mangroves in effect reducing sediment transported offshore.

Mining and Industrial Development

These are confined to two areas, Merida, Leyte and southern Samar. As observed in the PASAR processing plant, effects of the industrial plant on the physical aspect of the coast are alteration of shoreline because of reclamation and construction of offshore structures. Although, no longer within the realm of the physical environment, pollution seems to be prevalent in the near coastal water around the plant site. Color of the substrate of the shallow coastal water is observed to be the same as the color of the stockpile in the yard of the processing plant. This indicates high level of spillage of materials into the marine water.

What can be considered as major mining activities in the coastal zone of Samar are the nickel and chromite mining in the islands of Manicani and Homonhon. Mining in these islands have resulted to large barren areas. In addition, access roads have been opened into the hinterland, increasing the susceptibility of the island to erosion. Small-scale miners on the other hand have made numerous small excavations, leaving patches bare areas in the landscape of Homonhon Island. Aside from its effect on the physical environment, effects on the biological component is deemed more serious. Mining has stressed the natural vegetation of the island. Due to the toxic character of the soil substrate, it will be difficult to revegetate the island. In addition, because of the islands unique physico-chemical condition, it is possible that it is harboring a special community of plant species. Plant species which have adopted to the toxic condition of the soil. Continued denudation of these islands can result to loss of biological diversity.

Although not documented during the aerial survey, it was noted during the travel from Borongan to Tacloban that Taft River has not recovered from the effects of mining activities in its headwater. The lower reaches of Taft River is noted to be highly silted with rust staining.

Agriculture and Aquaculture

Impacts of these two activities are more on the biological aspects. Majority of the coastal areas of Samar and Leyte are now converted to agriculture. Judging from the coconuts and the maps produced from 1950 aerial photos, conversion started more than four decades ago. As a result, beach forest of Samar has been eliminated. Natural vegetations are now only observed in some karst areas which are inaccessible and not suited for agriculture.

Conversion of mangrove into fishponds is very prevalent in Ormoc and Carigara in Leyte and the western coastline of Samar (e.g. Maqueda Bay).

Mangrove in the eastern side are more less intact although there are signs of harvesting of mangrove. Pilots sites which are recommended for conservation of mangrove forest are Oras Bay, Borongan Bay, Maydolong and Matarinao Bay.

Aesthetics and Potential of Coastal Area for Tourism Development

Much of the beaches of Samar and Leyte can be classified average, in terms of aesthetic quality. Most of the coastal area are inhabited and dominated by agriculture. However, there are areas with high aesthetic quality. The area which is considered to have the best potential for tourism is the Guiuan Peninsula. This area is characterized by natural vegetation, sparsely populated, long stretches of white sandy beach, clear water and uncommon to unique topogrpahic feature. The second area is the Biri group of island in northern Samar.

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Chapter 4

Coastal Pollution Sources

4.1 Introduction

The previous chapters have shown how we can characterise or describe a regional area of study by portraying its geophysical features through maps. These are information that can be presented visually through maps because we can fix their position relative to their location on earth. This provides us a way of thinking in a spatial context with a good view of the extent of the physical characteristics abutting or encroaching our domains. This helps us understand the environment surrounding us and thus helps us to decide and plan accordingly and appropriately. This is the principal support that can be provided by this GIS component of the CRMP Project. Essentially, this supporting tool provides a visual context of the spatial dimension of our territories.

Besides the land-based features and geomorphological characteristics that are mostly associated with the landscape, another type of feature that has a geographical dimension and importance to coastal planning and management is coastal pollution. Although this feature is generally associated with chemical quantification and qualification of its sources and impacts, the GIS component of the CRMP project would focus on its spatial dimension that which can be portrayed through the GIS. This is the main objective of this chapter.

We note that this report on the coastal pollution aspect has been made with considerable limitations on the contingency provided for this aspect. It has been a prior consensus by the CRMP study teams that it would be an expensive undertaking to carry out an intensive assessment, which includes chemical analyses, of the coastal pollution situation in Eastern Visayas. Hence, a complete description of the extent of the activities and/or pollution per pilot site is not possible at this stage due to the limited framework and budgetary constraints.

In lieu of a quantifiable approach to coastal pollution, we used an approach that could provide a qualitative overview of pollution threats (coming from identified sources) to the coastal environment through a map-based visual approach. This is explained below. Any omissions or additions to the material presented in this chapter can be referred directly to Cybersoft and indirectly to the CRMP research teams involved or the proponent of the CRMP project, the Regional Development Council, through its technical arm, the National Economic and Development Authority for Region VIII.

4.2 The Basic Approach for the Coastal Pollution Aspect

To meet the objective of this chapter, which is to provide a spatial dimension to the coastal pollution aspect, this document reports on the existing pollution sources, as to its geographical context in Region VIII. The data for this were obtained through the field inventory and assessment undertaken by the CRMP survey teams, VISCA, ESSC and UEP, in their respective pilot sites, from DENR sources and from the aerial survey conducted last May 29 to 31, 1997.

These pollution sources are portrayed on maps and overlaid on the maps of the location of coastal habitats. The overlay is intended to show the proximity of the coastal habitats or coastal resources, as possible receptors to pollution, that are sheltering aquatic life. The pollution sources are shown superimposed over the coastal habitats in maps provided in Appendix C.

Pollution, specifically marine pollution, has been defined by GESAMP (the IMO/ FAO/ UNESCO/ WMO/ WHO/ IAEA / UN/ UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution) as "the introduction by man, directly or indirectly, of substances or energy into the marine environment (including estuaries) resulting in such deleterious effects as harm to living resources, hazards to human health, hindrance to marine activities including fishing, impairment of quality for use of sea water and reduction amenities" (UNEP 1983).

4.3 The Existing Pollution Sources in the Region

The pollution sources in Leyte and Samar are predominantly sand and gravel mining or quarrying, logging and kaingin, mining, tourism, coastal settlements, industrial sites and agricultural areas. These sources were identified by the various CRMP survey teams in their assigned pilot areas. Specific areas where the activities have been observed or reported are indicated on the maps shown in Appendix C.

Sand and Gravel Mining or Quarrying

Surface deposits such as sand, gravel and shell are the most commonly extracted material by dredging and/or excavation. These materials are of low unit value with transportation costs determining the feasibility of the operation.

The most severe environmental impacts from these activities result from the disruption of important habitats in estuaries and the degradation of water quality of sea water. The latter is manifested in various ways such as turbidity, sedimentation, loss of productive bottom or diminished resources (plants, shellfish beds and fish stocks) (Clark 1983). Other effects include saltwater intrusion and adversely, altered circulation characteristics as a result of widened or deepened channels. When done too close to the shore, it may result in the loss of slope equilibrium causing the beach to slump away into the sea (Plate 1 in Appendix C).

In Region VIII, sand and gravel mining has been identified in Carigara Bay, Ormoc Bay, Sogod Bay, Cuatro Islas and in Maripipi. The most extensive activities occur in Ormoc Bay (Map 4) where seven individuals and or corporations have been identified to be engaged in sand and gravel mining (VISCA, 1997). The activities are alarming enough to have landed a news item in one of the national newspapers. The article indicated that "the rampant extraction of sand and gravel has widened the riverbed, threatening to erode ricefields near the riverbank" (e.g. Plate 2 in Appendix C). The news item identifies the Panilahan River (Plate 3 in Appendix C) as the site of these activities which the "Department of Environment and Natural Resources seems helpless against…" ('Today', 28 Dec. 1996, p. 4).

The GAP Assessment and Legal Study undertaken for CRMP identified Gamay Bay (Map 8 in Appendix C) as another area where massive quarrying is taking place. Here, coral mining takes place because there are no available mountain rocks, which can be used as construction material for roads, piers, building and other infrastructure.

Logging and Kaingin

The conversion of forests takes various forms: conversion to kaingin or marginal upland agriculture (Plate 4 in Appendix C); conversion to communal agricultural use (e.g. grazing), conversion to non-forest plantations (e.g. coconut and abaca) and destructive timber harvesting (both legal and illegal).

Along steep slopes of mountains, large areas of forests are cleared to grow crops. The trees are burned and agricultural crops are planted (Plate 5 in Appendix C). This agricultural practice is generally referred to as kaingin. In two or three years, when the soil in the cleared area loses its fertility, farmers move on, burn and make another clearing without replanting the used land with trees (Plate 6 in Appendix C). Kaingin is, therefore, one of the major causes for deforestation.

Another major cause of deforestation is logging (Plate 7 in Appendix C). Logging is a major dollar earning industry. Thus, often, cutting of trees is uncontrolled. Uncontrolled logging removes almost all the vegetation which protects the soil. The soil is, therefore, exposed to erosion by rain. In addition to tree cutting, other logging activities such as road and trail construction, loading, hauling and site preparation disturb the soil. Heavy logging machines pack the soil so that less water enters it and runoff increases.

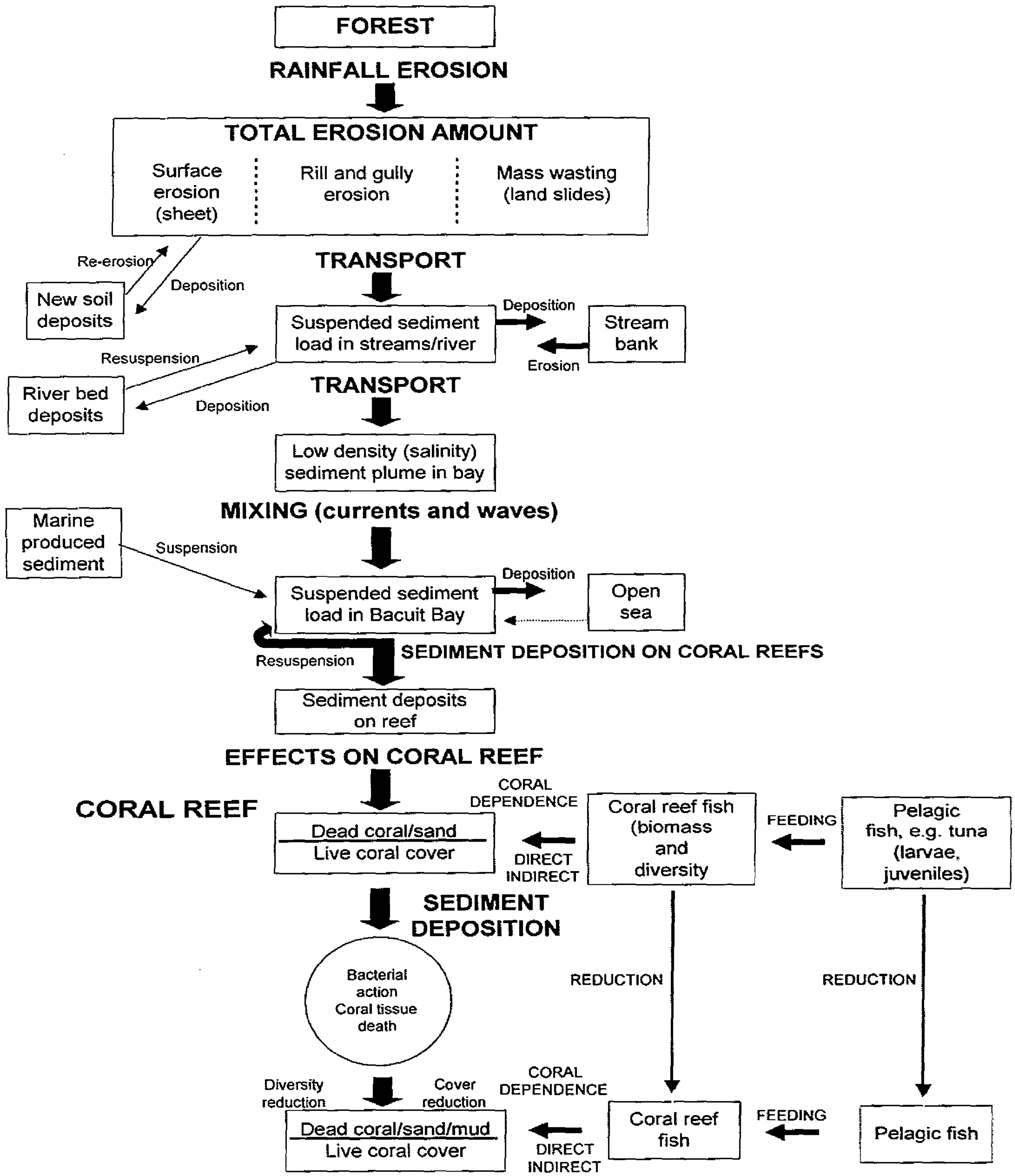

Figure 4.1 Pathway of soil erosion
The predicted pathway of soil eroded from the forest floor as it passes to the sea. Note the many locations where soil can be temporarily stored and then later rejoin the transport process. Upon reaching the sea, sediment settles to the bottom. If coral reefs are present, the living corals may be damaged by sediment deposition. Since fisheries are linked to the coral directly and indirectly, they will be reduced by losses of living coral cover.
(Source: Hodgson and Dixon 1988, p. 5)

Logging and kaingin have been identified in Carigara Bay and Silago Bay by the VISCA team. The disaster at Ormoc in 1994 alone, however, is a grim indicator of the extensiveness of logging activities in the region. Kaingin activities have also been observed in Homonhon island.

In general terms, these kaingin and logging activities can be labelled as land clearing and Figure 4.1 is a diagram of the cascade effects logging activities may have on the environment. A good example of the cascade effects of land clearing is the turbidity of Matarinao Bay due to siltation resulting from the denudation of mountains upstream. Pandan River in Barangay Subang Dako, Sogod (Plate 8 in Appendix C) was observed to have a very high siltation load due to illegal logging and rampant extraction of sand and gravel.

Mining

Mining operations dig out and loosen rocks in the mountains, exposing them to further erosion (Plate 9 in Appendix C). Forested areas are cleared and millions of tons of rocks are removed. In open pit mining, large tracts of land are dug up and exposed to air and water, resulting in the weathering and erosion of deeper rocks (Plate 10 in Appendix C). Aside from this, mining activities result in disposal of waste and tailings into rivers (Plate 11 in Appendix C), streams and the coast, bringing about siltation, heavy metal pollution and general degradation of the receiving aquatic system.

Documented effects of mine tailings are siltation of the waterway and coral reefs resulting in decrease in live coral cover and diversity (McManus 1986), increased turbidity, elevated trace metal levels in marine sediments, organisms, and water (Lowrie 1981; Lowrie et. al. 1982), and the disappearance of commercially valuable marine species.

Table 4.1 Identified mineral resources of Region 8 (Based on available reports)

Mineral	LEYTE		SAMAR		
	Northern	Southern	Eastern	Western	Northern
Gold	X	X	X		
Silver with gold		X			
Copper	X	X	X	X	
Lead and zinc				X	
Bauxite (aluminum)			X	X	X
Iron	X	X	X	X	
Chromite			X	X	
Nickel	X	X	X		
Manganese	X	X		X	
Guano and rock phosphate	X	X		X	
Peat	X				
Bentonite	X				
Clay	X	X	X		
Dolomite		X			
Gypsum	X				
Magnesite		X			
Marbleized limestone	X			X	
Rock asphalt	X				
Sulfur and pyrite	X			X	
Uvarovite (semiprecious stone)			X		
Coal			X	X	
Uranium				X	
Geothermal	X	X			

Source: Mines and Geosciences Bureau 1994

Table 4.1, identifies the mineral resources of Region 8. Based on available data, chromite, nickle and other complex ores are available for mining. Small scale mining (20 hectares and below) has been identified in Carigara Bay (Babatngon) and Homonhon Island (Plate 12 in Appendix C). The open-pit nickle mining at Manicani Island is well known and laterite deposits in Homonhon Island have potential for extracting nickel, iron, lead and bauxite). The complex ore mine (kurokho type deposit) in Samar has been closed for several years now. However, the pollution caused by tailings is still evident in Taft River and is a cause for concern.

Tourism

Tourism may have direct and indirect impacts to the environment. Direct impacts are those caused in situ by tourists, while indirect impacts are those resulting from activities undertaken to serve the tourist and the souvenir trade (Gomez 1982).

Under direct impacts, stress may result from damage by access or by handling and collecting. Damage by access result from: (1) trampling by waders and swimmers; (2) trampling and physical abrasion by skin and SCUBA divers; (3) anchor damage on shallow reefs; and (4) refuse and garbage directly thrown into the water by tourists such as bottles and cans, have an abrading effect when they roll back and forth in the surge (Gomez 1982). Damage by handling, on the other hand, is most pronounced in shallow reef flats (Plate 13 in Appendix C). Overturning of rocks and coral, and killing or breaking off attached plants and animals have adverse effects on coral reef epifauna (Gomez, 1982).

Among the activities undertaken to serve tourists, which have an indirect impact on the environment, are: (1) land development for tourist accommodation and services (Plate 14 in Appendix C); (2) overfishing ; (3) sewage disposal; (4) souvenir trade; and (5) oil pollution.

Land development include activities such as landscaping, construction on land, changes in nearshore environment (in terms of land fill and reclamation) (Plate 15 in

Appendix C), blasting and removal of corals for navigation channels, and development of swimming areas. In some areas, the increased demand for seafoods may results in overfishing of the areas nearest tourist accommodations (Gomez 1982).

The more chronic and long term effect of tourism development is the resulting sewage disposal problem. When island resort development is undertaken by local and small entrepreneurs, proper sewage treatment is not a capital expenditure. As such, raw sewage is directed to the sea, often in areas close to the resort.

The souvenir trade leads to the indiscriminate collection of corals, seashells and aquarium fish. The collection of corals and seashells results in their removal and destruction, while the collection of aquarium fish is undertaken with the use of cyanide and other toxic chemicals resulting in the damage of reefs and other marine communities.

Another indirect impact of tourism in the coastal environment is oil pollution brought about by the boats used for and by these tourists (Plate 16 in Appendix C).

The environmental problems associated with the tourism industry include:

- the conversion of mangrove swamps to resorts;
- overcollection of shells and fishes for aquaria;
- poorly regulated tourist buildings along the coast;
- construction of new and longer sea ports; and
- littering

Sites identified by the VISCA team as important tourism sites were ('Gap Assessment' 1997): Carigara Bay (Map 1 in Appendix C) (Barugo, Capoocan and Babatngon), Ormoc Bay (Map 4 in Appendix C) (Tongonan, Macabug, Danhug, San Antonio and Carlota Hills), Sogod Bay (Map 6 in Appendix C) (Libagon, Liloan Bridge, Padre Burgos, Limasawa Island and Sta. Sofia Beach) Cuatro Islas (Map 2 in Appendix

C), Anahawan, Silago Bay (Map 2 in Appendix C) and Sambawan Island in Maripipi (Map 3 in Appendix C). Other sites include Canawayan Island in Gamay Bay (Map 8), Borongan (Map 7 in Appendix C), Dolores (Map 11 in Appendix C), Matarinao (Map 10 in Appendix C), and Biri and Talisay (Map 13 in Appendix C).

Coastal Settlements

The Philippine Archipelago is made up of more than 7,000 islands amounting to more than 18,000 kilometers of coastline. Of the roughly 1,525 municipalities, nearly 70% are coastal, including ten of the country's largest cities. In Region VIII, majority of the municipalities are coastal. Of Leyte's 49 municipalities, 39 are coastal (80%). Southern Leyte has all 18 municipalities(100%) located along the coast. Western Samar has 25 municipalities, 20 of which (80%) are coastal, and northern Samar has 20 coastal municipalities out of a total of 24 (83%). Examples of large coastal settlements are those of Tacloban City, northwest of Leyte (Plate 17 in Appendix C) and, right across the San Pedro and San Pablo Bay, is Basey, Samar (Plate 18 in Appendix C).

Domestic waste from coastal settlements pose the greatest impact on coastal water. The domestic waste load could be inferred from the per capita BOD load of 16.9kg/yr (Viray 1982) and the per capita solid waste generation of 0.2kg/day of which 43% consists of putrescible matter (NCSO 1983). Accompanying high levels of BOD are elevated levels of bacterial contamination.

Contribution of municipal wastewater is perhaps the most universal form of marine pollution. The effect of sewage on such filter feeders as oysters, clams and mussels is well known. These shellfish concentrate bacteria and viruses from sewage in the process of feeding. The consumption of raw or partially cooked shellfish, which have been exposed to untreated sewage, can thus lead to the transmittal of viral diseases such as hepatitis (UNEP 1983).

Sewage pollution in coastal waters affects water-related recreation and amenities. While cases of serious diseases, e.g. typhoid and cholera, due to sea bathing in sewage-polluted water have not been conclusively proved, there is evidence of transmittal of certain mild afflictions, such as respiratory infections and gastro-enteritis, through this mode. The more undesirable aspect of this type of pollution lies in its effect on the amenity value of the water and beach. There may be visible turbidity, scum and other 'floatables' on the water surface and an offensive odour (UNEP 1983).

Coastal settlements also contribute to the introduction of persistent solids such as plastics into the coastal environment. These may have undesirable ecological effects and could contribute to aesthetic degradation. Cancabato Bay has been identified as an area with extensive local settlements contributing to the pollution of the bay (Plate 19 in Appendix C).

Coastal settlements or establishments of concern in the Region are the town markets in Carigara Proper (Map 1 in Appendix C); Liloan, Sogod and Bontoc (Map 6 in Appendix C); the towns of Albuera, Ormoc, Isabel, Merida (Map 4 in Appendix C); the ports in Hilongos and Hindang (Map 2 in Appendix C); and the towns of Silago Bay (Map 5 in Appendix C) ('Gap Assessment' 1997).

Industrial Sites

Wastewater from industries located in coastal areas have potential impact on coastal ecosystems (Plate 20 in Appendix C). These impacts range from relatively minor disturbances (such as temporary, localized increase in turbidity) to major disruptions (such as water pollution caused by discharge of toxic chemicals).

Continuous discharge of materials from various industries can cause serious damage in local areas. These materials normally undergo degradation in the natural environment but are often introduced in quantities which exceed the assimilative capacity of the local receiving waters. These materials include: dissolved organic substances; particulate organic matter; particulate inorganic matter; soluble inorganic substances including nutrient constituents; and micro-organisms and thermal discharges.

There are 212 firms and industries listed as holders of temporary pollution clearances in the region. However, their compliance in abatement of pollution is inadequate and limited in view of the lack of technical personnel. Obviously, there is a growing menace of environmental pollution (DENR, IRDPP 1989-1993).

The industries listed by the VISCA survey team include: Ormoc Bay - two sugar mills, an oil company (Map 4 in Appendix C), PASAR (copper cathode and ore metal production), PHILPHOS (fertiliser and phosphoric acid production), a geothermal plant and a roasting plant (Plate 21 in Appendix C).

As documented in the GAP report for the CRMP project, an urgent concern is raised for the presence of the Leyte Industrial Development Estate, which has a smelter and fertiliser plant, because Ormoc Bay may be contaminated with toxic waste from the plants.

Agricultural Areas

Runoff from agricultural areas end up in riverine or coastal waters. Agricultural runoff is detrimental when siltation loads are excessive and when amounts of fertilizers and pesticides encourage algal blooms. The Borongan-Maydolong area is such an agricultural area drained by 5 big rivers bringing sediments and nutrients from forest and agricultural lands planted mostly with coconut.

Maqueda Bay, which used to support a large and varied fish population, is presently one of the most depleted fishing grounds in the country. The strong southward current running along the western coast of Samar causes coastal erosion and massive transport of silt into the bay. The inner part of Maqueda Bay is characterised by low salinity due to surface run-off from the mountains in the east. This, however, has created an environment conducive for mussel and oyster culture.

The mussel farms, however, were the sites of 'red tid' occurrence in 1983. The mechanism that triggered this in Maqueda Bay is still unknown. Theoretically, the bloom is believed to be caused by the long period of drought in the locality followed by heavy rains that may have caused a sudden influx of nutrients through surface run-off (PCARR 1983). Another problematic agricultural area identified in the region is Matarinao Bay. As can be seen from Map 10 of Appendix C, the problem area is quite extensive.

4.4 Recommendations for Creating a Better Picture for Coastal Pollution

To put into a simple perspective the trend of pollution potential in a pilot site, the presence of different pollution sources is summarised in Table 4.2 below.

It is noteworthy from the table that coastal settlements is the most 'widespread' polluting source followed by industrial sites and tourism sites. This table can be used as an initial tool to prioritise areas that need to be studied further. Since the extent of the pollution from these sources is not included in the scope of this report, the number of sources present in an area may serve as an initial priority criteria. Using this criteria, for example, Ormoc Bay and Sogod Bay would be priority areas.

In general, the following steps are recommended to gather more information and give a better picture of the extent of pollution contributed by the various sources in a particular area.

1) Undertake broad area surveys; and

2) Undertake in-depth studies and secondary information gathering from municipal offices and possibly interviews with local residents

First Step

Step 1 serves to ground truth the mapped location of sources. A banca ride along the coast and shoreline walk-overs will serve the same purpose. In coastal settlement areas for example, observations on the following may be noted:

Table 4.2 Tabulation of the number of pollution sources for each pilot site*

	Sand and Gravel Mining	Logging and Kaingin	Large-scale Mining	Tourism	Coastal Settlements	Industrial Sites
Carigara Bay				2	6	1
Cuatro Islas	2			4	16	
Maripipi-Santo Niño	1				18	2
Ormoc Bay	7			7	25	7
Silago		3		1	11	
Sogod		1		3	22	
Borongan-Maydolong				1	15	1
Gamay Bay				2		
Guiuan			5		8	1
Homonhon			1		6	1
Matarinao Bay				2	13	1
Oras-Dolores				1	4	
San Pedro					27	7
Biri				2		
Laoang Bay					8	
Maqueda					5	

*Note that the number of pollution sources per site were based on mapped data provided by the various CRMP teams and DENR's hot spots of polution. Any omissions should be referred to the CRMP and GIS teams involved in the project through the Regional Development Council for Region VIII.

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- coastline distance occupied by the settlements;
- cleanliness of immediate shoreline (e.g. plastics, debris and 'floatables');
- shoreline uses (bathing, gleaning, daungan, etc.); and
- shoreline integrity/erosion sites.

For industrial sites, presence of discharge or intake pipes are things to note during broad area surveys.

Another major source of pollution are the agricultural areas. These were not reflected in the above table, because our basis for it was mainly those that can be accounted for as point-sources of pollution.

Second Step

The outputs from step 2 may include but not be limited to the following:

- Number of households, in particular, settlement area or population;
- Number of households with or without septic tanks;
- Water quality characterisation in terms of BOD, coliform count, total suspended solids for coastal settlement and tourism areas, and presence of certain metals (industry specific) in industrial sites;
- Sedimentation and siltation rates from mining and logging areas;
- Presence of phosphates and nitrates in waters for agricultural areas;
- Volumes of extracted material (sand and gravel quarries);
- Volumes of intake and discharges (industrial sites; and
- Volumes and frequency of tourist visitors, peak months, actual practices of tourists, number of 'bancas' in the area (for tourism areas).

A second prioritisation scheme may be undertaken upon completion of the various in-depth studies. The criteria this time will be severity of pollution and the presence of coastal resources in the area. With these data, mitigation measures may then be developed. These mitigation measures will then be inputs to the coastal management plans being developed for the various areas.

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Chapter
5

Coastal Habitats

5.1 Introduction

The main coastal features that comprise an important group of coastal resources and that which can be located at fixed geographical sites are coastal habitats. These consist of coral reefs, seagrasses and mangroves. They are a haven to a varied and diverse forms of aquatic life. The biological diversity that exist in these habitats have great ecological and economic significance and they must therefore be conserved and developed sustainably.

This chapter is to describe the coastal habitats with respect to area and their present condition. The data for this purpose have been provided for by the CRMP Project Teams from the Visayas State College of Agriculture (VISCA), University of Eastern Philippines (UEP), and Eastern State Samar College (ESSC) based on their field inventory and assessment work on selected pilot areas. The main objective of this chapter is to translate into a visual form the spatial location, extent, and indicative condition of these habitats relative to the coastlines of Leyte and Samar Islands and their neighbouring coastal features.

5.2 Location of Pilot Areas

For the purpose of the study, a total of fifteen (15) pilot areas were selected.. There are three (3) pilot sites located in Eastern Samar. These are Matarinao Bay, Borongan-Maydolong and Guian. Another four (4) sites were located in Northern Samar, namely, Oras-Dolores, Laoang Bay, Biri Group of Islands and Gamay Bay. Only one (1) pilot site, Maqueda Bay is located in Western Samar. The rest of seven (7) pilot areas are in the province of Leyte. These are Silago, San Pedro Bay, Carigara Bay, Ormoc Bay, Sogod

Bay, Maripipi-Sto. Niño and Cuatro Islas, Inopacan.

The above mentioned areas were the subject of a coastal resource inventory and assessment accomplished by the CRMP teams. They focused on the inventory and assessment of the current condition of the selected pilot areas in terms of mangrove areas, the corals reefs and the seagrasses.

5.3 Importance of the Coastal Habitats

The coastal resources inventory and assessment undertaken by the CRMP teams was concentrated on three important coastal resources, namely, corals, mangroves and seagrasses. These resources have one thing in common. They serve as habitats for sea life to support biodiversity.

The importance of the coral reefs to the regional fisheries could not be over emphasised. Coral reefs are an important coastal resource. They serve as the spawning and nursery grounds for fishes and act as natural breakwaters. They also contribute to sand formation and deposition, thus preventing beach erosion.

Mangroves or mangrove forest refer to a distinctive community of trees and associated plants and marine species which is found on tidal flats along the sea coast. These tidal flats extend along streams that are brackish. The value of the mangrove forest has long been recognised as a vital coastal resource that provides many direct and indirect benefits to the society. Their direct benefits include shoreline protection from erosion, wind and wave damage as well as the harvest of forest and marine products. Indirect benefits include providing vital spawning and nursery grounds as well as nutrient export to support other coastal fisheries.

On the other hand, seagrasses are an essential link between the coral reefs and mangrove areas. Some of their function include the following : reduction of water energy and motion; regulation of chemical composition of coastal waters and sediments;

regulation of runoff and stabilisation of bottom sediments; maintenance of coastal fertility; regulation of biological control mechanism; maintenance of migration and nursery habitat; enhancement and maintenance of coastal ecosystem and genetic diversity.

5.4 Description of the Coastal Habitats

The following sub-sections describe the spatial extent of the coastal habitats with varying degrees of their condition (good, fair or poor), in relation to their neighbouring counterparts. This is expressed in percent share of a particular coastal habitat relative to the total area occupied by the habitats in a certain pilot site. The CRMP teams have categorised the existing condition of the coral reefs according to whether they are in good, fair or poor condition.

Carigara Bay, Leyte

Within the Carigara Bay (Map 1 in Appendix C), a total of 74.5 hectares was covered by the assessment. Of the area assessed (Table 5.1), 9% was covered with corals and 86% was covered by mangroves, while 5% was composed of seagrass. Of the total area composed of corals, 29% was characterised as corals of good quality, 29% was of fair quality and 43% was of poor quality corals.

Cuatros Islas, Inopacan, Leyte

In the Cuatro Islas pilot site (Map 2 in Appendix C), three coastal resources were covered by the assessment, corals, mangrove and seagrass. Of the total area covered (Table 5.2), 20% consisted of seagrass, 65% was of corals and 16% was mangrove area. Of the total coral area, 34% was characterised as corals of fair quality, 42% was described as corals of poor quality and 24% was considered as corals of good quality.

Table 5.1 Attributes of coastal habitats present at the Carigara Bay site

PARTICULARS	AREA (ha)	% SHARE OF TOTAL AREA	% SHARE FOR CORALS
Coral - Good	2.0	2.7	28.6
Coral - Fair	2.0	2.7	28.6
Coral - Poor	3.0	4.0	42.9
Sub-total	7.0		
Mangroves	64.0	85.9	
Seagrass	3.5	4.7	
Grand Total	74.5	100	

Maripipi-Sto. Niño

Of the total 46 hectares covered by the assessment in the Maripipi-Sto. Niño site (Map 3 in Appendix C), 91% was composed of corals, 4% was covered by seagrass and 4% was covered by mangrove (Table 5.3). The total area covered by corals was categorised further into 36% covered with corals of fair quality, 36% was corals of poor quality and 28% was covered with corals of good quality.

Table 5.2 Attributes of coastal habitats present at the Cuatro Islas, Inopacan site

PARTICULARS	AREA (ha)	% SHARE OF TOTAL AREA	% SHARE FOR CORALS
Coral - Good	10.0	15.6	24.2
Coral - Fair	14.2	22.2	34.3
Coral - Poor	17.2	26.8	41.5
Sub-Total	41.4		
Mangroves	10.0	15.6	
Seagrass	12.7	19.8	
Grand Total	64.1	100	

Ormoc Bay, Leyte

The assessment in the Ormoc Bay site covered a total of 92 hectares (Map 4 in Appendix C). Sixteen percent of these was attributed to corals (Table 5.4), which appeared to be entirely of poor quality. The rest of the 92 hectares were attributed to 76% mangroves and 8% seagrass.

Table 5.3 Attributes of coastal habitats present at the Maripipi-Sto. Niño site

PARTICULARS	AREA (ha)	% SHARE OF TOTAL AREA	% SHARE FOR CORALS
Coral - Good	11.6	25.2	27.6
Coral - Fair	15.2	33.0	36.2
Coral - Poor	15.2	33.0	36.2
Sub-Total	42.0		
Mangroves	2.0	4.3	
Seagrass	2.0	4.3	
Grand Total	46.0	100	

Silago Bay, Leyte

In the Silago Bay site (Map 5 in Appendix C), the area covered by the assessment was a total of 44 hectares. Of the area covered (Table 5.5), 57% consist of corals, 14% was mangroves and 29% was composed of seagrass. Of the total area composed of corals, 28% was coral of fair quality, 56% was corals of poor quality and 16% was characterised as good corals.

Table 5.4 Attributes of coastal habitats present at the Ormoc Bay site

PARTICULARS	AREA (ha)	% SHARE OF TOTAL AREA	% SHARE FOR CORALS
Coral -Poor	15.0	16.3	100
Mangroves	70.0	76.1	
Seagrass	7.0	7.6	
Total	92.0	100	

Sogod Bay,Leyte

In the Sogod Bay site (Map 6 in Appendix C), total of 97.5 hectares was covered by the assessment. The coverage was broken down into 15% covered with corals (Table 5.6), 80% was composed of mangroves and 5% was covered with seagrass. Of the total area covered by corals, 53% was characterised as corals of good quality, 7% was of fair quality and 40% was described as corals of poor quality.

Table 5.5 Attributes of coastal habitats present at the Silago site

PARTICULARS	AREA (ha)	% SHARE OF TOTAL AREA	% SHARE FOR CORALS
Coral - Good	4.0	9.0	16
Coral - Fair	7.2	16.2	28.3
Coral - Poor	14.2	32.0	55.9
Sub-Total	25.4		
Mangroves	6.0	13.5	
Seagrass	13.0	29.3	
Grand Total	44.4	100	

Borongan-Maydolong, Eastern Samar

Total area covered in the Borongan-Maydolong site (Map 7 in Appendix C) by the assessment was 1,559 hectares. Of this total area assessed (Table 5.7), 75% of it consisted of corals, 19% was covered by mangroves, 2% was covered by seagrass, and 4% was declared fish sanctuary. Of the total area covered by corals, 62% was considered as unclassified corals, that is, condition of corals could not be indicated. The rest of the corals were classified as 27% of good quality and another 11% was described as corals of fair quality.

Table 5.6 Attributes of coastal habitats present at the Sogod Bay site

PARTICULARS	AREA (ha)	% SHARE OF TOTAL AREA	% SHARE FOR CORALS
Coral - Good	1.0	1.0	6.7
Coral - Fair	8.0	8.2	53
Coral - Poor	6.0	6.2	40
Sub-Total	15.0		
Mangroves	77.5	79.5	
Seagrass	5.0	5.1	
Grand Total	97.5	100	

Gamay Bay, Northern Samar

The pilot area (Map 8 in Appendix C), assessed for its coastal habitats, in Gamay Bay was 3,725 hectares. Of the said area (Table 5.8), 55% was composed of corals, 37% was covered by mangroves and only 8% was composed of seagrass.

Of the total area comprised of corals, 60% was said to be corals in fair condition, 15% was characterised as corals in good condition, while 25% of the corals could be not be classified as to its present condition.

Table 5.7 Attributes of coastal habitats present at the Borongan-Maydolong site

PARTICULARS	AREA (ha)	% SHARE OF TOTAL AREA	% SHARE FOR CORALS
Coral -Good	315.3	20.2	27.0
Coral -Fair	129.3	8.3	11.1
Coral - Unclassified	723.5	46.4	61.9
Sub-Total	1,168.1		
Mangroves	300.7	19.3	
Seagrass	31.4	2.0	
Fish Sanctuary	58.4	3.7	
Grand Total	1,558.6	100	

Guiuan, Eastern Samar

The area assessed in the Guiuan site (Map 9 in Appendix C) was 11,473 hectares. Accordingly (Table 5.9), the area was broken down into 89% corals, 6% mangrove and 5% seagrass. Of the total area under corals, 81% was unclassified corals with no indications of their present condition, 18% was described as corals of fair quality, while only 1% was characterised as corals of good quality.

Table 5.8 Attributes of coastal habitats present at the Gamay Bay site

PARTICULARS	AREA (ha)	% SHARE OF TOTAL AREA	% SHARE FOR CORALS
Coral -Good	303.9	8.2	14.9
Coral -Fair	1,220.8	32.8	59.7
Coral - Unclassified	520.2	14.0	25.4
Sub-total	2,044.9		
Mangroves	1,396.2	37.5	
Seagrass	283.5	7.6	
Grand Total	3,724.6	100	

Matarinao Bay, Eastern Samar

A total of 4,328 hectares was covered by the assessment activity in Matarinao Bay (Map 10 in Appendix C). Results showed that of the area covered (Table 5.10), 71% was corals, 16% was mangrove area and 13% was under seagrass. Of the total area covered by corals, 73% was characterised as unclassified coral areas with no distinct characteristics as to its indicative condition. Of the remaining corals classified, 12% was described as having poor condition, 11% was in fair condition while only 4% was in good condition.

Table 5.9 Attributes of coastal habitats present at the Guiuan site

PARTICULARS	AREA (ha)	% SHARE OF TOTAL AREA	% SHARE FOR CORALS
Coral -Good	141.3	1.2	1.4
Coral -Fair	1,797.0	15.7	17.5
Coral - Unclassified	8,327.7	72.6	81.1
Sub-total	10,266.0		
Mangroves	651.0	5.7	
Seagrass	555.8	4.8	
Grand Total	11,472.8	100	

Table 5.10 Attributes of coastal habitats present at the Matarinao Bay site

PARTICULARS	AREA (ha)	% SHARE OF TOTAL AREA	% SHARE FOR CORALS
Coral -Good	115.4	2.7	3.8
Coral -Fair	337.3	7.8	11.0
Coral - Poor	364.4	8.4	11.9
Coral - Unclassified	2,253.6	52.1	73.4
Sub-total	3,070.7		
Mangroves	706.2	16.3	
Seagrass	551.4	12.7	
Grand Total	4,328.3	100	

Oras-Dolores, Northern Samar

The assessment in the Oras-Dolores pilot site (Map 11 in Appendix C) covered a total of 2,908 hectares (Table 5.11), of which 65% was covered by corals, 16% was mangrove and 19% was seagrass. Of the total area comprised of corals, 38% was described as covered by corals of fair quality, while 62% was characterised as unclassified corals with no indications of its present condition.

Table 5.11 Attributes of coastal habitats present at the Oras-Dolores site

PARTICULARS	AREA (ha)	% SHARE OF TOTAL AREA	% SHARE FOR CORALS
Coral -Fair	721.4	24.8	38.0
Coral - Unclassified	1,174.9	40.4	62.0
Sub-total	1,896.3		
Mangroves	457.8	15.7	
Seagrass	554.0	19.1	
Grand Total	2,908.1	100	

San Pedro Bay, Leyte

The pilot area assessed within San Pedro Bay (Map 12 in Appendix C) covered a total of 1,102 hectares. Of these (Table 5.12), 66% was covered with seagrass, 31% was covered with corals and 3% was covered by mangrove. Of the total area covered by corals, 32% was unclassified corals, that is, there is no indication of their existing condition, 27% are characterised as corals of fair quality, 24% was described as corals of poor quality, while 17% was characterised as corals of good quality.

Table 5.12 Attributes of coastal habitats present at the San Pedro Bay site

PARTICULARS	AREA (ha)	% SHARE OF TOTAL AREA	% SHARE FOR CORALS
Coral -Good	56.8	5.2	16.6
Coral -Fair	93.9	8.5	27.5
Coral - Poor	82.0	7.4	24.0
Coral - Unclassified	108.7	9.9	31.8
Sub-total	341.4		
Mangroves	36.1	3.3	
Seagrass	724.9	65.8	
Grand Total	1,102.4	100	

Biri Group of Islands, Northern Samar

In the Biri Group of Islands (Map 13 in Appendix C), the assessment covered a total of 1,678 hectares covering 4 types of coastal resources, namely, purely corals, corals mixed with seagrass, mangoves and purely seagrass. Of these total area (Table 5.13), 56% was composed of corals, 17% was under a mixture of corals and seagrass, 23% was covered by mangoves and the remaining 3% was covered by seagrass. A mere half a percent was declared as fish sanctuary.

Table 5.13 Attributes of coastal habitats present at the Biri site

PARTICULARS	AREA (ha)	% SHARE OF TOTAL AREA	% SHARE FOR CORALS
Coral - Good	3.6	0.2	0.4
Coral - Fair	20.8	1.2	2.2
Coral - Poor	922.5	55.0	97.4
Sub-Total	946.9		
Coral - Fair with Seagrass	41.7	2.5	14.5
Coral - Poor with Seagrass	245.5	14.6	85.5
Sub-Total	287.2		
Mangroves	378.1	22.5	
Seagrass	57.2	3.4	
Fish Sanctuary	8.4	0.5	
Grand Total	1,677.8	100	

Of the total area covered by the mixture of corals and seagrass, 86% was assessed to be of poor quality, while 14% was of fair quality. Of the purely coral area, 97% was of poor quality, 2% was of fair quality and barely two-fifths of a percent was of good quality.

Table 5.14 Attributes of coastal habitats present at the Laoang Bay site

PARTICULARS	AREA (ha)	% SHARE OF TOTAL AREA	% SHARE FOR CORALS
Coral - Good	16.11	1.0	4.6
Coral - Fair	32.7	2.0	9.3
Coral - Poor	304.7	18.8	86.2
Sub-Total	353.51		
Coral - Good with Seagrass	21.4	1.3	4.7
Coral - Fair with Seagrass	130.6	8.0	28.8
Coral - Poor with Seagrass	300.9	18.5	66.4
Sub-Total	452.9		
Mangroves	762.6	47.0	
Seagrass	55.0	3.4	
Grand Total	1,624	100	

Laoang Bay, Northern Samar

In the Laoang Bay site (Map 14 in Appendix C), the total area covered by the assessment was 1,624 hectares. As with the Biri pilot site, there were four (4) types of coastal resources assessed, namely, plain corals, corals with seagrass, plain seagrass and mangroves.

Table 5.15 Attributes of coastal habitats present at the Maqueda Bay site

PARTICULARS	AREA (ha)	% SHARE OF TOTAL AREA	% SHARE FOR CORALS
Coral -Good	1.6	0.3	1.2
Coral -Fair	1.0	0.2	0.8
Coral - Poor	127.2	23.1	98.0
Sub-Total	129.8		
Mangroves	236.8	43.0	
Seagrass	169.7	30.8	
Fish Sanctuary	13.8	2.5	
Grand Total	550.1	100	

Of the total area assessed (Table 5.14), 28% was a mixture of corals and seagrass, 22% was purely corals, 47% was under mangroves and 3% was covered by seagrass. Of the area covered by the mixture of corals and seagrass, 66% was of poor quality, 29% was characterised as of fair quality, while only 5% was described as of good quality. Of the area covered by purely coral, 86% was described as coral of poor quality, 9% was coral of fair quality and 5% was coral of good quality.

Maqueda Bay, Western Samar

The resource assessment within Maqueda Bay (Map 15 in Appendix C) covered a total of 550 hectares. Of these areas (Table 5.15), 24% was covered with corals, about 2% was classified as fish sanctuaries, 43% was covered with mangroves, and 31% was under seagrass. Of the corals considered by the assessment, a large majority (98%) was described as corals of poor quality with a mere 1% each for good and fair quality corals.

5.5 Conclusion

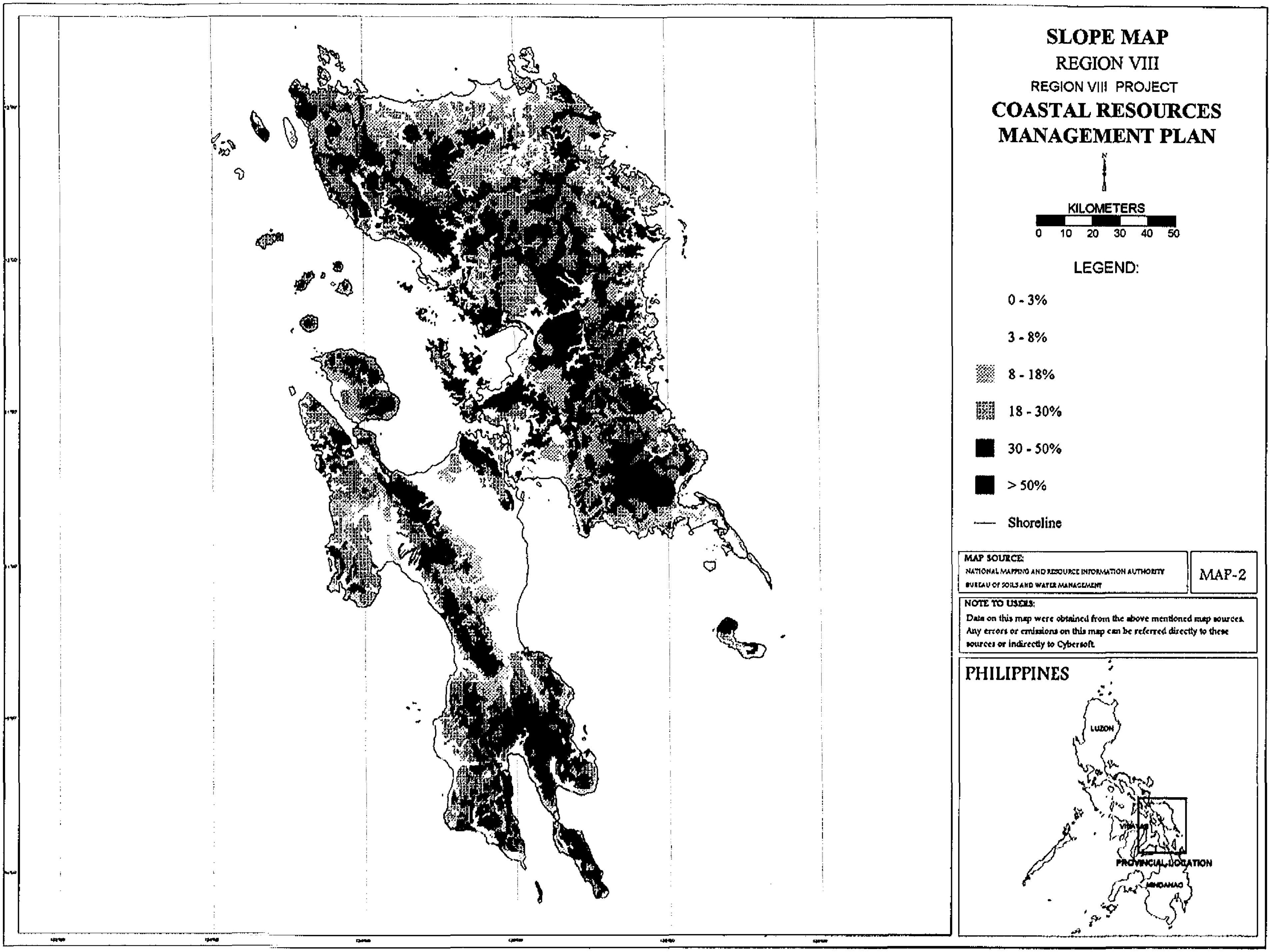
The data for the maps used in this chapter were gathered through the field surveys of the three CRMP research teams. Because of the nature of the data collection, some of these data presented in map form would just be indicative of the conditions, location and spatial extent of the habitats. Each map in Appendix C carry a note to inform the potential map users of this limitation. With respect to the spatial or areal extent of the mangroves, these can be verified from the maps derived from the recent aerial survey conducted over the pilot sites for the CRMP project.

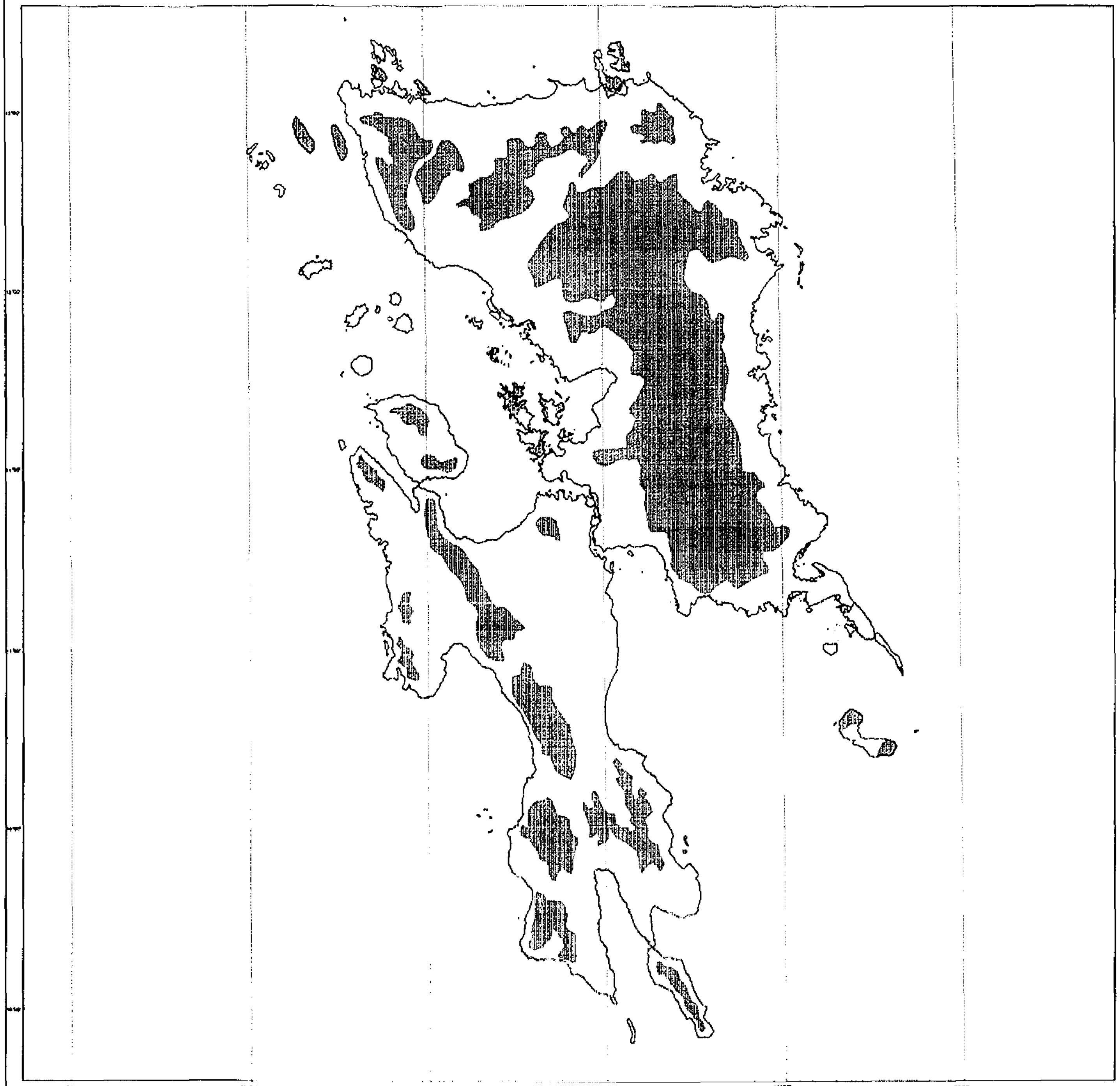
The mapped data for the coastal habitats (coastal resources) represent the location, spatial extent and condition of the coastal habitats relative to other geographic features nearby. For example, the coastal habitats are a haven for aquatic life and they also exist as life forms, which we could consider as receptors to pollution. From the maps, we can perceive the relative location of a coastal habitat to a pollution source..

The visual representation of the coastal habitats in map form thus provides us a two-dimensional perspective of space from which we can express deductions on spatial and cause-and-effect relationships. The major problem involved in collecting these types of data is that they are labour intensive and costly. However, the trade-off between producing such a data and the necessity of having such a data could justify the extent to which we could carry out such data collection activity.

Appendix A

Regional Physical Characteristics


SLOPE MAP
REGION VIII
REGION VIII PROJECT
COASTAL RESOURCES
MANAGEMENT PLAN
N
KILOMETERS
0 10 20 30 40 50
LEGEND:
0 - 3%
3 - 8%
8 - 18%
18 - 30%
30 - 50%
> 50%
Shoreline
MAP SOURCE:
NATIONAL MAPPING AND RESOURCE INFORMATION AUTHORITY
BUREAU OF SOILS AND WATER MANAGEMENT
MAP-2
NOTE TO USERS:
Data on this map were obtained from the above mentioned map sources. Any errors or omissions on this map can be referred directly to these sources or indirectly to Cybersoft.
PHILIPPINES
LUZON
VISAYAS
PROVINCIAL LOCATION
MINDANAO



LAND CLASSIFICATION MAP

REGION VIII

REGION VIII PROJECT

COASTAL RESOURCES MANAGEMENT PLAN

KILOMETERS

0 10 20 30 40 50

LEGEND:

Alienable and Disposable

Forest

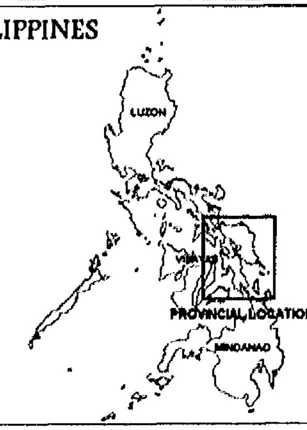
Shoreline

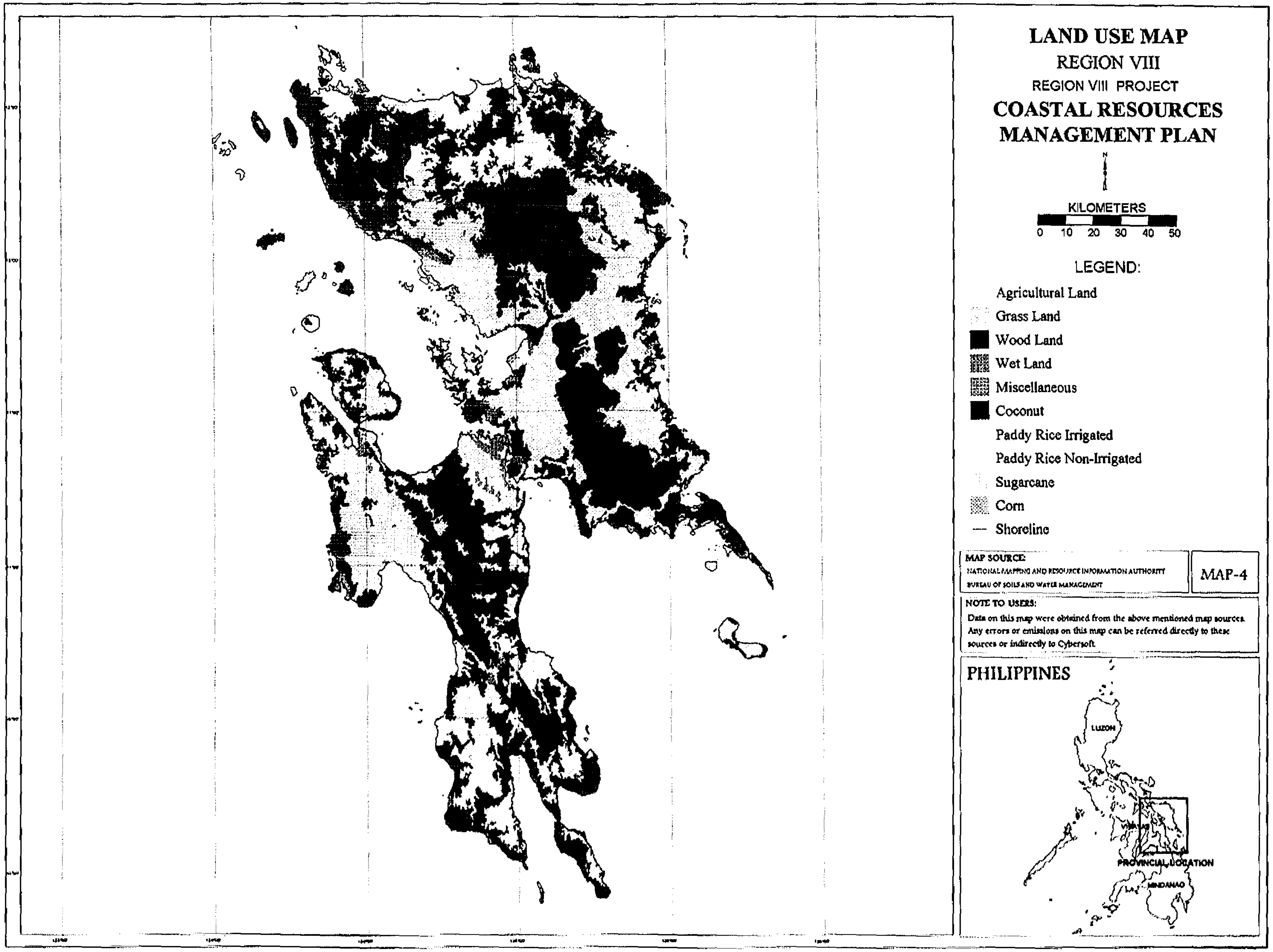
MAP SOURCE:
NATIONAL MAPPING AND RESOURCE INFORMATION AUTHORITY
BUREAU OF SOILS AND WATER MANAGEMENT

MAP-3

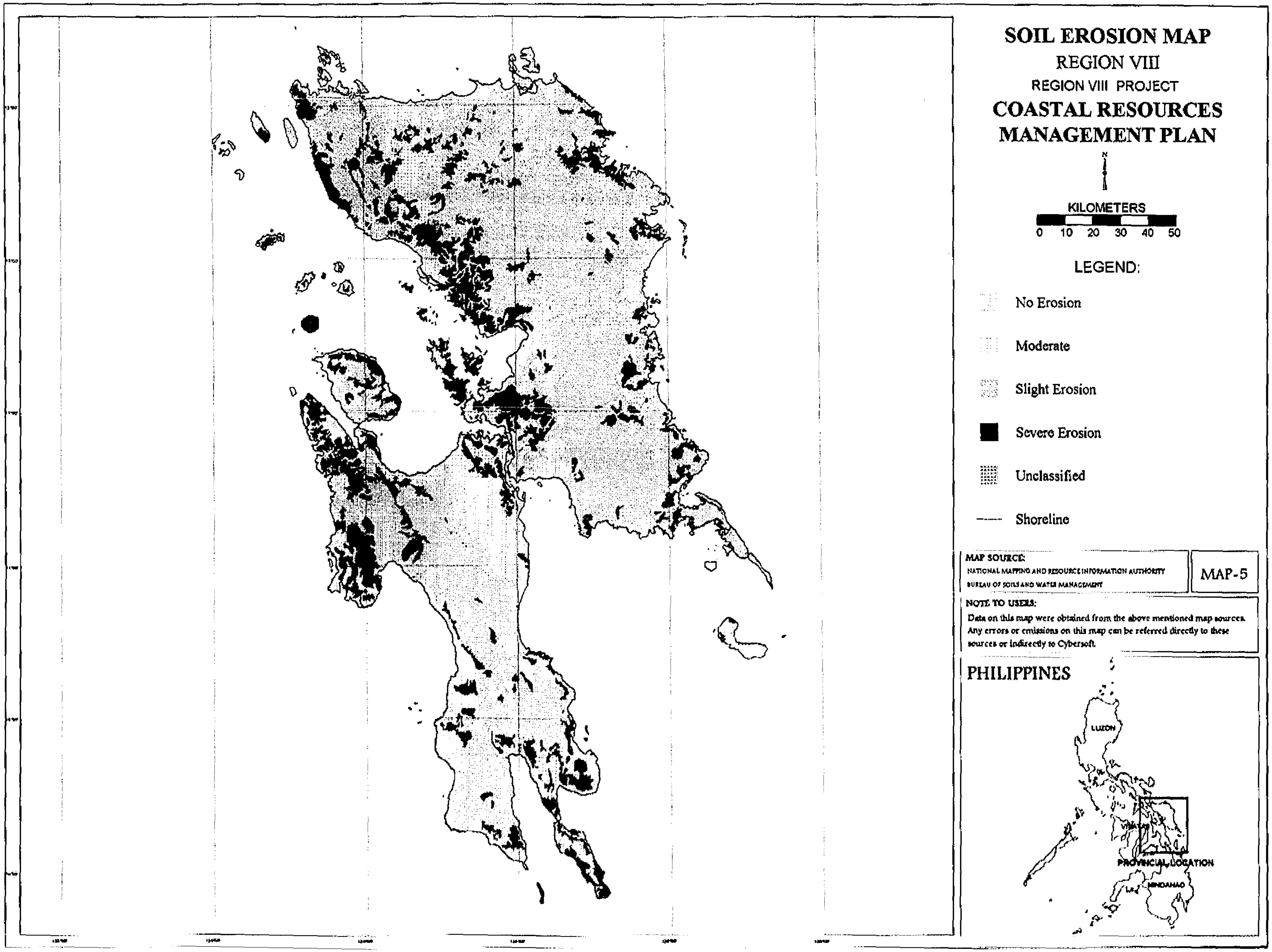
NOTE TO USERS:
Data on this map were obtained from the above mentioned map sources. Any errors or emissions on this map can be referred directly to these sources or indirectly to Cybersoft.

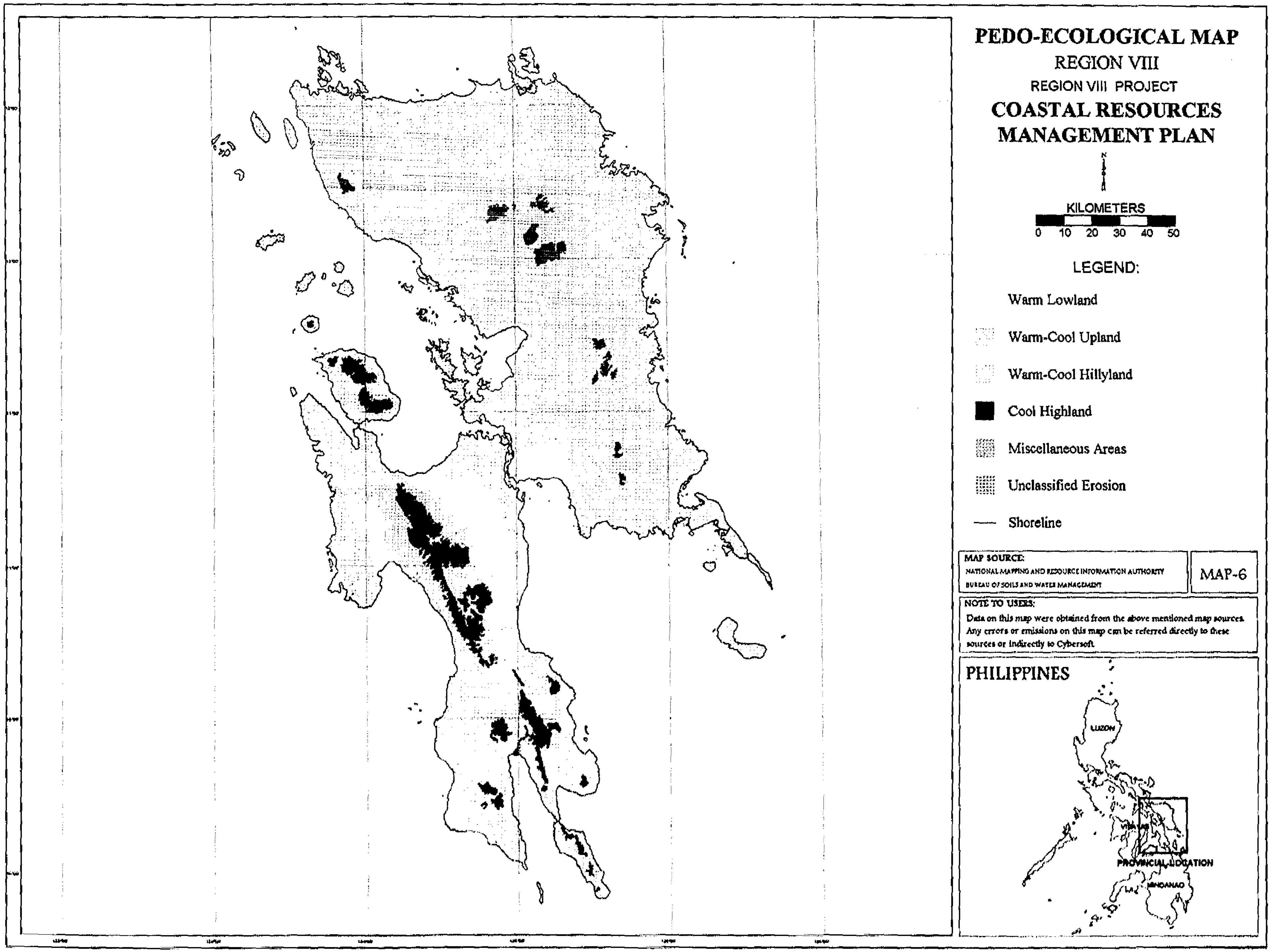
PHILIPPINES

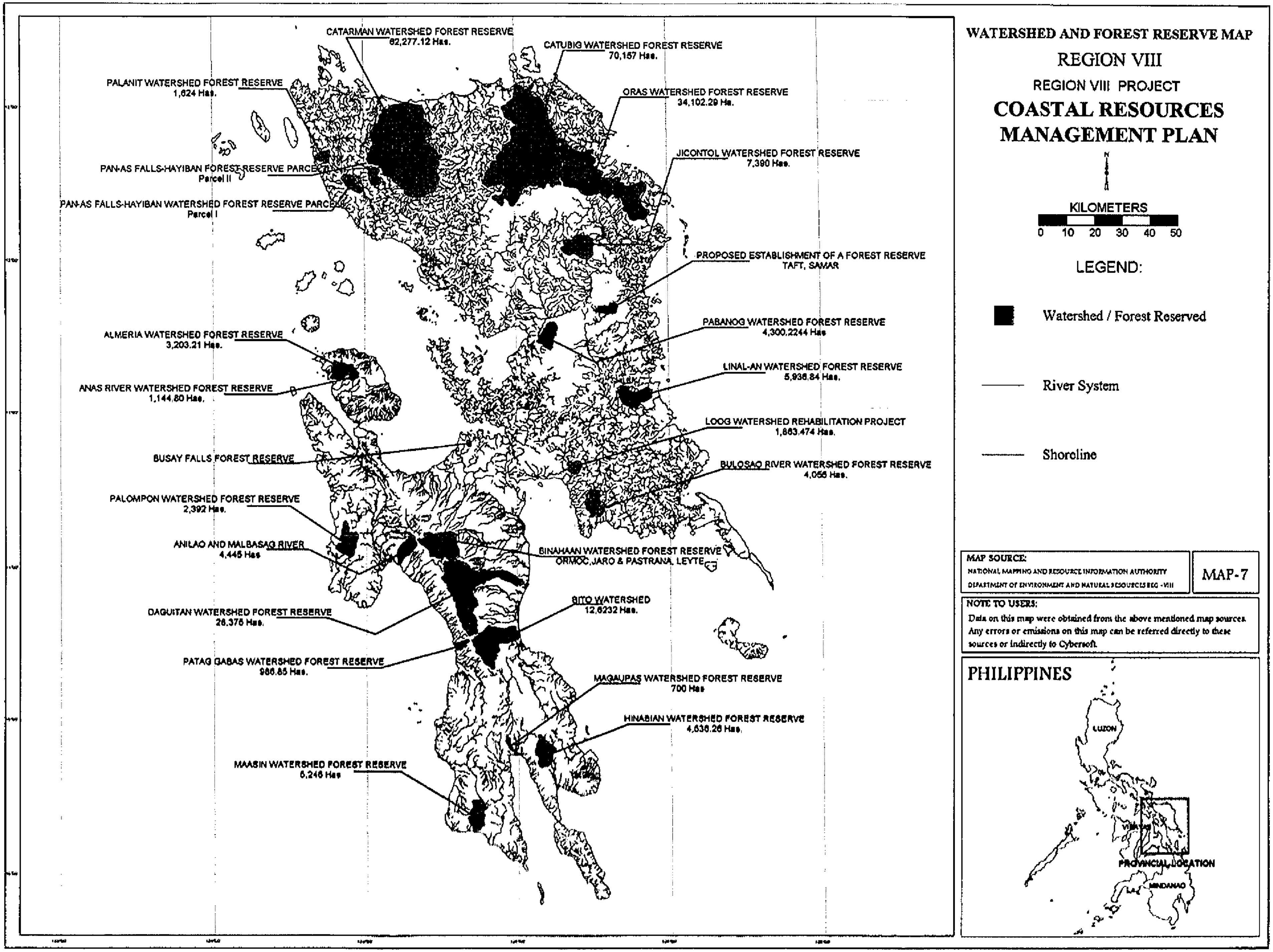




LAND USE MAP
REGION VIII
REGION VIII PROJECT
COASTAL RESOURCES
MANAGEMENT PLAN
KILOMETERS
0 10 20 30 40 50
LEGEND:
Agricultural Land
Grass Land
Wood Land
Wet Land
Miscellaneous
Coconut
Paddy Rice Irrigated
Paddy Rice Non-Irrigated
Sugarcane
Corn
Shoreline
MAP SOURCE:
NATIONAL MAPPING AND RESOURCE INFORMATION AUTHORITY
BUREAU OF SOILS AND WATER MANAGEMENT
MAP-4
NOTE TO USERS:
Data on this map were obtained from the above mentioned map sources.
Any errors or emissions on this map can be referred directly to these sources or indirectly to Cybersoft.
PHILIPPINES
LUZON
PROVINCIAL LOCATION
MINDANAO

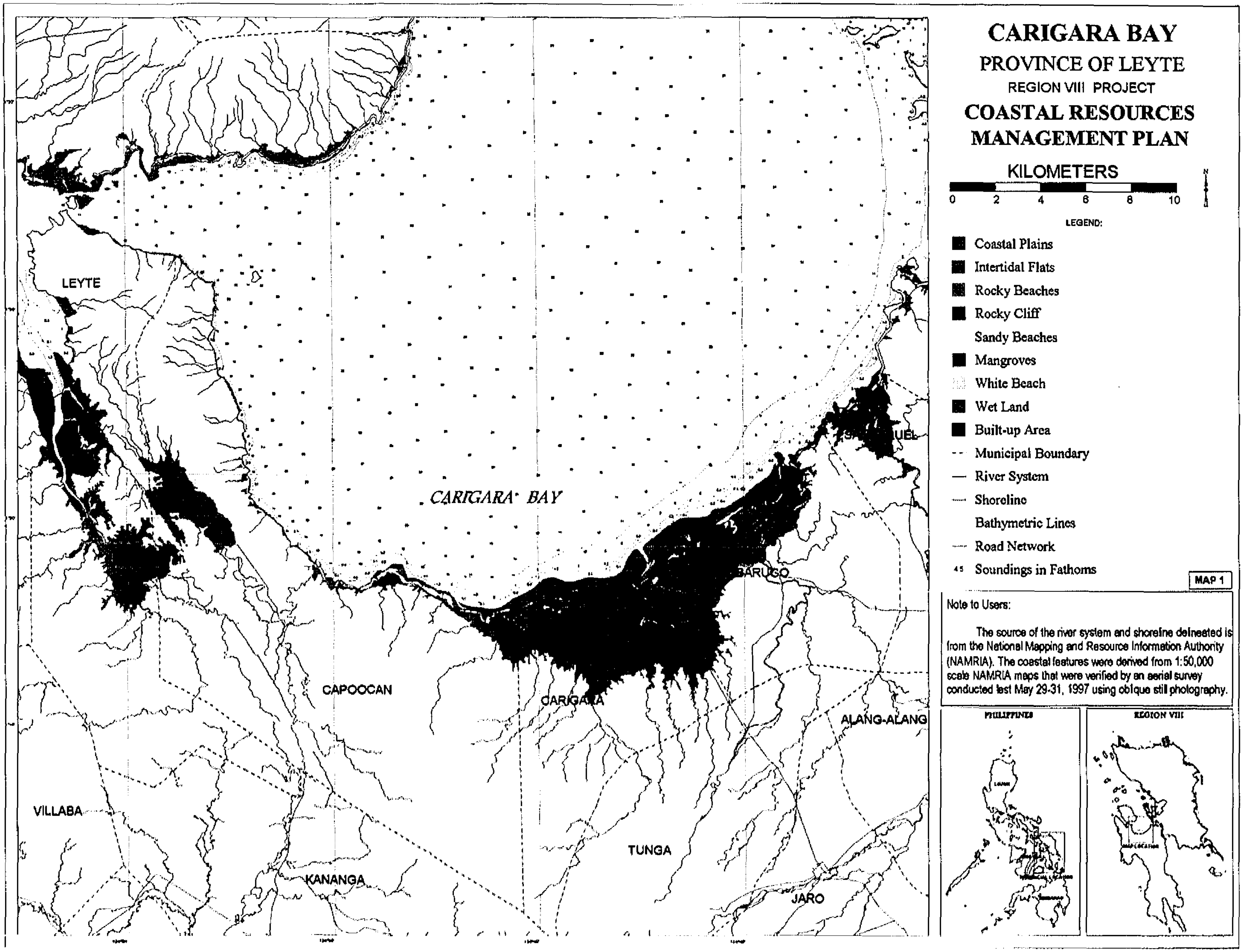

SOIL EROSION MAP
REGION VIII
REGION VIII PROJECT
COASTAL RESOURCES
MANAGEMENT PLAN
N
KILOMETERS
0 10 20 30 40 50
LEGEND:
No Erosion
Moderate
Slight Erosion
Severe Erosion
Unclassified
Shoreline
MAP SOURCE:
NATIONAL MAPPING AND RESOURCE INFORMATION AUTHORITY
BUREAU OF SOILS AND WATER MANAGEMENT
MAP-5
NOTE TO USERS:
Data on this map were obtained from the above mentioned map sources. Any errors or omissions on this map can be referred directly to these sources or indirectly to Cybersoft.
PHILIPPINES
LUZON
VISAYAS
PROVINCIAL LOCATION
MINDANAO

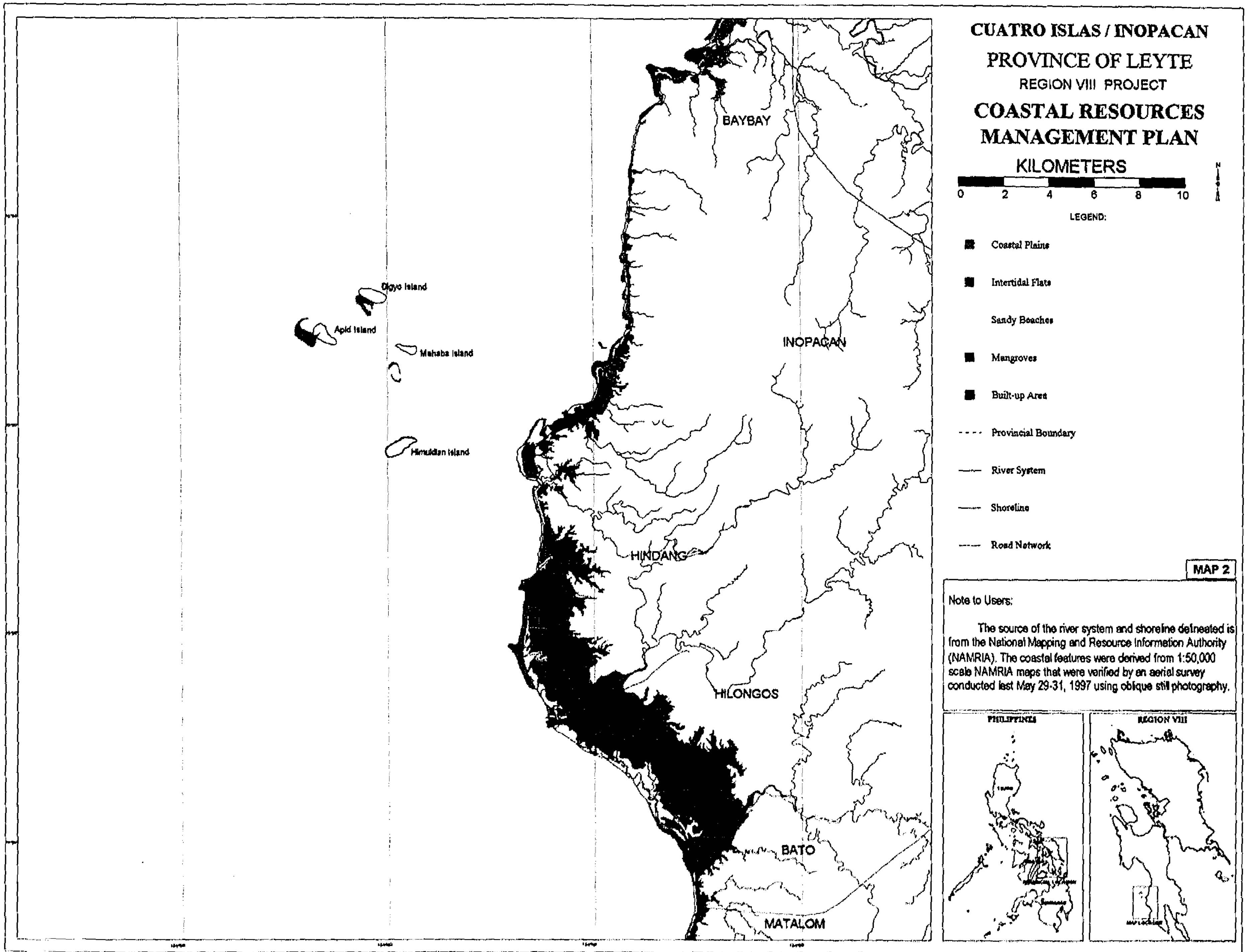

PEDO-ECOLOGICAL MAP
REGION VIII
REGION VIII PROJECT
COASTAL RESOURCES
MANAGEMENT PLAN
KILOMETERS
0 10 20 30 40 50
LEGEND:
Warm Lowland
Warm-Cool Upland
Warm-Cool Hillyland
Cool Highland
Miscellaneous Areas
Unclassified Erosion
Shoreline
MAP SOURCE:
NATIONAL MAPPING AND RESOURCE INFORMATION AUTHORITY
BUREAU OF SOILS AND WATER MANAGEMENT
MAP-6
NOTE TO USERS:
Data on this map were obtained from the above mentioned map sources. Any errors or emissions on this map can be referred directly to these sources or indirectly to Cybersoft.
PHILIPPINES
LUZON
PROVINCIAL LOCATION
MINDANAO


WATERSHED AND FOREST RESERVE MAP
REGION VIII
REGION VIII PROJECT
COASTAL RESOURCES MANAGEMENT PLAN
KILOMETERS
0 10 20 30 40 50
LEGEND:
Watershed / Forest Reserved
River System
Shoreline
MAP SOURCE:
NATIONAL MAPPING AND RESOURCE INFORMATION AUTHORITY
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES REG - VIII
MAP-7
NOTE TO USERS:
Data on this map were obtained from the above mentioned map sources. Any errors or omissions on this map can be referred directly to these sources or indirectly to Cybersoft.
PHILIPPINES
LUZON
VISAYAS
PROVINCIAL LOCATION
MINDANAO
CATARMAN WATERSHED FOREST RESERVE 82,277.12 Has.
CATUBIG WATERSHED FOREST RESERVE 70,157 Has.
PALANIT WATERSHED FOREST RESERVE 1,624 Has.
ORAS WATERSHED FOREST RESERVE 34,102.29 Ha.
JICONTOL WATERSHED FOREST RESERVE 7,390 Has.
PAN-AS FALLS-HAYIBAN FOREST RESERVE PARCEL Parcel II
PAN-AS FALLS-HAYIBAN WATERSHED FOREST RESERVE PARCEL Parcel I
PROPOSED ESTABLISHMENT OF A FOREST RESERVE TAFT, SAMAR
PABANOG WATERSHED FOREST RESERVE 4,300.2244 Has
ALMERIA WATERSHED FOREST RESERVE 3,203.21 Has.
LINAL-AN WATERSHED FOREST RESERVE 5,936.84 Has.
ANAS RIVER WATERSHED FOREST RESERVE 1,144.80 Has.
LOOG WATERSHED REHABILITATION PROJECT 1,863.474 Has.
BUSAY FALLS FOREST RESERVE
BULOSAO RIVER WATERSHED FOREST RESERVE 4,056 Has.
PALOMPON WATERSHED FOREST RESERVE 2,392 Has.
ANILAO AND MALBASAG RIVER 4,445 Has
BINAHAAN WATERSHED FOREST RESERVE ORMOC,JARO & PASTRANA, LEYTE
BITO WATERSHED 12,6232 Has.
DAGUITAN WATERSHED FOREST RESERVE 26,376 Has.
PATAG GABAS WATERSHED FOREST RESERVE 986.85 Has.
MAGAUPAS WATERSHED FOREST RESERVE 700 Has
HINABIAN WATERSHED FOREST RESERVE 4,636.26 Has.
MAASIN WATERSHED FOREST RESERVE 5,246 Has

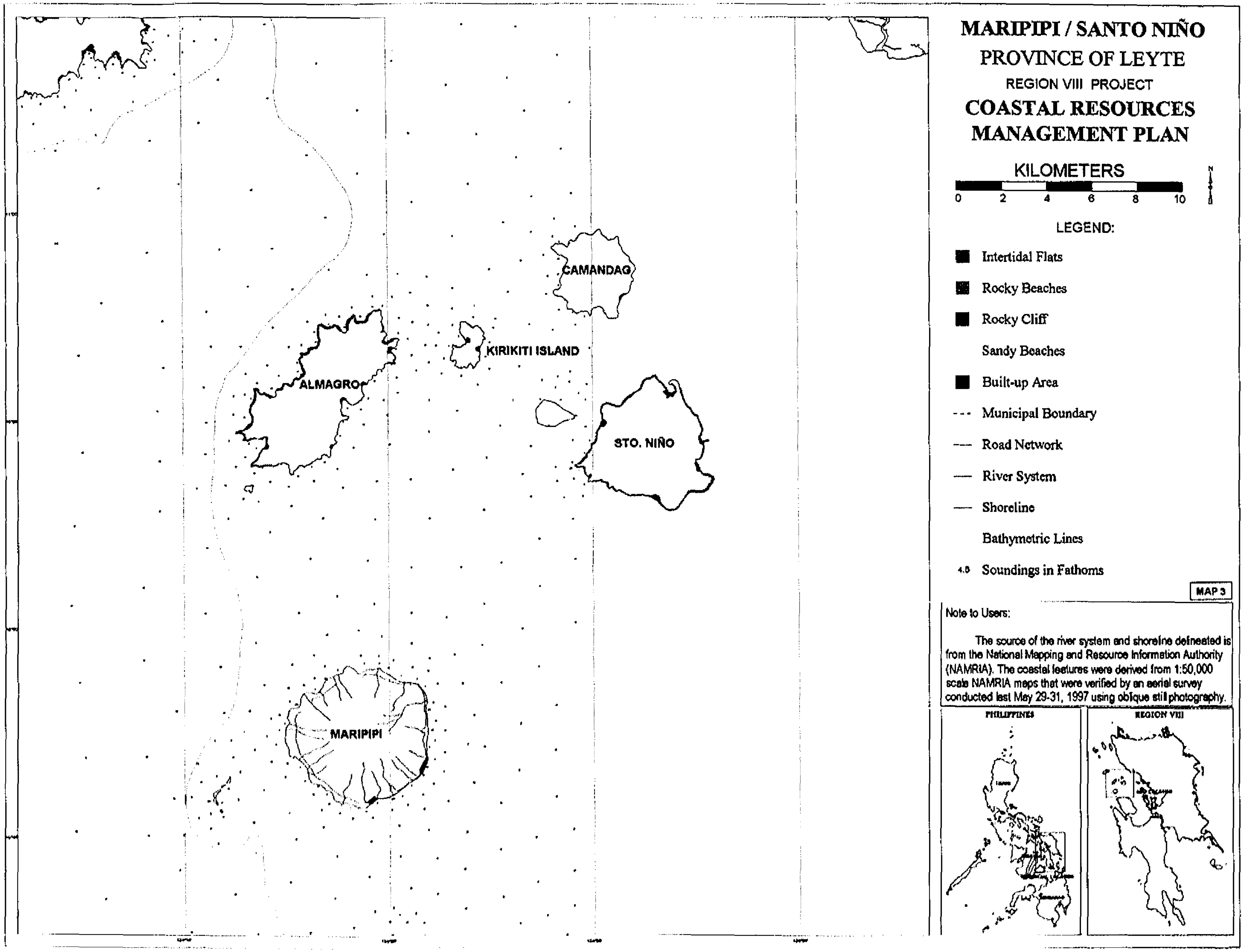
Appendix B

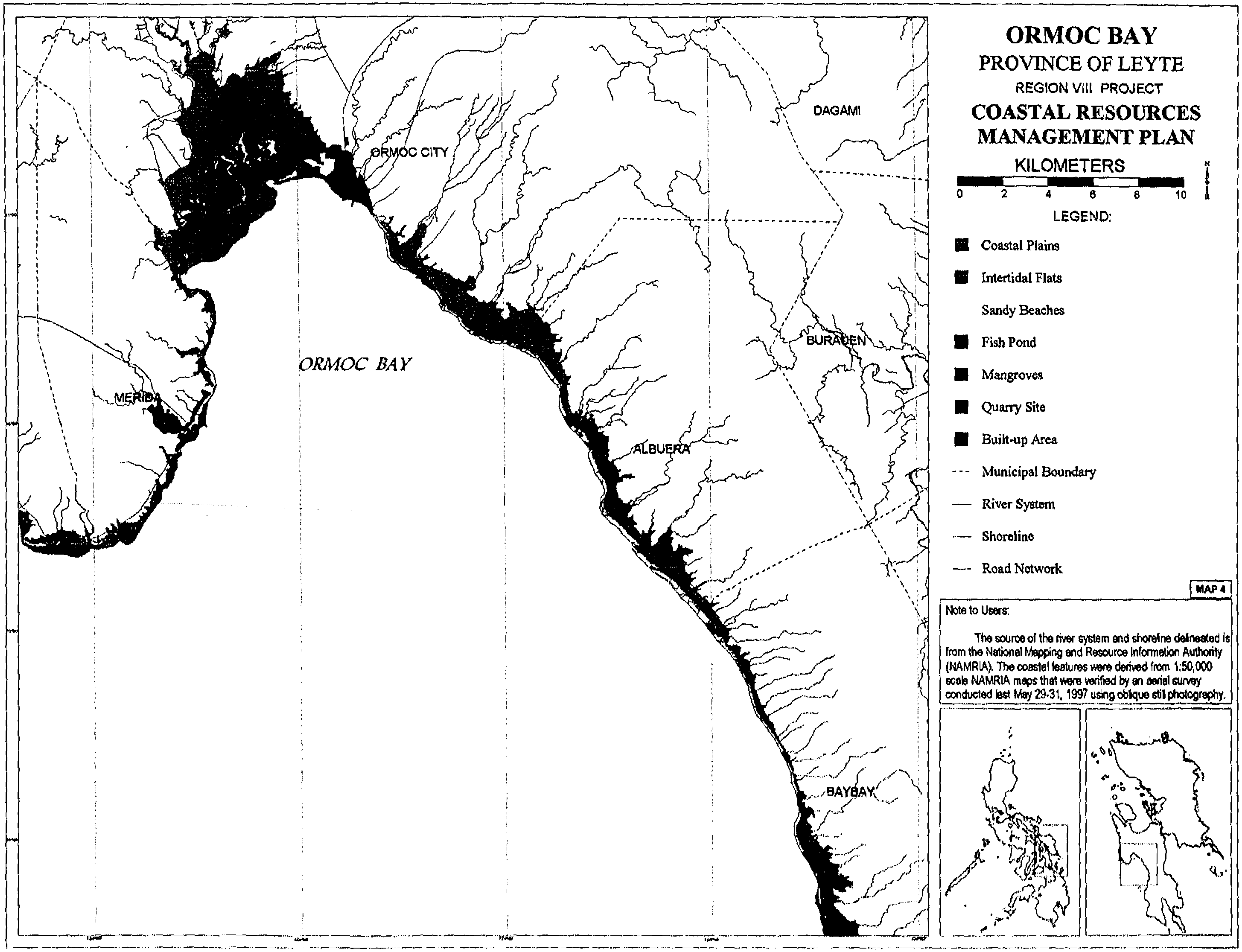
Regional Geology and Coastal Features

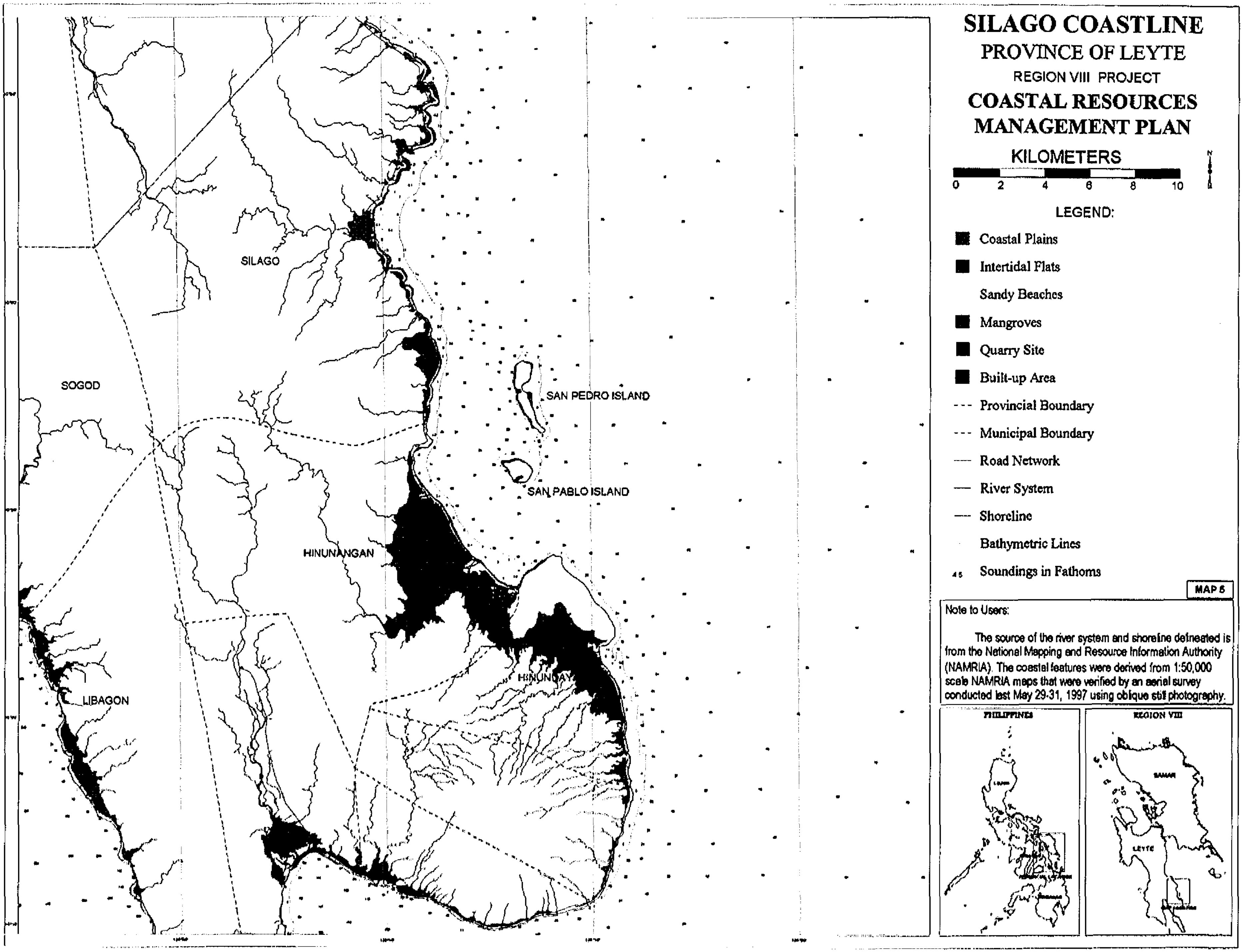

CARIGARA BAY
PROVINCE OF LEYTE
REGION VIII PROJECT
COASTAL RESOURCES MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Coastal Plains
Intertidal Flats
Rocky Beaches
Rocky Cliff
Sandy Beaches
Mangroves
White Beach
Wet Land
Built-up Area
Municipal Boundary
River System
Shoreline
Bathymetric Lines
Road Network
Soundings in Fathoms
MAP 1
Note to Users:
The source of the river system and shoreline delineated is from the National Mapping and Resource Information Authority (NAMRIA). The coastal features were derived from 1:50,000 scale NAMRIA maps that were verified by an aerial survey conducted last May 29-31, 1997 using oblique still photography.
PHILIPPINES
REGION VIII
CARIGARA BAY
LEYTE
CAPOOCAN
CARIGARA
BARUGO
ALANG-ALANG
VILLABA
KANANGA
TUNGA
JARO

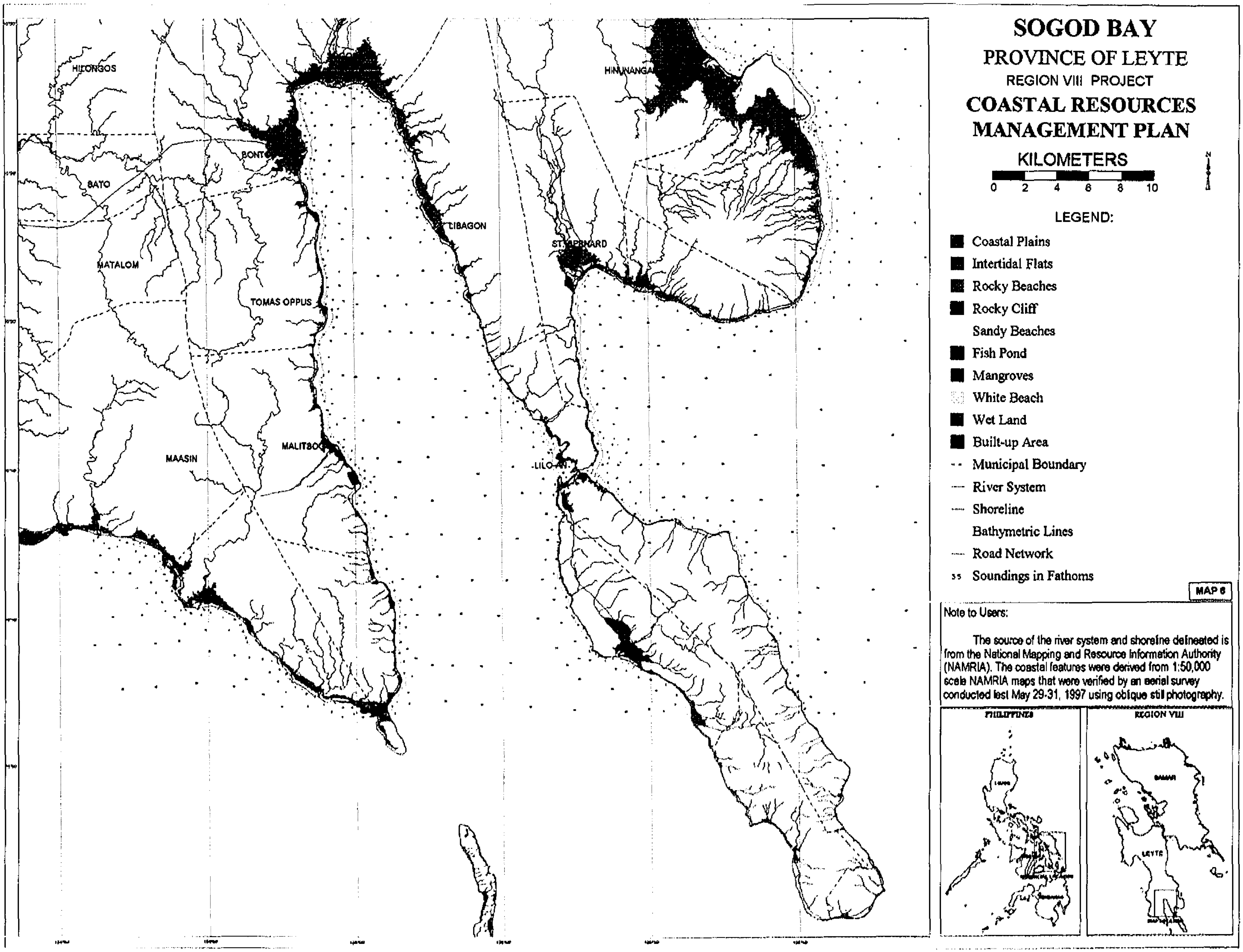


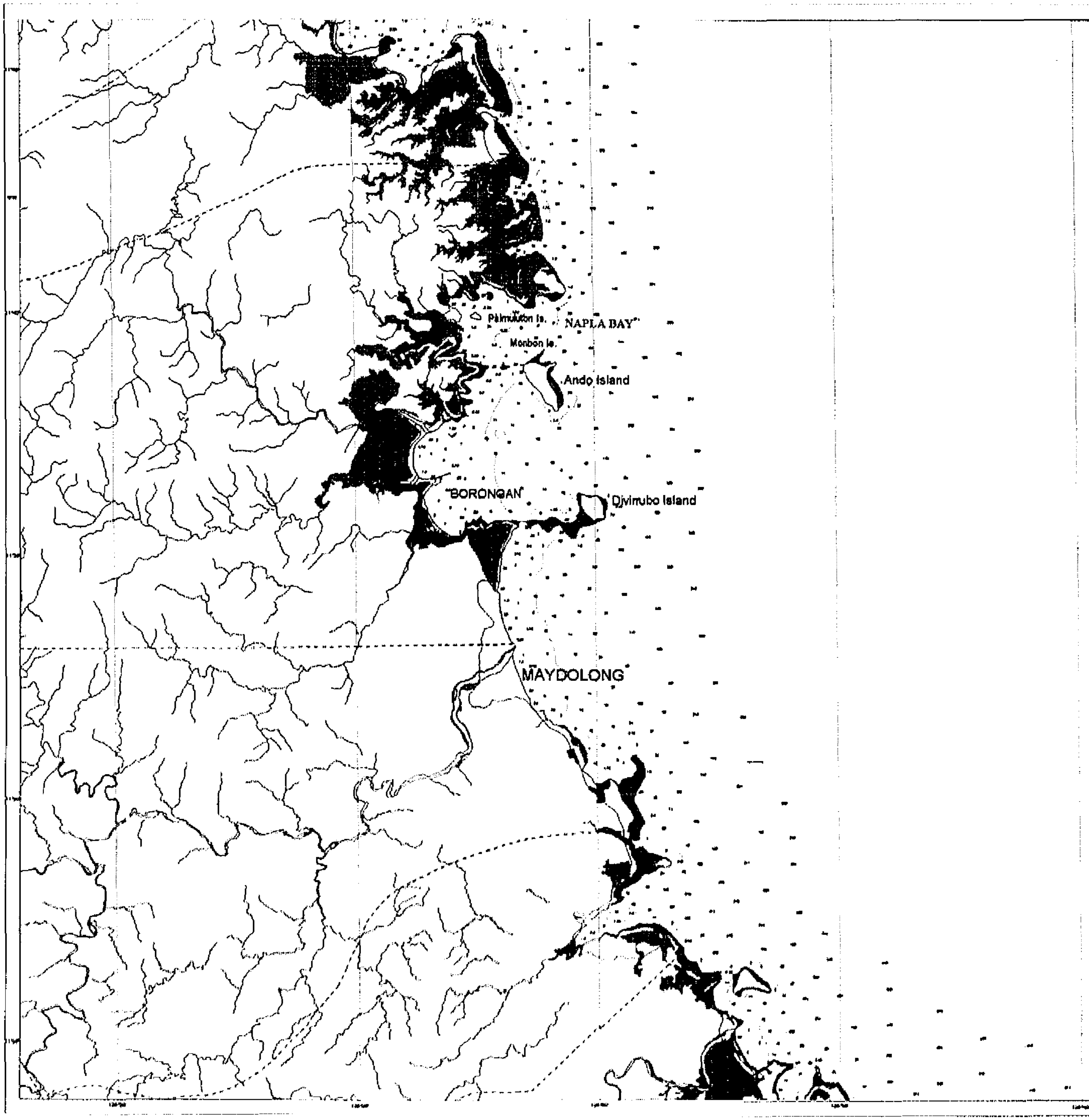
CUATRO ISLAS / INOPACAN
PROVINCE OF LEYTE
REGION VIII PROJECT
COASTAL RESOURCES
MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Coastal Plains
Intertidal Flats
Sandy Beaches
Mangroves
Built-up Area
Provincial Boundary
River System
Shoreline
Road Network
MAP 2
Note to Users:
The source of the river system and shoreline delineated is from the National Mapping and Resource Information Authority (NAMRIA). The coastal features were derived from 1:50,000 scale NAMRIA maps that were verified by an aerial survey conducted last May 29-31, 1997 using oblique still photography.
PHILIPPINES
REGION VIII
BAYBAY
INOPACAN
HINDANG
HILONGOS
BATO
MATALOM
Digyo Island
Apid Island
Mahaba Island
Himukilan Island


MARIPIPI / SANTO NIÑO
PROVINCE OF LEYTE
REGION VIII PROJECT
COASTAL RESOURCES MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Intertidal Flats
Rocky Beaches
Rocky Cliff
Sandy Beaches
Built-up Area
Municipal Boundary
Road Network
River System
Shoreline
Bathymetric Lines
4.0 Soundings in Fathoms
MAP 3
Note to Users:
The source of the river system and shoreline delineated is from the National Mapping and Resource Information Authority (NAMRIA). The coastal features were derived from 1:50,000 scale NAMRIA maps that were verified by an aerial survey conducted last May 29-31, 1997 using oblique still photography.
PHILIPPINES
REGION VIII
CAMANDAG
KIRIKITI ISLAND
ALMAGRO
STO. NIÑO
MARIPIPI


ORMOC BAY
PROVINCE OF LEYTE
REGION VIII PROJECT
COASTAL RESOURCES MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Coastal Plains
Intertidal Flats
Sandy Beaches
Fish Pond
Mangroves
Quarry Site
Built-up Area
Municipal Boundary
River System
Shoreline
Road Network
MAP 4
Note to Users:
The source of the river system and shoreline delineated is from the National Mapping and Resource Information Authority (NAMRIA). The coastal features were derived from 1:50,000 scale NAMRIA maps that were verified by an aerial survey conducted last May 29-31, 1997 using oblique still photography.
DAGAMI
ORMOC CITY
ORMOC BAY
MERIDA
BURAUEN
ALBUERA
BAYBAY


SILAGO COASTLINE
PROVINCE OF LEYTE
REGION VIII PROJECT
COASTAL RESOURCES MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Coastal Plains
Intertidal Flats
Sandy Beaches
Mangroves
Quarry Site
Built-up Area
Provincial Boundary
Municipal Boundary
Road Network
River System
Shoreline
Bathymetric Lines
Soundings in Fathoms
MAP 5
Note to Users:
The source of the river system and shoreline delineated is from the National Mapping and Resource Information Authority (NAMRIA). The coastal features were derived from 1:50,000 scale NAMRIA maps that were verified by an aerial survey conducted last May 29-31, 1997 using oblique still photography.
PHILIPPINES
REGION VIII
SILAGO
SOGOD
SAN PEDRO ISLAND
SAN PABLO ISLAND
HINUNANGAN
HINUNDAYAN
LIBAGON


SOGOD BAY
PROVINCE OF LEYTE
REGION VIII PROJECT
COASTAL RESOURCES
MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Coastal Plains
Intertidal Flats
Rocky Beaches
Rocky Cliff
Sandy Beaches
Fish Pond
Mangroves
White Beach
Wet Land
Built-up Area
Municipal Boundary
River System
Shoreline
Bathymetric Lines
Road Network
Soundings in Fathoms
MAP 6
Note to Users:
The source of the river system and shoreline delineated is from the National Mapping and Resource Information Authority (NAMRIA). The coastal features were derived from 1:50,000 scale NAMRIA maps that were verified by an aerial survey conducted last May 29-31, 1997 using oblique stil photography.
PHILIPPINES
REGION VIII
HILONGOS
BATO
MATALOM
TOMAS OPPUS
MAASIN
MALITBOG
LIBAGON
HINUNANGAN
LILO-AN



BORONGAN / MAYDOLONG

PROVINCE OF EASTERN SAMAR

REGION VIII PROJECT

COASTAL RESOURCES MANAGEMENT PLAN

KILOMETERS

0 2 4 6 8 10

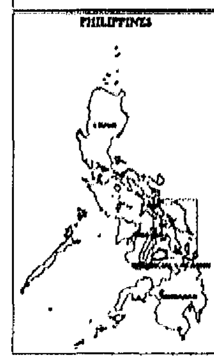
LEGEND:

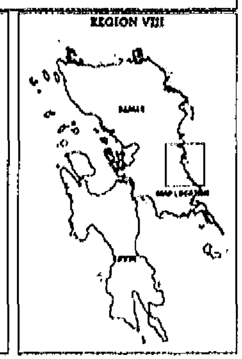
- Coastal Plains
- Intertidal Flats
- Rocky Beaches
- Rocky Cliff
- Sandy Beaches
- Mangroves
- White Beach
- Wet Land
- Built-up Area
- Municipal Boundary
- Road Network
- Shoreline
- Bathymetric Lines
- Soundings in Fathoms

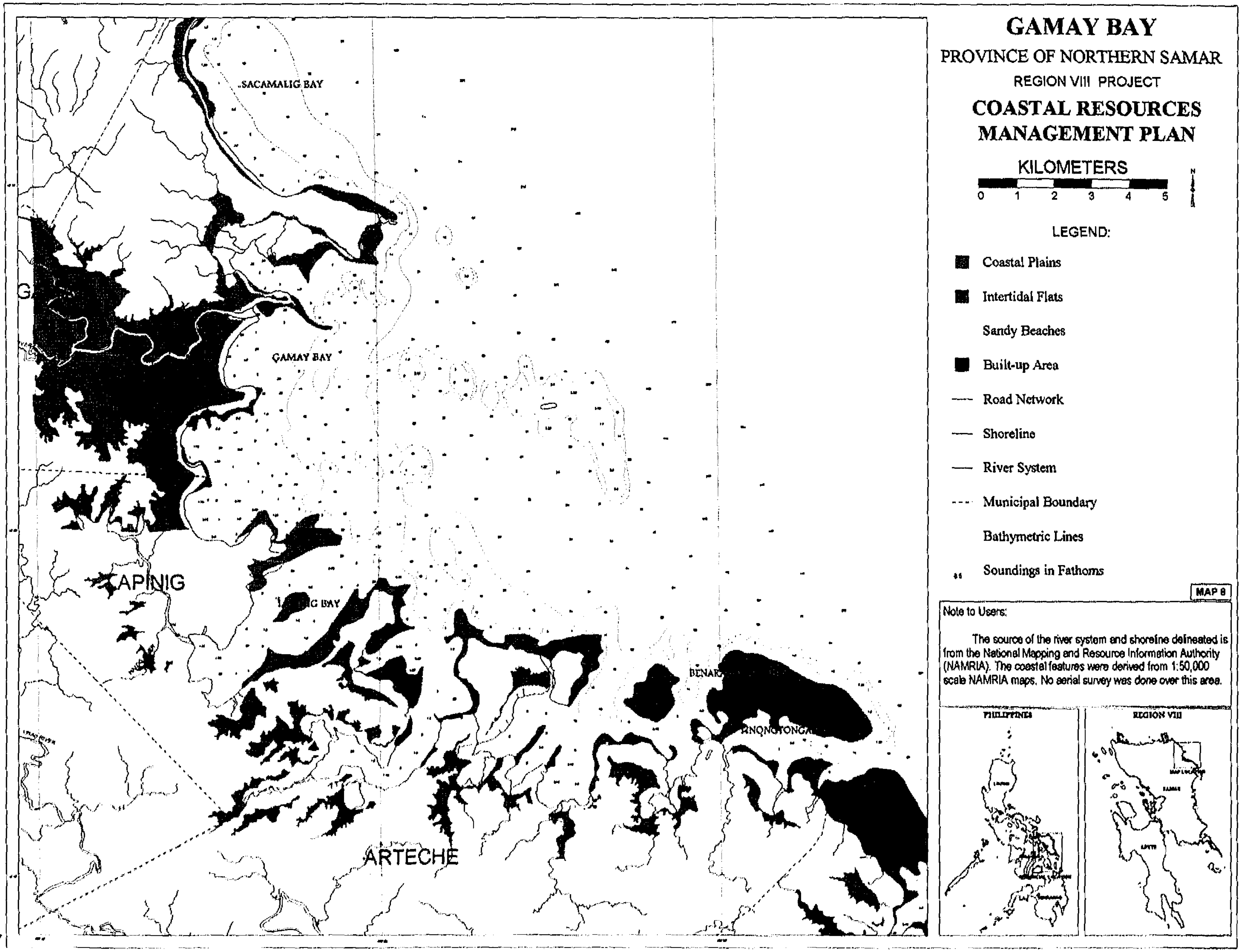
MAP 7

Note to Users:

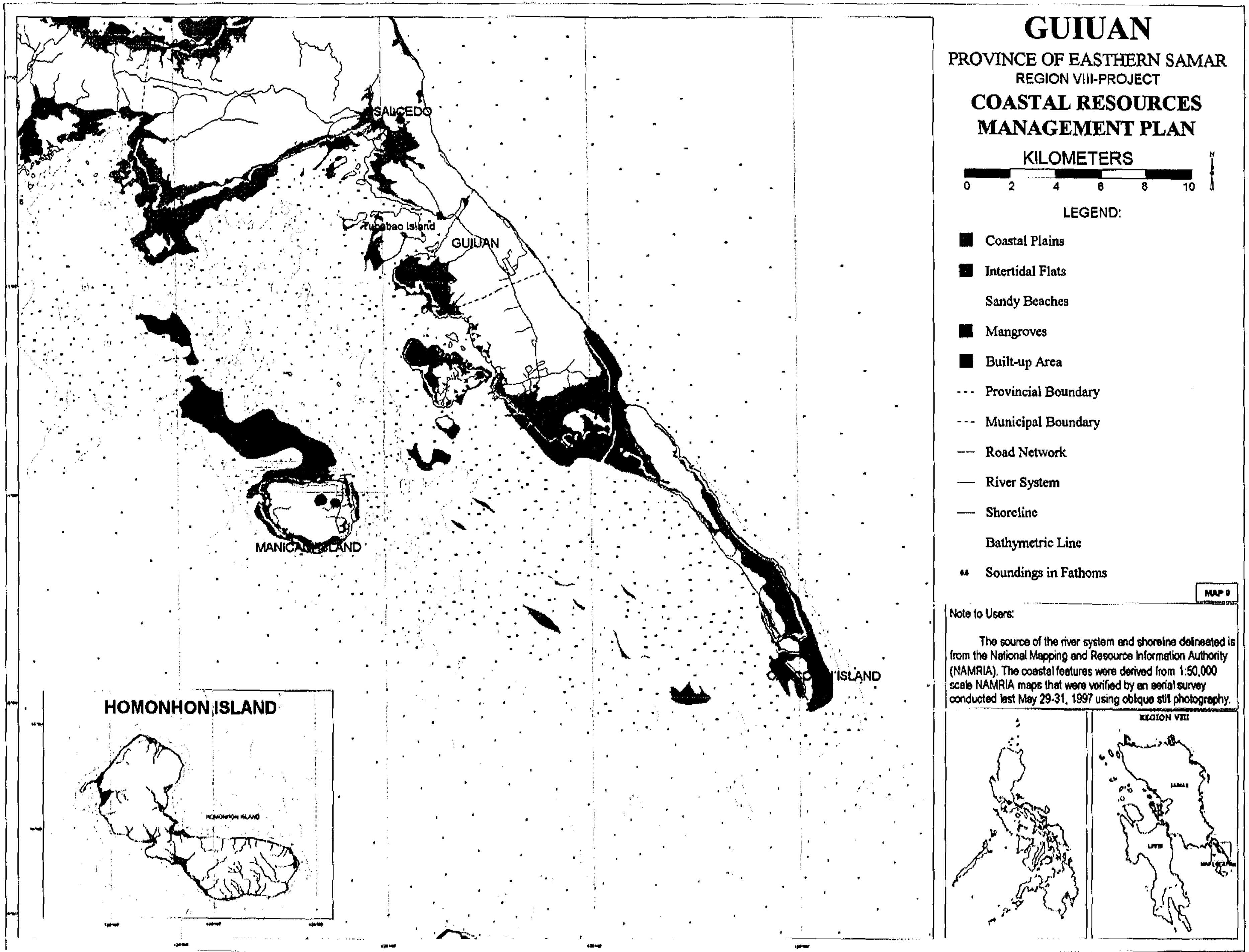
The source of the river system and shoreline delineated is from the National Mapping and Resource Information Authority (NAMRIA). The coastal features were derived from 1:50,000 scale NAMRIA maps that were verified by an aerial survey conducted last May 29-31, 1997 using oblique still photography.

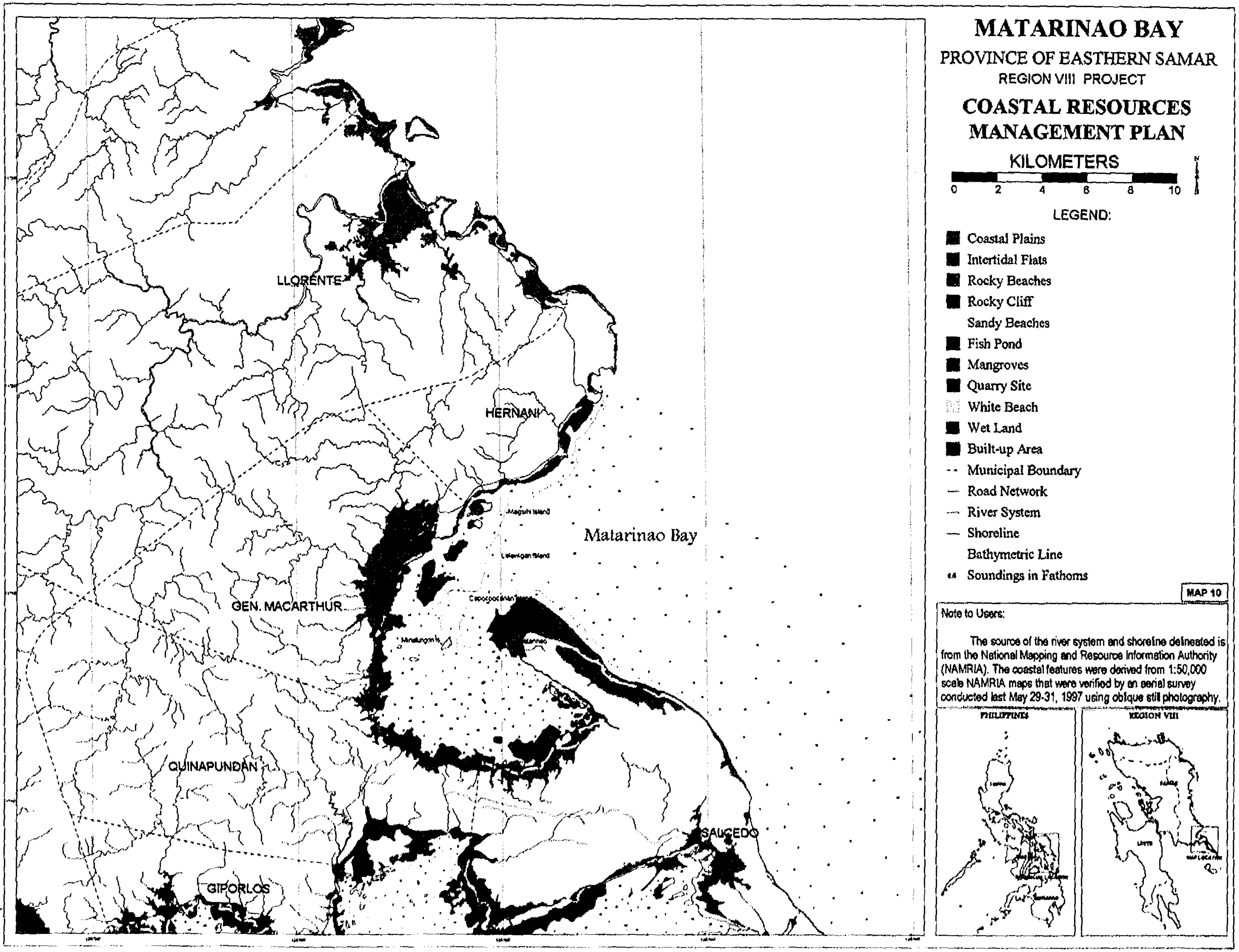




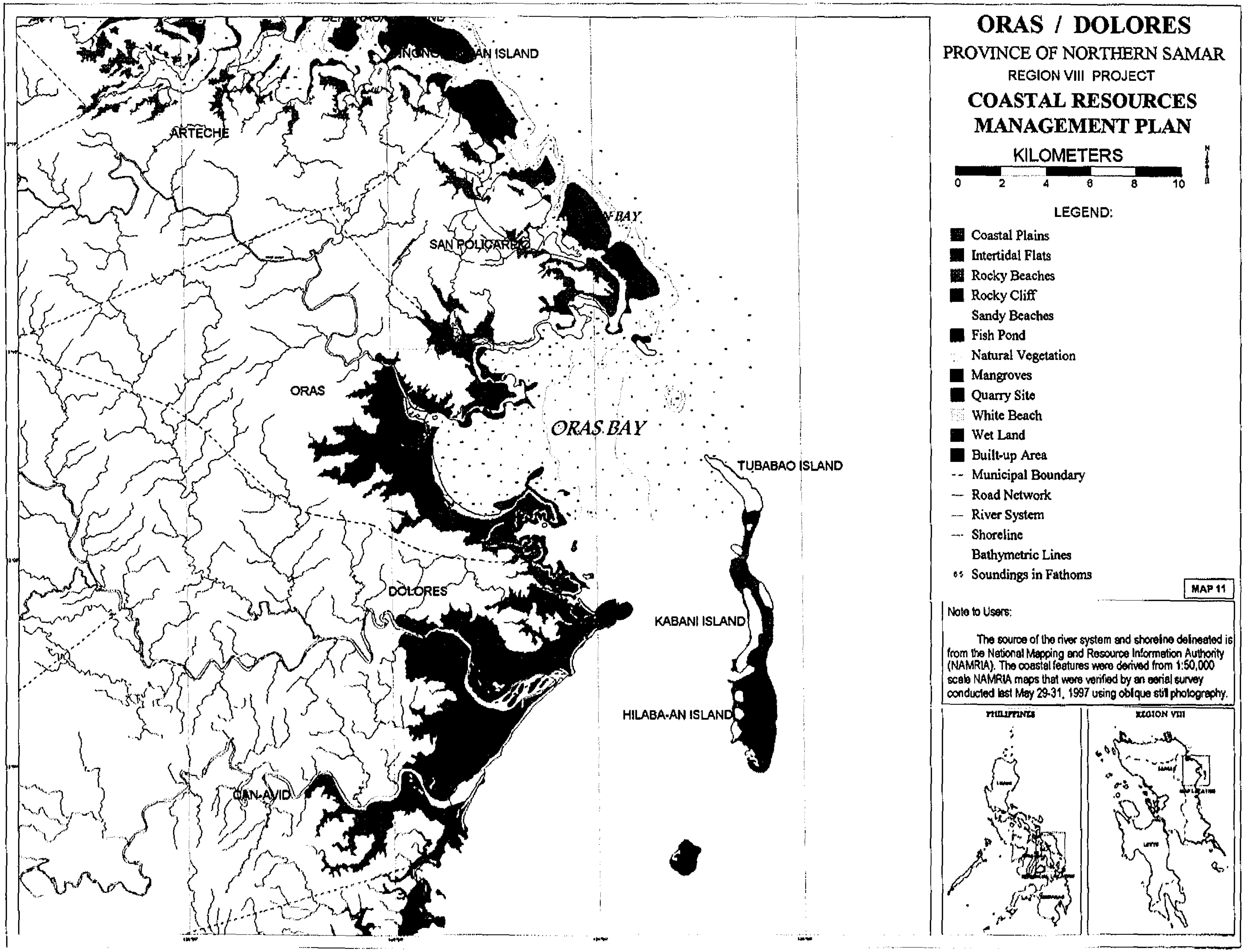


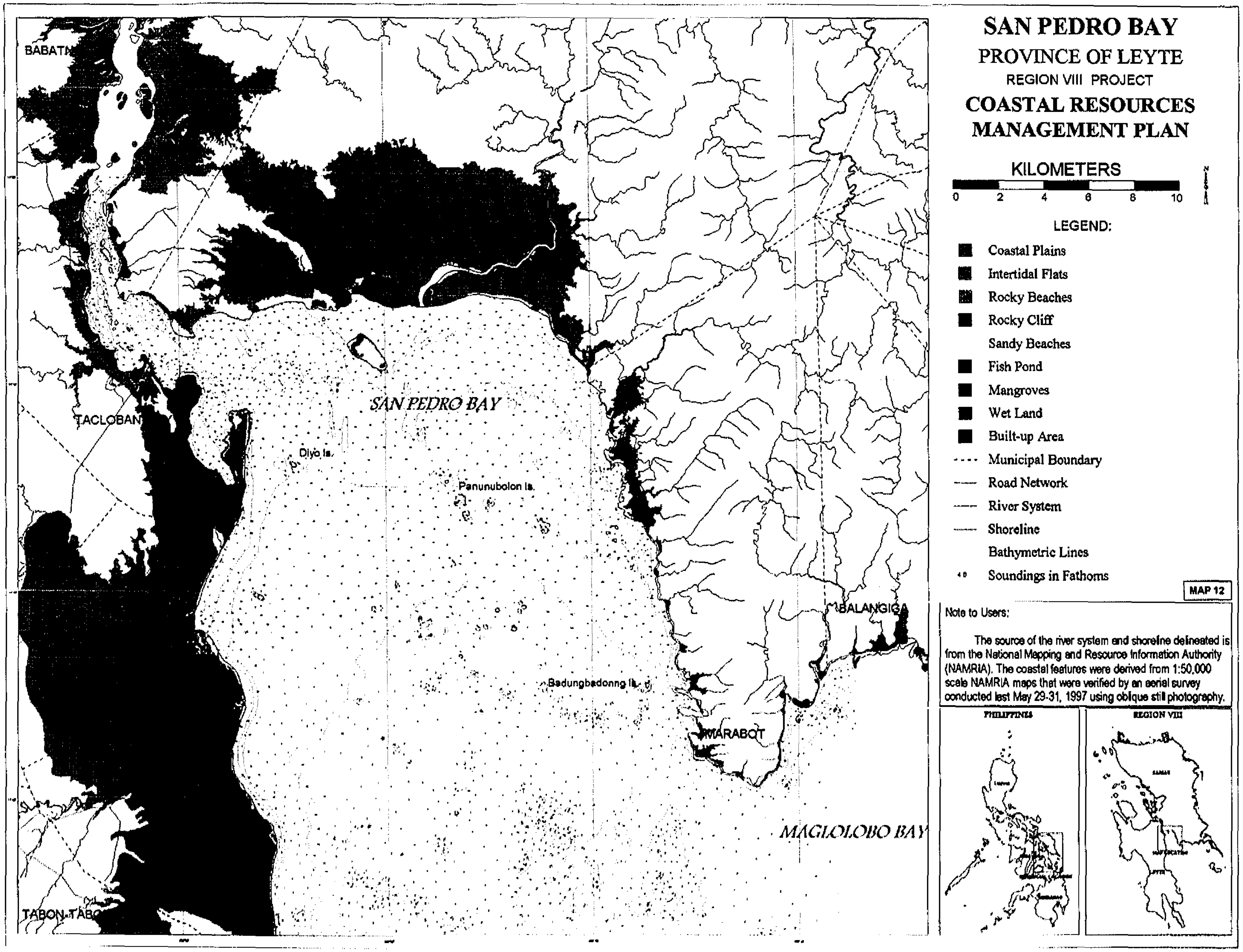
GAMAY BAY
PROVINCE OF NORTHERN SAMAR
REGION VIII PROJECT
COASTAL RESOURCES MANAGEMENT PLAN
KILOMETERS
0 1 2 3 4 5
LEGEND:
Coastal Plains
Intertidal Flats
Sandy Beaches
Built-up Area
Road Network
Shoreline
River System
Municipal Boundary
Bathymetric Lines
Soundings in Fathoms
MAP 8
Note to Users:
The source of the river system and shoreline delineated is from the National Mapping and Resource Information Authority (NAMRIA). The coastal features were derived from 1:50,000 scale NAMRIA maps. No aerial survey was done over this area.
PHILIPPINES
REGION VIII
SACAMALIG BAY
GAMAY BAY
ARTECHE


GUIUAN
PROVINCE OF EASTHERN SAMAR
REGION VIII-PROJECT
COASTAL RESOURCES
MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Coastal Plains
Intertidal Flats
Sandy Beaches
Mangroves
Built-up Area
Provincial Boundary
Municipal Boundary
Road Network
River System
Shoreline
Bathymetric Line
Soundings in Fathoms
MAP 9
Note to Users:
The source of the river system and shoreline delineated is from the National Mapping and Resource Information Authority (NAMRIA). The coastal features were derived from 1:50,000 scale NAMRIA maps that were verified by an aerial survey conducted last May 29-31, 1997 using oblique still photography.
REGION VIII
SALCEDO
Tubabao Island
GUIUAN
MANICANI ISLAND
ISLAND
HOMONHON ISLAND

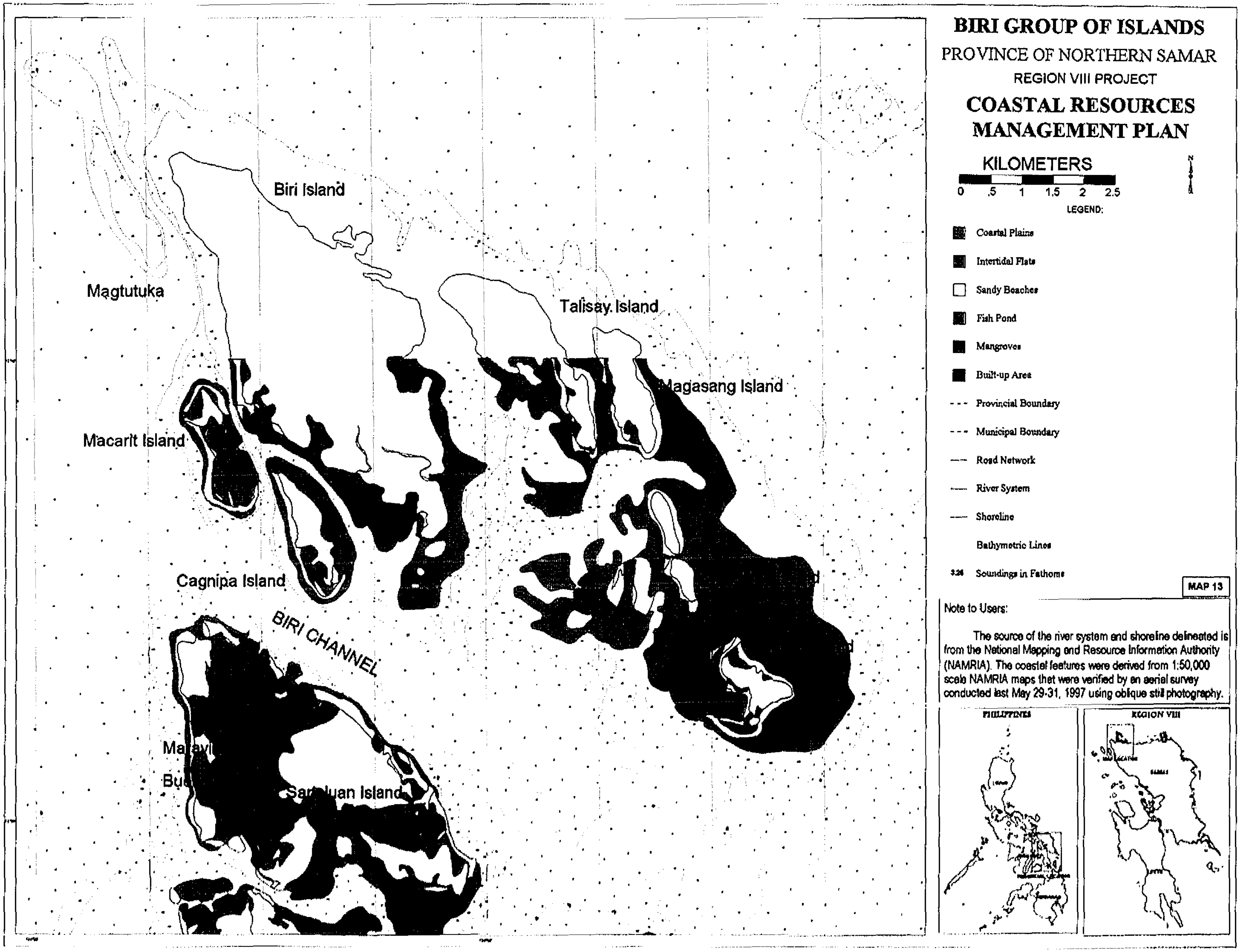

MATARINAO BAY
PROVINCE OF EASTHERN SAMAR
REGION VIII PROJECT
COASTAL RESOURCES
MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Coastal Plains
Intertidal Flats
Rocky Beaches
Rocky Cliff
Sandy Beaches
Fish Pond
Mangroves
Quarry Site
White Beach
Wet Land
Built-up Area
Municipal Boundary
Road Network
River System
Shoreline
Bathymetric Line
Soundings in Fathoms
MAP 10
Note to Users:
The source of the river system and shoreline delineated is from the National Mapping and Resource Information Authority (NAMRIA). The coastal features were derived from 1:50,000 scale NAMRIA maps that were verified by an aerial survey conducted last May 29-31, 1997 using oblique still photography.
PHILIPPINES
REGION VIII
LLORENTE
HERNANI
Matarinao Bay
GEN. MACARTHUR
QUINAPUNDAN
SALCEDO
GIPORLOS

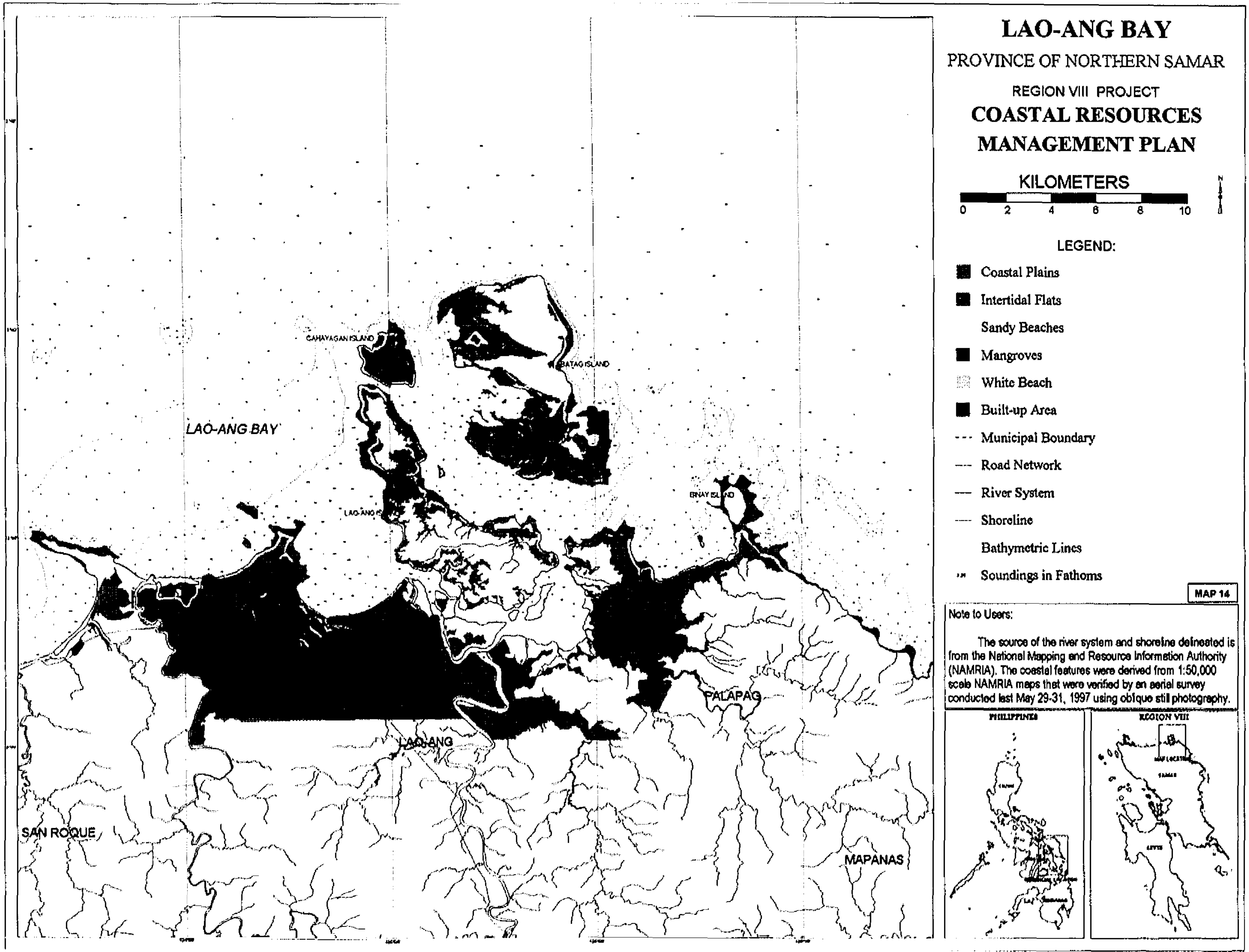
135

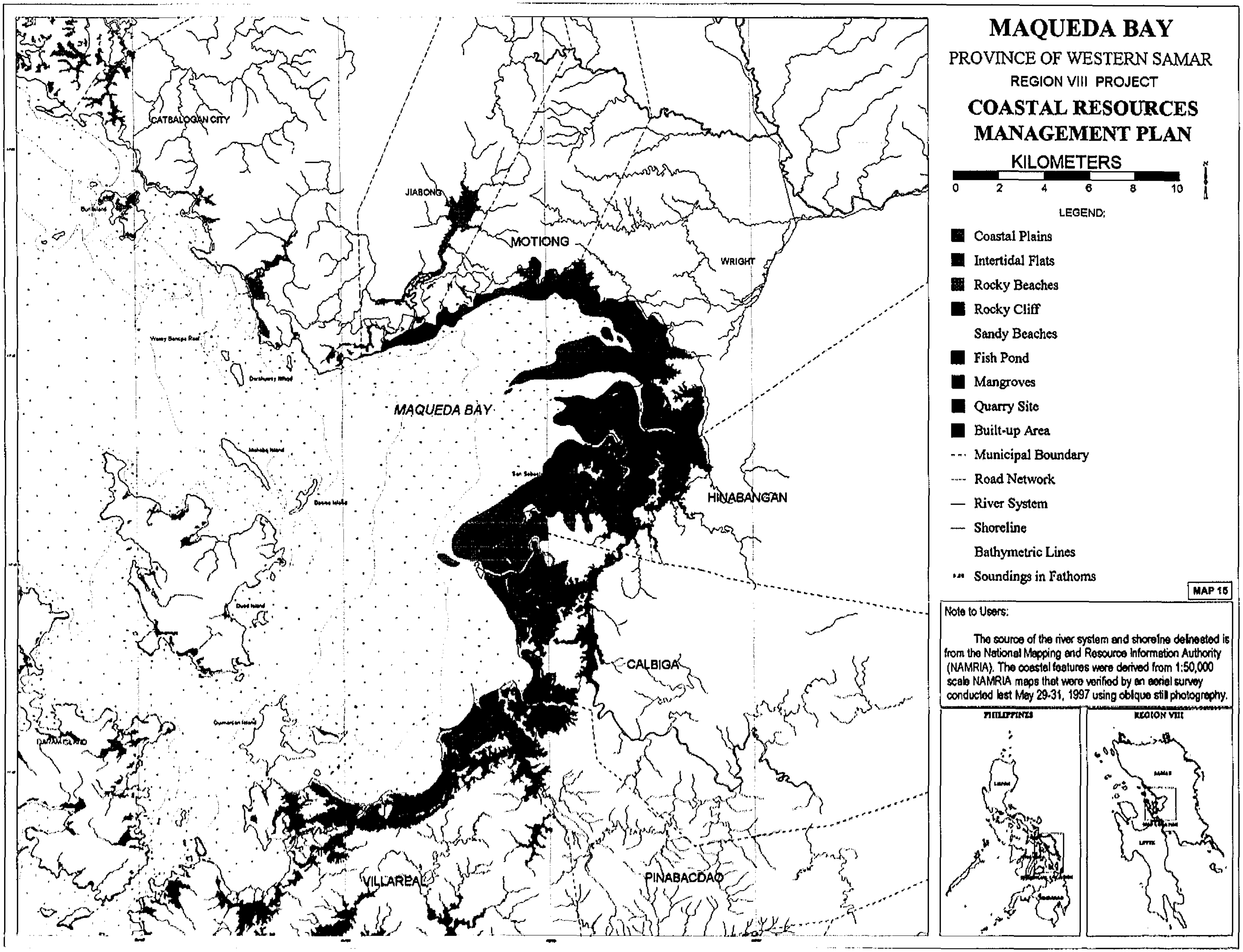

ORAS / DOLORES
PROVINCE OF NORTHERN SAMAR
REGION VIII PROJECT
COASTAL RESOURCES
MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Coastal Plains
Intertidal Flats
Rocky Beaches
Rocky Cliff
Sandy Beaches
Fish Pond
Natural Vegetation
Mangroves
Quarry Site
White Beach
Wet Land
Built-up Area
Municipal Boundary
Road Network
River System
Shoreline
Bathymetric Lines
Soundings in Fathoms
MAP 11
Note to Users:
The source of the river system and shoreline delineated is from the National Mapping and Resource Information Authority (NAMRIA). The coastal features were derived from 1:50,000 scale NAMRIA maps that were verified by an aerial survey conducted last May 29-31, 1997 using oblique still photography.
PHILIPPINES
REGION VIII
ARTECHE
SAN POLICARPO
ORAS
ORAS BAY
TUBABAO ISLAND
DOLORES
KABANI ISLAND
HILABA-AN ISLAND
CAN-AVID

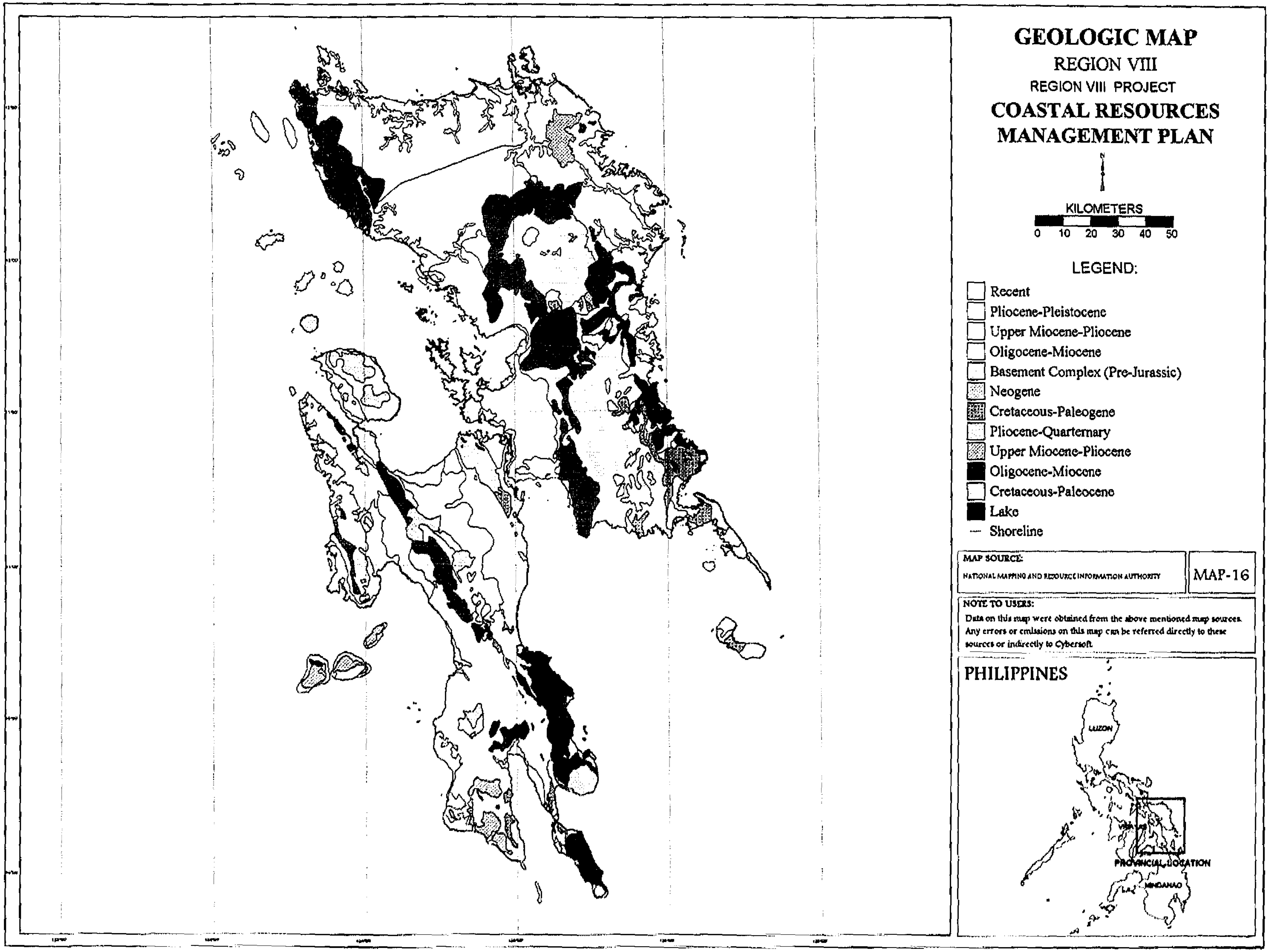


SAN PEDRO BAY
PROVINCE OF LEYTE
REGION VIII PROJECT
COASTAL RESOURCES MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Coastal Plains
Intertidal Flats
Rocky Beaches
Rocky Cliff
Sandy Beaches
Fish Pond
Mangroves
Wet Land
Built-up Area
Municipal Boundary
Road Network
River System
Shoreline
Bathymetric Lines
Soundings in Fathoms
MAP 12
Note to Users:
The source of the river system and shoreline delineated is from the National Mapping and Resource Information Authority (NAMRIA). The coastal features were derived from 1:50,000 scale NAMRIA maps that were verified by an aerial survey conducted last May 29-31, 1997 using oblique still photography.
PHILIPPINES
REGION VIII
SAN PEDRO BAY
TACLOBAN
Diyo Is.
Panunubolon Is.
Badungbadonng Is.
BALANGIGA
MARABOT
MAGLOLOBO BAY


BIRI GROUP OF ISLANDS
PROVINCE OF NORTHERN SAMAR
REGION VIII PROJECT
COASTAL RESOURCES MANAGEMENT PLAN
KILOMETERS
0 .5 1 1.5 2 2.5
LEGEND:
Coastal Plains
Intertidal Flats
Sandy Beaches
Fish Pond
Mangroves
Built-up Area
Provincial Boundary
Municipal Boundary
Road Network
River System
Shoreline
Bathymetric Lines
Soundings in Fathoms
MAP 13
Note to Users:
The source of the river system and shoreline delineated is from the National Mapping and Resource Information Authority (NAMRIA). The coastal features were derived from 1:50,000 scale NAMRIA maps that were verified by an aerial survey conducted last May 29-31, 1997 using oblique still photography.
PHILIPPINES
REGION VIII
Biri Island
Magtutuka
Talisay Island
Magasang Island
Macarit Island
Cagnipa Island
BIRI CHANNEL

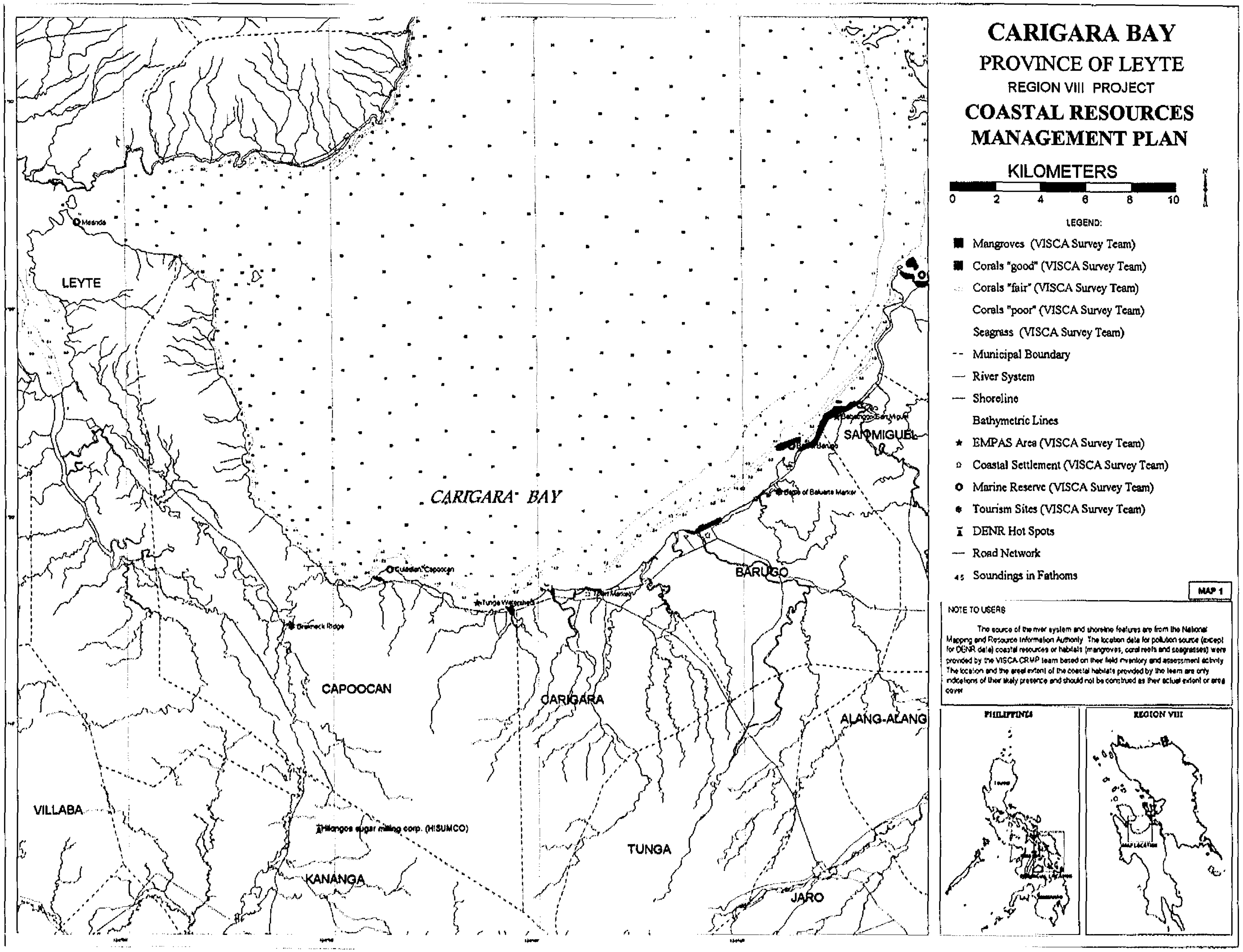

LAO-ANG BAY
PROVINCE OF NORTHERN SAMAR
REGION VIII PROJECT
COASTAL RESOURCES
MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Coastal Plains
Intertidal Flats
Sandy Beaches
Mangroves
White Beach
Built-up Area
Municipal Boundary
Road Network
River System
Shoreline
Bathymetric Lines
Soundings in Fathoms
MAP 14
Note to Users:
The source of the river system and shoreline delineated is from the National Mapping and Resource Information Authority (NAMRIA). The coastal features were derived from 1:50,000 scale NAMRIA maps that were verified by an aerial survey conducted last May 29-31, 1997 using oblique still photography.
PHILIPPINES
REGION VIII
LAO-ANG BAY
CAHAYAGAN ISLAND
BATAG ISLAND
BINAY ISLAND
PALAPAG
LAO-ANG
SAN ROQUE
MAPANAS


MAQUEDA BAY
PROVINCE OF WESTERN SAMAR
REGION VIII PROJECT
COASTAL RESOURCES MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Coastal Plains
Intertidal Flats
Rocky Beaches
Rocky Cliff
Sandy Beaches
Fish Pond
Mangroves
Quarry Site
Built-up Area
Municipal Boundary
Road Network
River System
Shoreline
Bathymetric Lines
Soundings in Fathoms
MAP 15
Note to Users:
The source of the river system and shoreline delineated is from the National Mapping and Resource Information Authority (NAMRIA). The coastal features were derived from 1:50,000 scale NAMRIA maps that were verified by an aerial survey conducted last May 29-31, 1997 using oblique still photography.
PHILIPPINES
REGION VIII
CATBALOGAN CITY
JIABONG
MOTIONG
WRIGHT
MAQUEDA BAY
HINABANGAN
CALBIGA
VILLAREAL
PINABACDAO


GEOLOGIC MAP
REGION VIII
REGION VIII PROJECT
COASTAL RESOURCES
MANAGEMENT PLAN
KILOMETERS
0 10 20 30 40 50
LEGEND:
Recent
Pliocene-Pleistocene
Upper Miocene-Pliocene
Oligocene-Miocene
Basement Complex (Pre-Jurassic)
Neogene
Cretaceous-Paleogene
Pliocene-Quaternary
Upper Miocene-Pliocene
Oligocene-Miocene
Cretaceous-Paleocene
Lake
Shoreline
MAP SOURCE:
NATIONAL MAPPING AND RESOURCE INFORMATION AUTHORITY
MAP-16
NOTE TO USERS:
Data on this map were obtained from the above mentioned map sources. Any errors or omissions on this map can be referred directly to these sources or indirectly to Cybersoft.
PHILIPPINES
LUZON
PROVINCIAL LOCATION
MINDANAO

Appendix C

Coastal Pollution Sources



CARIGARA BAY
PROVINCE OF LEYTE
REGION VIII PROJECT
COASTAL RESOURCES
MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Mangroves (VISCA Survey Team)
Corals "good" (VISCA Survey Team)
Corals "fair" (VISCA Survey Team)
Corals "poor" (VISCA Survey Team)
Seagrass (VISCA Survey Team)
Municipal Boundary
River System
Shoreline
Bathymetric Lines
EMPAS Area (VISCA Survey Team)
Coastal Settlement (VISCA Survey Team)
Marine Reserve (VISCA Survey Team)
Tourism Sites (VISCA Survey Team)
DENR Hot Spots
Road Network
Soundings in Fathoms
MAP 1
NOTE TO USERS
The source of the river system and shoreline features are from the National Mapping and Resource Information Authority. The location data for pollution source (except for DENR data) coastal resources or habitats (mangroves, coral reefs and seagrasses) were provided by the VISCA-CRMP team based on their field inventory and assessment activity. The location and the areal extent of the coastal habitats provided by the team are only indications of their likely presence and should not be construed as their actual extent or area cover.
PHILIPPINES
REGION VIII
LEYTE
CARIGARA BAY
SAN MIGUEL
BARUGO
CAPOOCAN
CARIGARA
ALANG-ALANG
VILLABA
TUNGA
KANANGA
JARO
Hilongos sugar milling corp. (HISUMCO)

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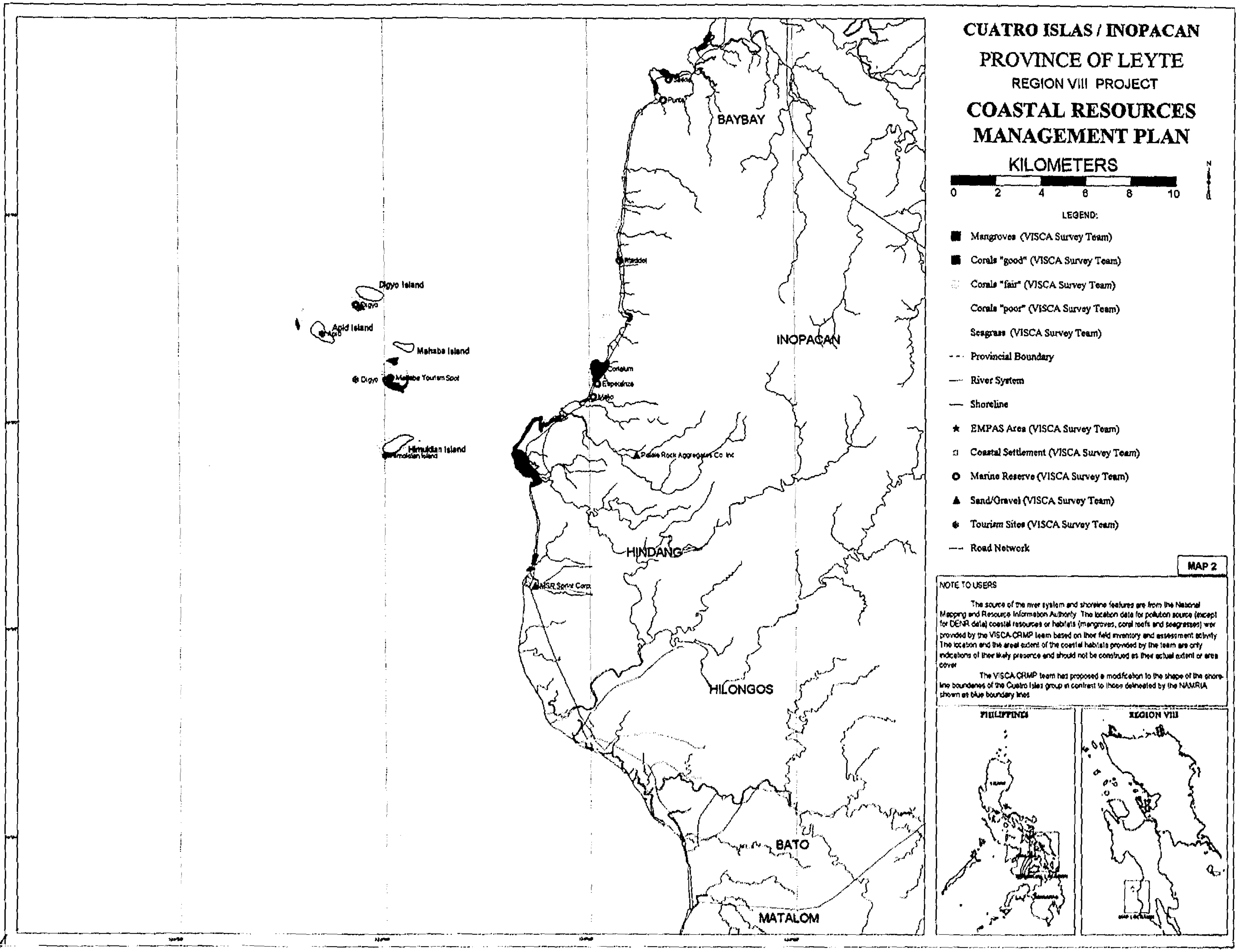
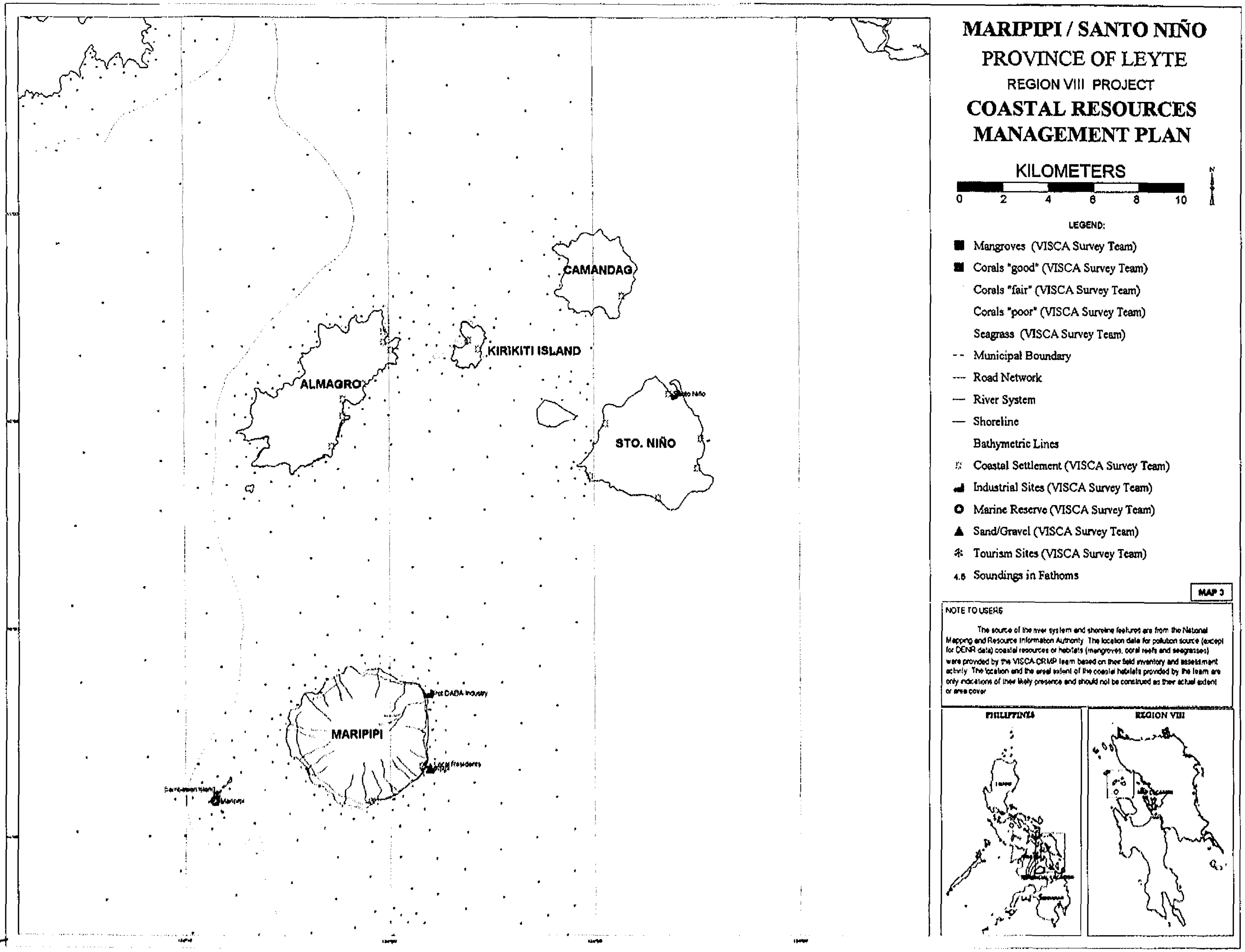
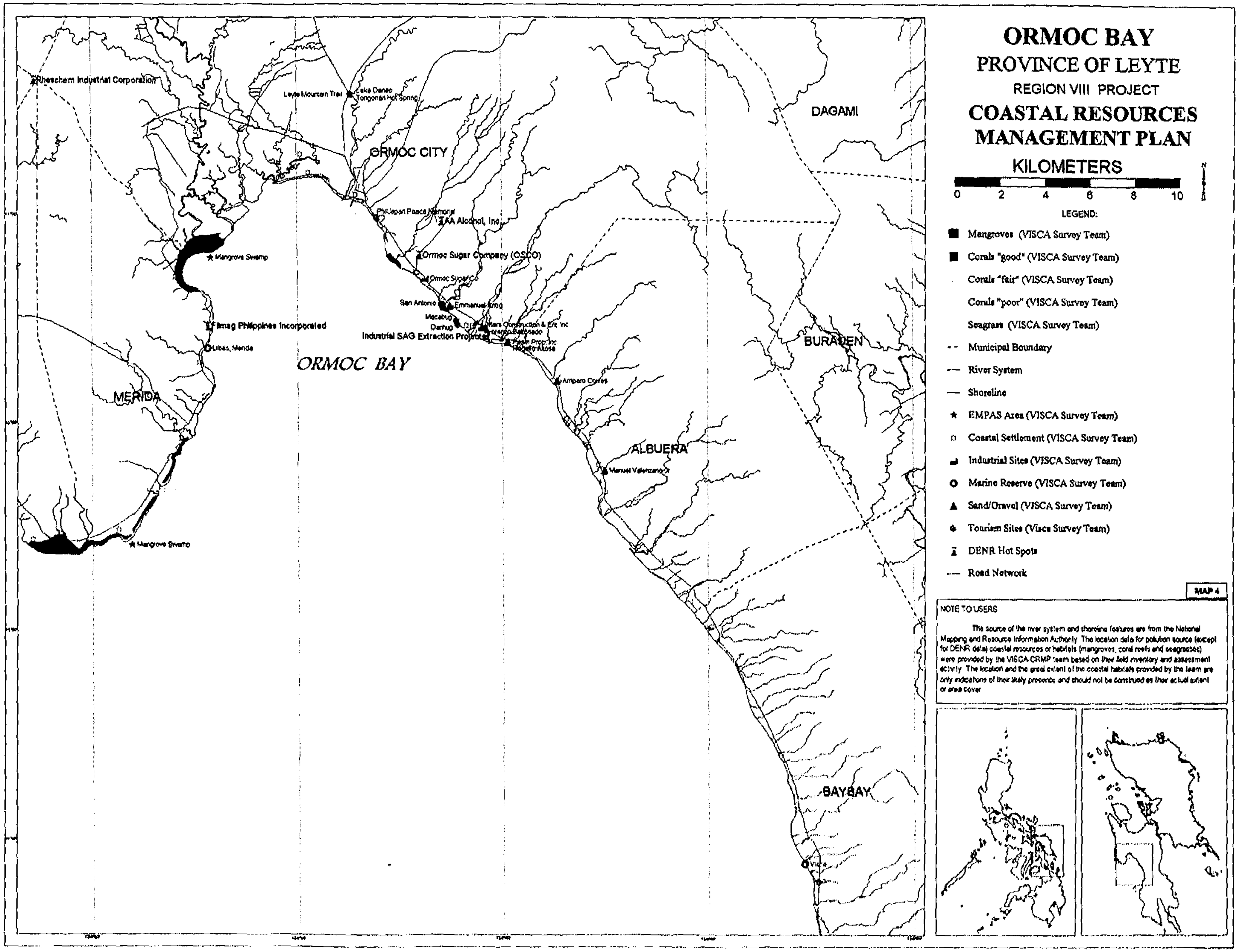
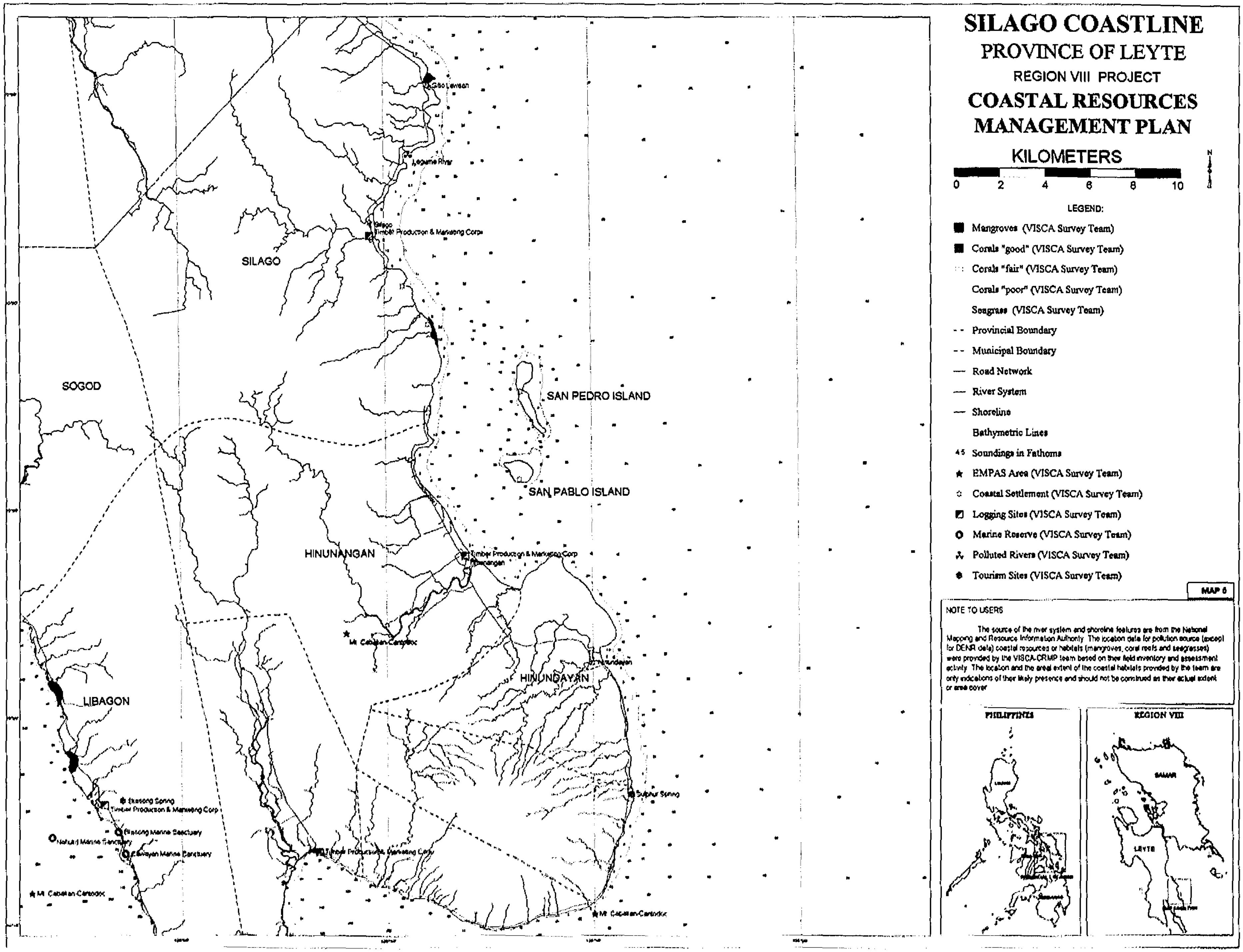
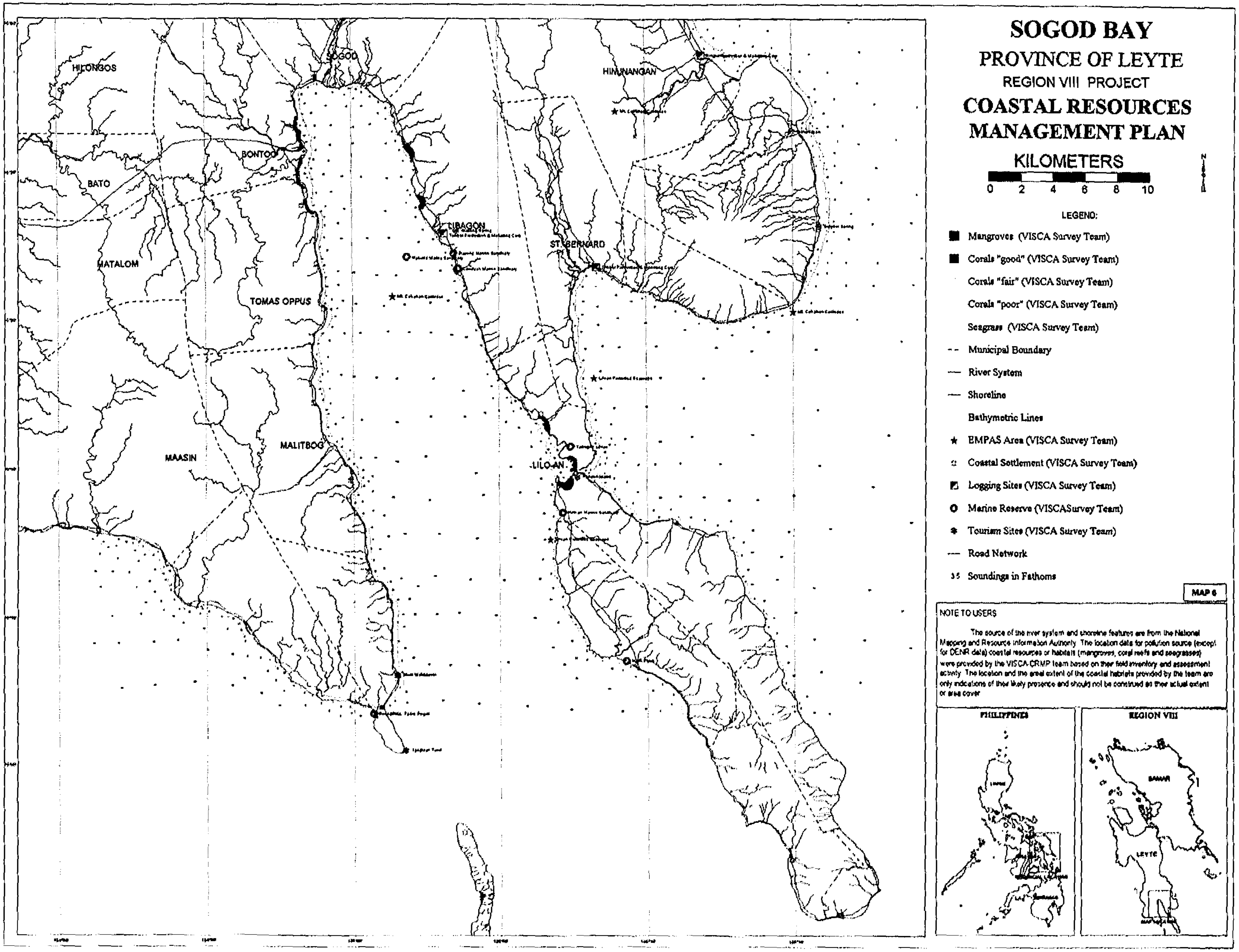

CUATRO ISLAS / INOPACAN
PROVINCE OF LEYTE
REGION VIII PROJECT
COASTAL RESOURCES MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Mangroves (VISCA Survey Team)
Corals "good" (VISCA Survey Team)
Corals "fair" (VISCA Survey Team)
Corals "poor" (VISCA Survey Team)
Seagrass (VISCA Survey Team)
Provincial Boundary
River System
Shoreline
EMPAS Area (VISCA Survey Team)
Coastal Settlement (VISCA Survey Team)
Marine Reserve (VISCA Survey Team)
Sand/Gravel (VISCA Survey Team)
Tourism Sites (VISCA Survey Team)
Road Network
MAP 2
NOTE TO USERS
The source of the river system and shoreline features are from the National Mapping and Resource Information Authority. The location data for pollution source (except for DENR data) coastal resources or habitats (mangroves, coral reefs and seagrasses) were provided by the VISCA-CRMP team based on their field inventory and assessment activity. The location and the areal extent of the coastal habitats provided by the team are only indications of their likely presence and should not be construed as their actual extent or area cover.
The VISCA-CRMP team has proposed a modification to the shape of the shoreline boundaries of the Cuatro Islas group in contrast to those delineated by the NAMRIA shown as blue boundary lines.
PHILIPPINES
REGION VIII
BAYBAY
INOPACAN
HINDANG
HILONGOS
BATO
MATALOM
Digyo Island
Apid Island
Mahaba Island
Himukilan Island
Mahaba Tourism Spot

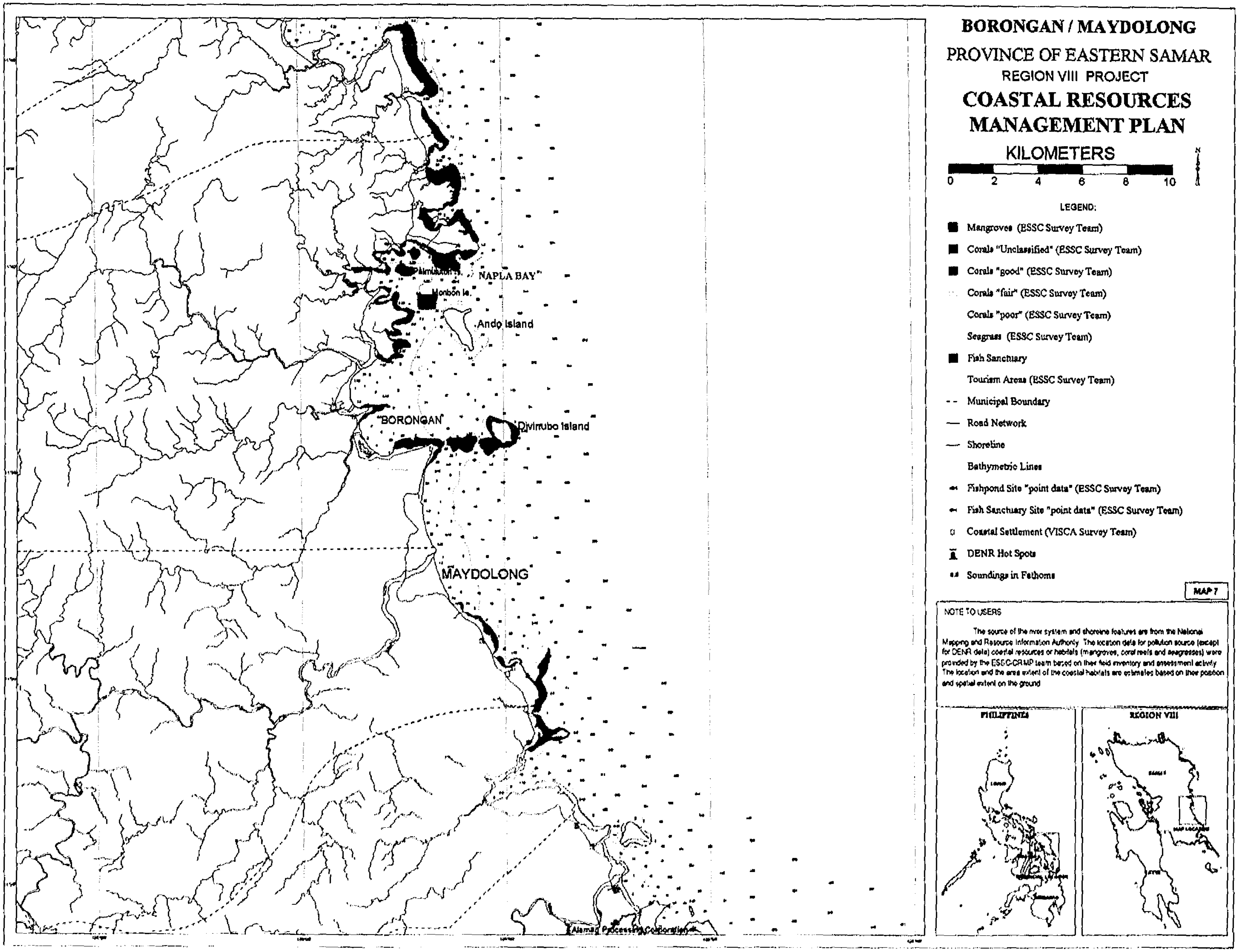

MARIPIPI / SANTO NIÑO
PROVINCE OF LEYTE
REGION VIII PROJECT
COASTAL RESOURCES MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Mangroves (VISCA Survey Team)
Corals "good" (VISCA Survey Team)
Corals "fair" (VISCA Survey Team)
Corals "poor" (VISCA Survey Team)
Seagrass (VISCA Survey Team)
Municipal Boundary
Road Network
River System
Shoreline
Bathymetric Lines
Coastal Settlement (VISCA Survey Team)
Industrial Sites (VISCA Survey Team)
Marine Reserve (VISCA Survey Team)
Sand/Gravel (VISCA Survey Team)
Tourism Sites (VISCA Survey Team)
4.6 Soundings in Fathoms
MAP 3
NOTE TO USERS
The source of the river system and shoreline features are from the National Mapping and Resource Information Authority. The location data for pollution source (except for DENR data) coastal resources or habitats (mangroves, coral reefs and seagrasses) were provided by the VISCA-CRMP team based on their field inventory and assessment activity. The location and the areal extent of the coastal habitats provided by the team are only indications of their likely presence and should not be construed as their actual extent or area cover.
PHILIPPINES
REGION VIII
CAMANDAG
KIRIKITI ISLAND
ALMAGRO
STO. NIÑO
MARIPIPI
DABA Industry
Local Residents

145


ORMOC BAY
PROVINCE OF LEYTE
REGION VIII PROJECT
COASTAL RESOURCES
MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Mangroves (VISCA Survey Team)
Corals "good" (VISCA Survey Team)
Corals "fair" (VISCA Survey Team)
Corals "poor" (VISCA Survey Team)
Seagrass (VISCA Survey Team)
Municipal Boundary
River System
Shoreline
EMPAS Area (VISCA Survey Team)
Coastal Settlement (VISCA Survey Team)
Industrial Sites (VISCA Survey Team)
Marine Reserve (VISCA Survey Team)
Sand/Gravel (VISCA Survey Team)
Tourism Sites (Visca Survey Team)
DENR Hot Spots
Road Network
MAP 4
NOTE TO USERS
The source of the river system and shoreline features are from the National Mapping and Resource Information Authority. The location data for pollution source (except for DENR data) coastal resources or habitats (mangroves, coral reefs and seagrasses) were provided by the VISCA-CRMP team based on their field inventory and assessment activity. The location and the areal extent of the coastal habitats provided by the team are only indications of their likely presence and should not be construed as their actual extent or area cover
ORMOC BAY
ORMOC CITY
DAGAMI
BURAUEN
ALBUERA
BAYBAY
MERIDA
Rheschem Industrial Corporation
Leyte Mountain Trail
Lake Danao
Tongonan Hot Spring
Phil-Japan Peace Memorial
AA Alcohol, Inc.
Ormoc Sugar Company (OSCO)
Ormoc Sugar Co
Mangrove Swamp
San Antonio
Emmanuel Arog
Filmag Philippines Incorporated
Libas, Merida
Industrial SAG Extraction Project
Ampero Cortes
Manuel Valenzano Jr
Mangrove Swamp


SILAGO COASTLINE
PROVINCE OF LEYTE
REGION VIII PROJECT
COASTAL RESOURCES
MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Mangroves (VISCA Survey Team)
Corals "good" (VISCA Survey Team)
Corals "fair" (VISCA Survey Team)
Corals "poor" (VISCA Survey Team)
Seagrass (VISCA Survey Team)
Provincial Boundary
Municipal Boundary
Road Network
River System
Shoreline
Bathymetric Lines
Soundings in Fathoms
EMPAS Area (VISCA Survey Team)
Coastal Settlement (VISCA Survey Team)
Logging Sites (VISCA Survey Team)
Marine Reserve (VISCA Survey Team)
Polluted Rivers (VISCA Survey Team)
Tourism Sites (VISCA Survey Team)
MAP 6
NOTE TO USERS
The source of the river system and shoreline features are from the National Mapping and Resource Information Authority. The location data for pollution source (except for DENR data) coastal resources or habitats (mangroves, coral reefs and seagrasses) were provided by the VISCA-CRMP team based on their field inventory and assessment activity. The location and the areal extent of the coastal habitats provided by the team are only indications of their likely presence and should not be construed as their actual extent or area cover
PHILIPPINES
REGION VIII
SILAGO
SOGOD
SAN PEDRO ISLAND
SAN PABLO ISLAND
HINUNANGAN
HINUNDAYAN
LIBAGON


SOGOD BAY
PROVINCE OF LEYTE
REGION VIII PROJECT
COASTAL RESOURCES
MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Mangroves (VISCA Survey Team)
Corals "good" (VISCA Survey Team)
Corals "fair" (VISCA Survey Team)
Corals "poor" (VISCA Survey Team)
Seagrass (VISCA Survey Team)
Municipal Boundary
River System
Shoreline
Bathymetric Lines
EMPAS Area (VISCA Survey Team)
Coastal Settlement (VISCA Survey Team)
Logging Sites (VISCA Survey Team)
Marine Reserve (VISCASurvey Team)
Tourism Sites (VISCA Survey Team)
Road Network
35 Soundings in Fathoms
MAP 6
NOTE TO USERS
The source of the river system and shoreline features are from the National Mapping and Resource Information Authority. The location data for pollution source (except for DENR data) coastal resources or habitats (mangroves, coral reefs and seagrasses) were provided by the VISCA CRMP team based on their field inventory and assessment activity. The location and the areal extent of the coastal habitats provided by the team are only indications of their likely presence and should not be construed as their actual extent or area cover
PHILIPPINES
REGION VIII
HILONGOS
SOGOD
HINUNANGAN
BONTOC
BATO
LIBAGON
ST. BERNARD
MATALOM
TOMAS OPPUS
MAASIN
MALITBOG
LILO-AN


BORONGAN / MAYDOLONG
PROVINCE OF EASTERN SAMAR
REGION VIII PROJECT
COASTAL RESOURCES MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Mangroves (ESSC Survey Team)
Corals "Unclassified" (ESSC Survey Team)
Corals "good" (ESSC Survey Team)
Corals "fair" (ESSC Survey Team)
Corals "poor" (ESSC Survey Team)
Seagrass (ESSC Survey Team)
Fish Sanctuary
Tourism Areas (ESSC Survey Team)
Municipal Boundary
Road Network
Shoreline
Bathymetric Lines
Fishpond Site "point data" (ESSC Survey Team)
Fish Sanctuary Site "point data" (ESSC Survey Team)
Coastal Settlement (VISCA Survey Team)
DENR Hot Spots
Soundings in Fathoms
MAP 7
NOTE TO USERS
The source of the river system and shoreline features are from the National Mapping and Resource Information Authority. The location data for pollution source (except for DENR data) coastal resources or habitats (mangroves, coral reefs and seagrasses) were provided by the ESSC-CRMP team based on their field inventory and assessment activity. The location and the area extent of the coastal habitats are estimates based on their position and spatial extent on the ground.
REGION VIII
"NAPLA BAY"
Monbon Is.
Ando Island
"BORONGAN"
Divinubo Island
"MAYDOLONG"
Alamag Processing Corporation

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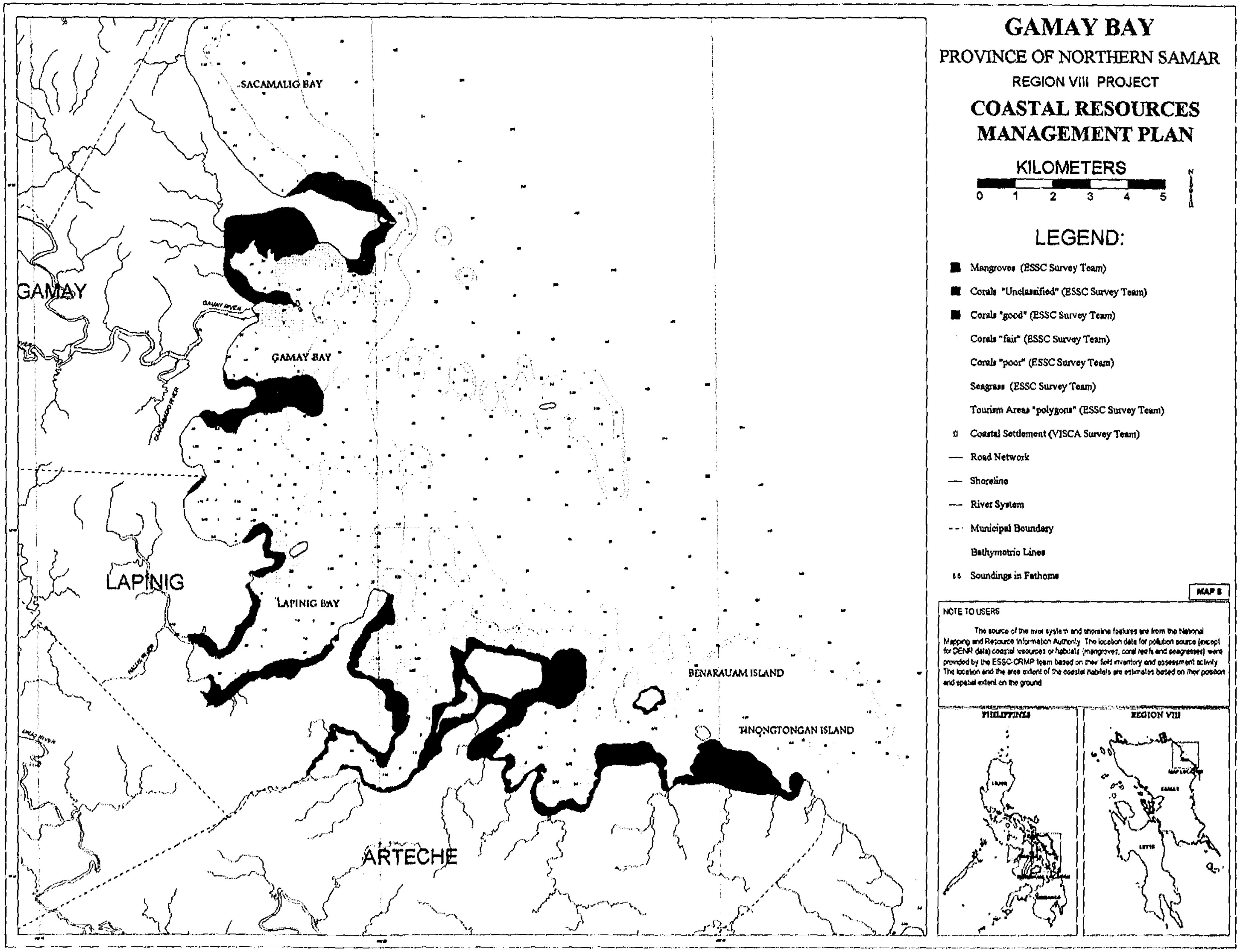
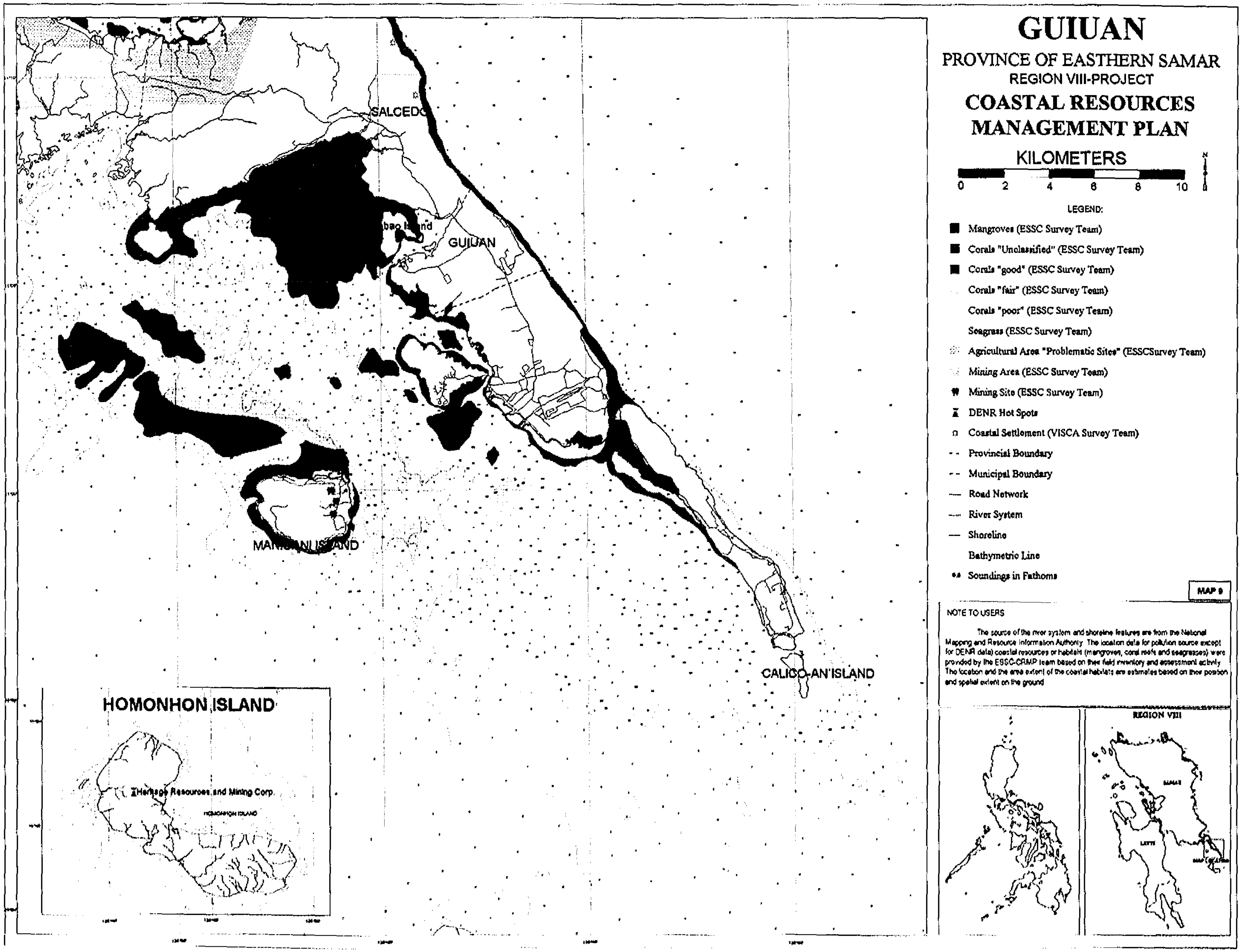

GAMAY BAY
PROVINCE OF NORTHERN SAMAR
REGION VIII PROJECT
COASTAL RESOURCES MANAGEMENT PLAN
KILOMETERS
0 1 2 3 4 5
LEGEND:
Mangroves (ESSC Survey Team)
Corals "Unclassified" (ESSC Survey Team)
Corals "good" (ESSC Survey Team)
Corals "fair" (ESSC Survey Team)
Corals "poor" (ESSC Survey Team)
Seagrass (ESSC Survey Team)
Tourism Areas "polygons" (ESSC Survey Team)
Coastal Settlement (VISCA Survey Team)
Road Network
Shoreline
River System
Municipal Boundary
Bathymetric Lines
Soundings in Fathoms
MAP 8
NOTE TO USERS
The source of the river system and shoreline features are from the National Mapping and Resource Information Authority. The location data for pollution source (except for DENR data) coastal resources or habitats (mangroves, coral reefs and seagrasses) were provided by the ESSC-CRMP team based on their field inventory and assessment activity. The location and the area extent of the coastal habitats are estimates based on their position and spatial extent on the ground.
PHILIPPINES
REGION VIII
SACAMALIG BAY
GAMAY
GAMAY BAY
LAPINIG
LAPINIG BAY
BENARAUAM ISLAND
TINONGTONGAN ISLAND
ARTECHE

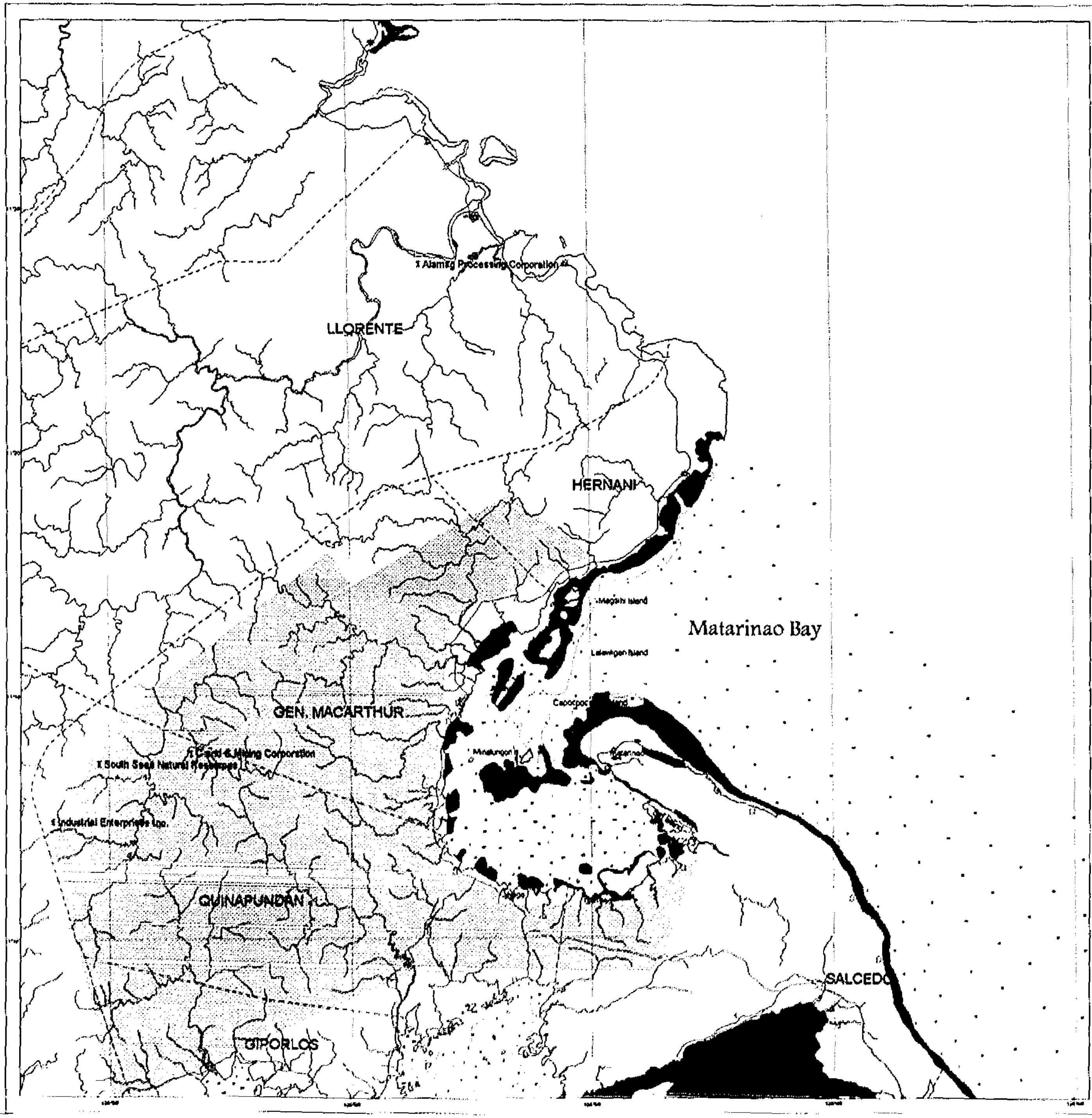

GUIUAN
PROVINCE OF EASTHERN SAMAR
REGION VIII-PROJECT
COASTAL RESOURCES
MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Mangroves (ESSC Survey Team)
Corals "Unclassified" (ESSC Survey Team)
Corals "good" (ESSC Survey Team)
Corals "fair" (ESSC Survey Team)
Corals "poor" (ESSC Survey Team)
Seagrass (ESSC Survey Team)
Agricultural Area "Problematic Sites" (ESSCSurvey Team)
Mining Area (ESSC Survey Team)
Mining Site (ESSC Survey Team)
DENR Hot Spots
Coastal Settlement (VISCA Survey Team)
Provincial Boundary
Municipal Boundary
Road Network
River System
Shoreline
Bathymetric Line
Soundings in Fathoms
NOTE TO USERS
The source of the river system and shoreline features are from the National Mapping and Resource Information Authority. The location data for pollution source except for DENR data) coastal resources or habitats (mangroves, coral reefs and seagrasses) were provided by the ESSC-CRMP team based on their field inventory and assessment activity. The location and the area extent of the coastal habitats are estimates based on their position and spatial extent on the ground
REGION VIII
SALCEDO
GUIUAN
MANICANI ISLAND
CALICOAN ISLAND
HOMONHON ISLAND
Heritage Resources and Mining Corp.

MATARINAO BAY

PROVINCE OF EASTERN SAMAR

REGION VIII PROJECT

COASTAL RESOURCES MANAGEMENT PLAN



KILOMETERS

0 2 4 6 8 10

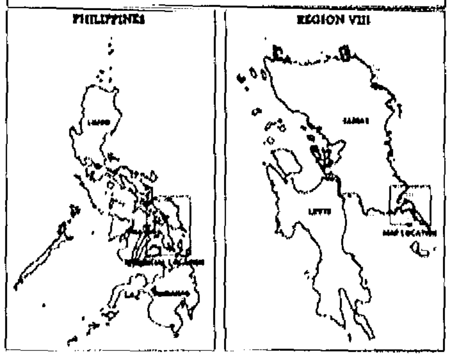
LEGEND:

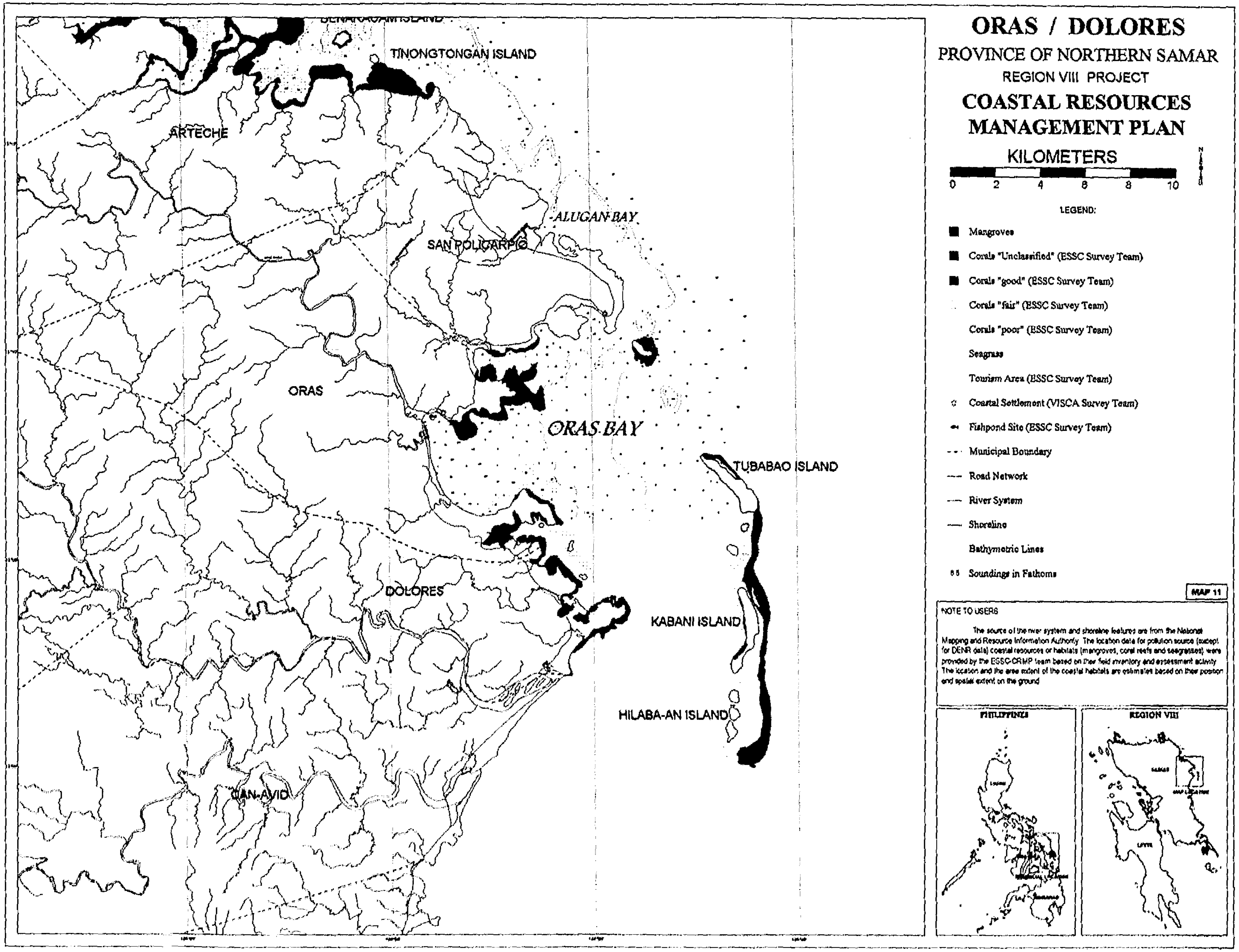
- Mangroves (ESSC Survey Team)
- Corals "Unclassified" (ESSC Survey Team)
- Corals "good" (ESSC Survey Team)
- Corals "fair" (ESSC Survey Team)
- Corals "poor" (ESSC Survey Team)
- Seagrass (ESSC Survey Team)
- Fish Sanctuary "polygons" (ESSC Survey Team)
- Agricultural Area "Problematic Sites" (ESSC Survey Team)
- Tourism Area (ESSC Survey Team)
- Fishpond Site (ESSC Survey Team)
- Coastal Settlement (VISCA Survey Team)
- DENR Hot Spots
- Municipal Boundary
- Road Network
- River System
- Shoreline
- Bathymetric Line
- Soundings in Fathoms

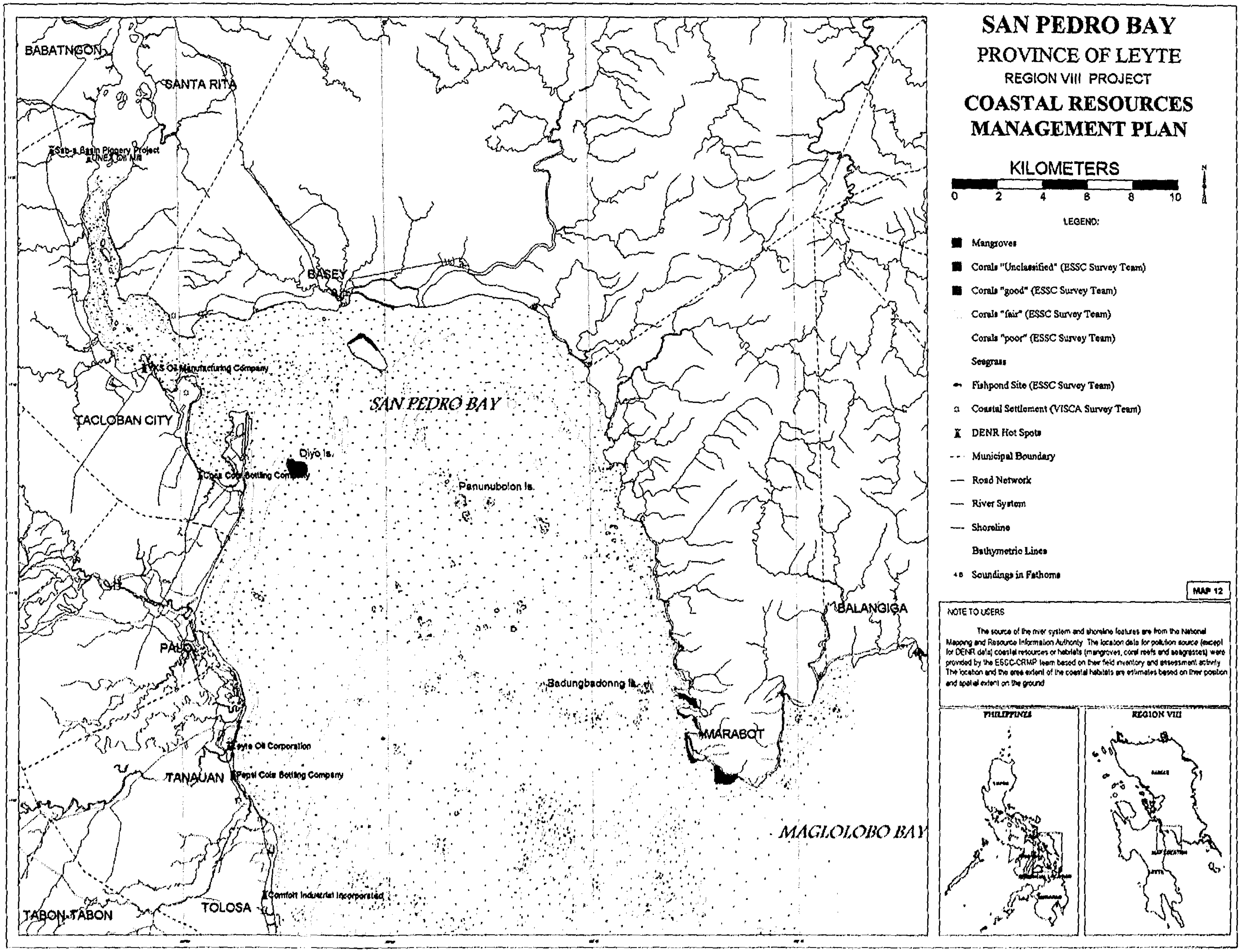
MAP 10

NOTE TO USERS

The source of the river system and shoreline features are from the National Mapping and Resource Information Authority. The location data for pollution source (except for DENR data) coastal resources or habitats (mangroves, coral reefs and seagrasses) were provided by the ESSC-CRMP team based on their field inventory and assessment activity. The location and the area extent of the coastal habitats are estimates based on their position and spatial extent on the ground.




ORAS / DOLORES
PROVINCE OF NORTHERN SAMAR
REGION VIII PROJECT
COASTAL RESOURCES
MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Mangroves
Corals "Unclassified" (ESSC Survey Team)
Corals "good" (ESSC Survey Team)
Corals "fair" (ESSC Survey Team)
Corals "poor" (ESSC Survey Team)
Seagrass
Tourism Area (ESSC Survey Team)
Coastal Settlement (VISCA Survey Team)
Fishpond Site (ESSC Survey Team)
Municipal Boundary
Road Network
River System
Shoreline
Bathymetric Lines
Soundings in Fathoms
MAP 11
NOTE TO USERS
The source of the river system and shoreline features are from the National Mapping and Resource Information Authority. The location data for pollution source (except for DENR data) coastal resources or habitats (mangroves, coral reefs and seagrasses) were provided by the ESSC-CRMP team based on their field inventory and assessment activity. The location and the area extent of the coastal habitats are estimates based on their position and spatial extent on the ground.
PHILIPPINES
REGION VIII
TINONGTONGAN ISLAND
ARTECHE
ALUGAN BAY
SAN POLICARPIO
ORAS
ORAS BAY
TUBABAO ISLAND
DOLORES
KABANI ISLAND
HILABA-AN ISLAND
CAN-AVID


SAN PEDRO BAY
PROVINCE OF LEYTE
REGION VIII PROJECT
COASTAL RESOURCES
MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Mangroves
Corals "Unclassified" (ESSC Survey Team)
Corals "good" (ESSC Survey Team)
Corals "fair" (ESSC Survey Team)
Corals "poor" (ESSC Survey Team)
Seagrass
Fishpond Site (ESSC Survey Team)
Coastal Settlement (VISCA Survey Team)
DENR Hot Spots
Municipal Boundary
Road Network
River System
Shoreline
Bathymetric Lines
Soundings in Fathoms
MAP 12
NOTE TO USERS
The source of the river system and shoreline features are from the National Mapping and Resource Information Authority. The location data for pollution source (except for DENR data) coastal resources or habitats (mangroves, coral reefs and seagrasses) were provided by the ESSC-CRMP team based on their field inventory and assessment activity. The location and the area extent of the coastal habitats are estimates based on their position and spatial extent on the ground.
PHILIPPINES
REGION VIII
BABATNGON
SANTA RITA
BASEY
SAN PEDRO BAY
TACLOBAN CITY
Diyo Is.
Panunubolon Is.
Coca Cola Bottling Company
Badungbadonng Is.
BALANGIGA
MARABOT
PALO
Leyte Oil Corporation
TANAUAN
Pepsi Cola Bottling Company
MAGLOLOBO BAY
TOLOSA
Comfoil Industrial Incorporated
TABON-TABON

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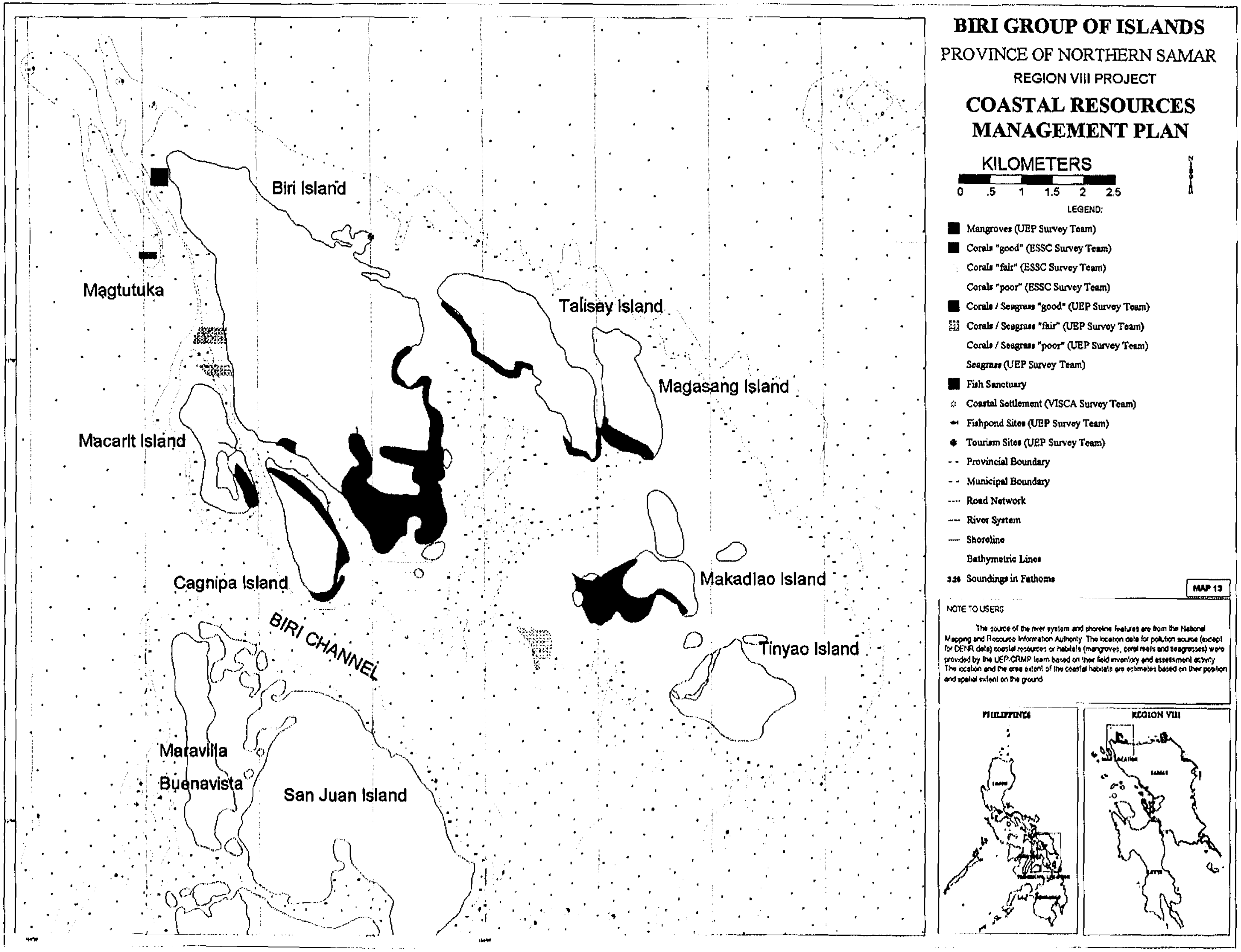

BIRI GROUP OF ISLANDS
PROVINCE OF NORTHERN SAMAR
REGION VIII PROJECT
COASTAL RESOURCES MANAGEMENT PLAN
KILOMETERS
0 .5 1 1.5 2 2.5
LEGEND:
Mangroves (UEP Survey Team)
Corals "good" (ESSC Survey Team)
Corals "fair" (ESSC Survey Team)
Corals "poor" (ESSC Survey Team)
Corals / Seagrass "good" (UEP Survey Team)
Corals / Seagrass "fair" (UEP Survey Team)
Corals / Seagrass "poor" (UEP Survey Team)
Seagrass (UEP Survey Team)
Fish Sanctuary
Coastal Settlement (VISCA Survey Team)
Fishpond Sites (UEP Survey Team)
Tourism Sites (UEP Survey Team)
Provincial Boundary
Municipal Boundary
Road Network
River System
Shoreline
Bathymetric Lines
Soundings in Fathoms
MAP 13
NOTE TO USERS
The source of the river system and shoreline features are from the National Mapping and Resource Information Authority. The location data for pollution source (except for DENR data) coastal resources or habitats (mangroves, coral reefs and seagrasses) were provided by the UEP-CRMP team based on their field inventory and assessment activity. The location and the area extent of the coastal habitats are estimates based on their position and spatial extent on the ground.
PHILIPPINES
REGION VIII
Biri Island
Magtutuka
Talisay Island
Magasang Island
Macarit Island
Cagnipa Island
Makadlao Island
BIRI CHANNEL
Tinyao Island
Maravilla
Buenavista
San Juan Island

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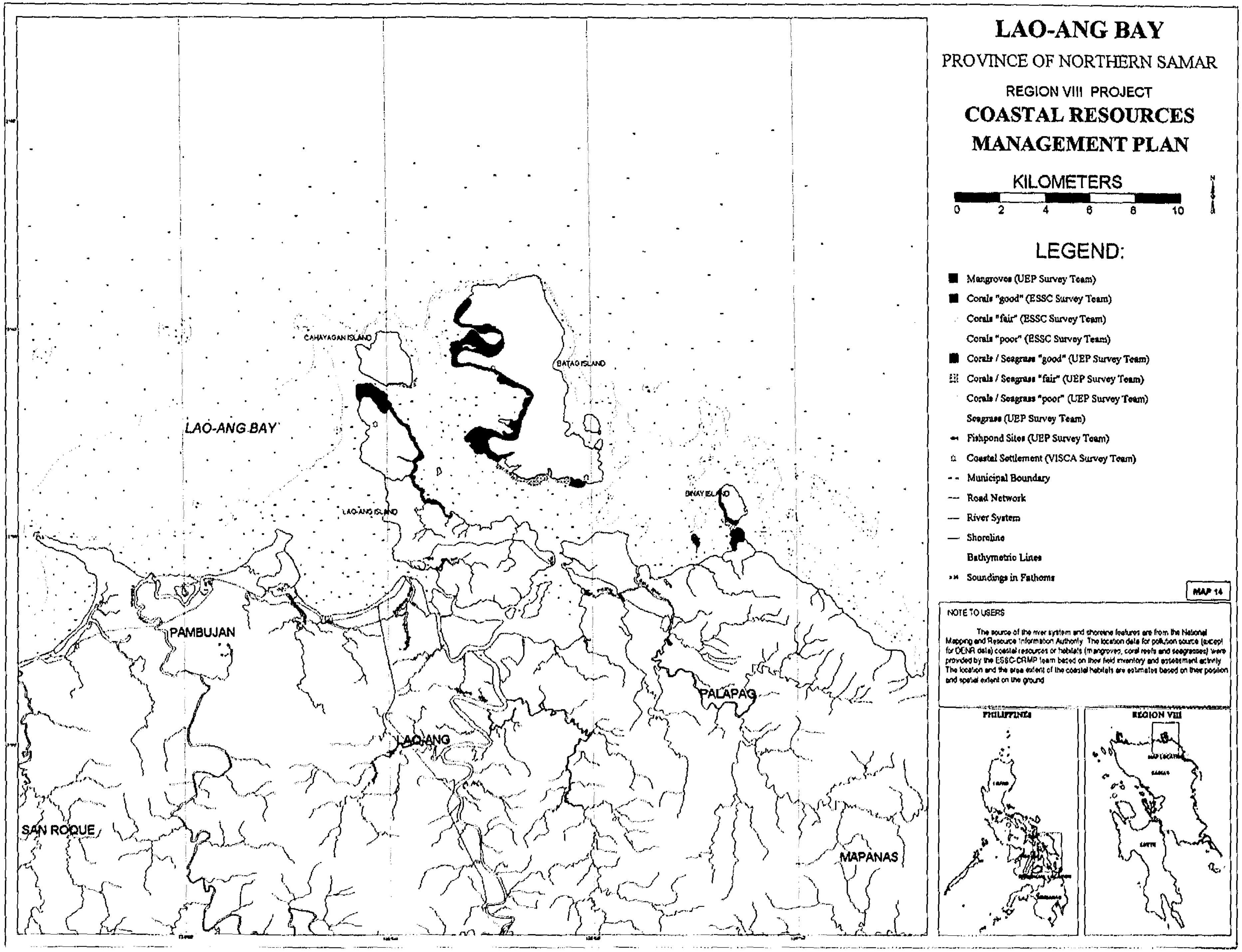
LAO-ANG BAY
PROVINCE OF NORTHERN SAMAR
REGION VIII PROJECT
COASTAL RESOURCES
MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Mangroves (UEP Survey Team)
Corals "good" (ESSC Survey Team)
Corals "fair" (ESSC Survey Team)
Corals "poor" (ESSC Survey Team)
Corals / Seagrass "good" (UEP Survey Team)
Corals / Seagrass "fair" (UEP Survey Team)
Corals / Seagrass "poor" (UEP Survey Team)
Seagrass (UEP Survey Team)
Fishpond Sites (UEP Survey Team)
Coastal Settlement (VISCA Survey Team)
Municipal Boundary
Road Network
River System
Shoreline
Bathymetric Lines
Soundings in Fathoms
MAP 14
NOTE TO USERS
The source of the river system and shoreline features are from the National Mapping and Resource Information Authority. The location data for pollution source (except for DENR data) coastal resources or habitats (mangroves, coral reefs and seagrasses) were provided by the ESSC-CRMP team based on their field inventory and assessment activity. The location and the area extent of the coastal habitats are estimates based on their position and spatial extent on the ground
PHILIPPINES
REGION VIII
CAHAYAGAN ISLAND
BATAG ISLAND
LAO-ANG BAY
LAO-ANG ISLAND
BINAY ISLAND
PAMBUJAN
PALAPAG
LAOANG
SAN ROQUE
MAPANAS

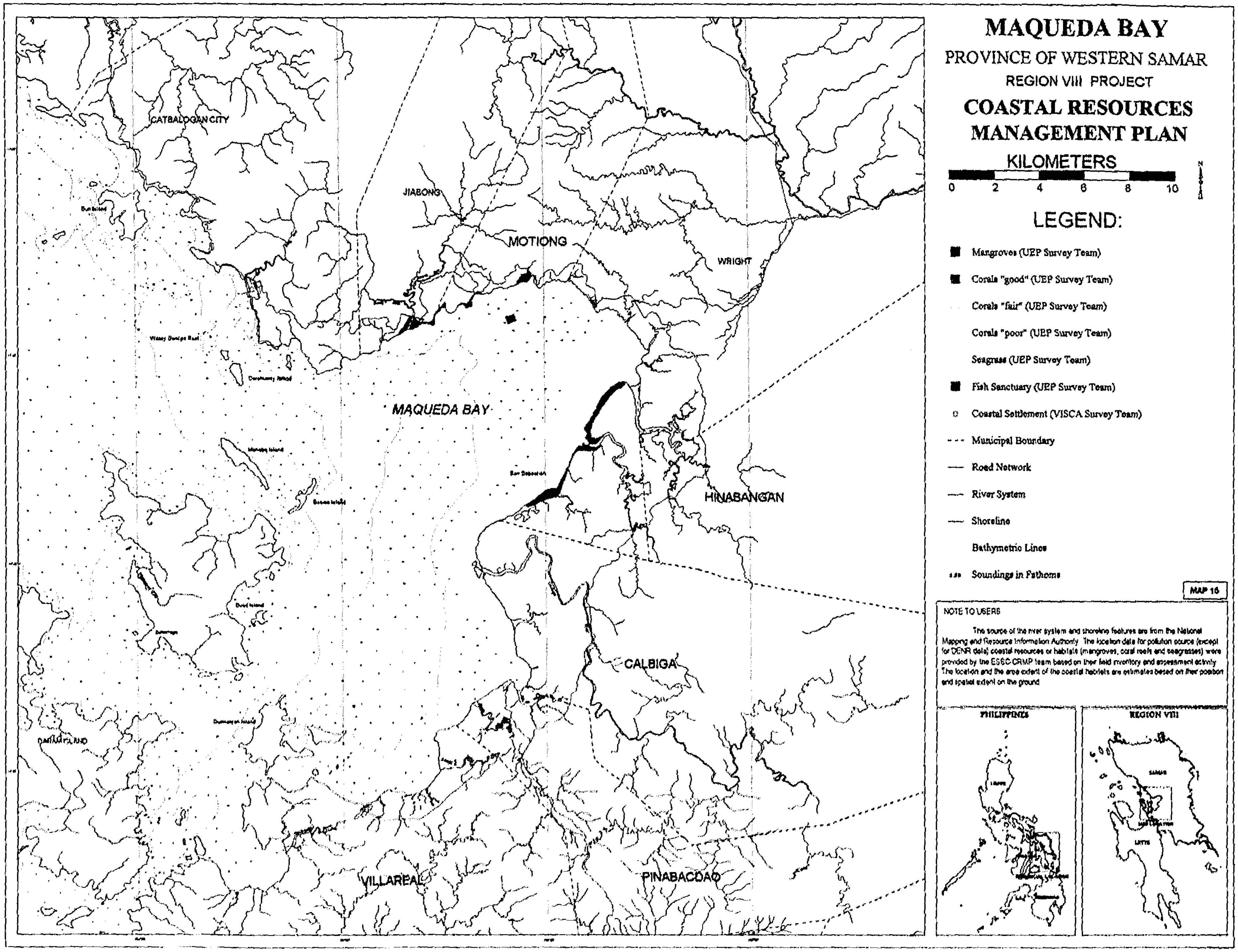
MAQUEDA BAY
PROVINCE OF WESTERN SAMAR
REGION VIII PROJECT
COASTAL RESOURCES MANAGEMENT PLAN
KILOMETERS
0 2 4 6 8 10
LEGEND:
Mangroves (UEP Survey Team)
Corals "good" (UEP Survey Team)
Corals "fair" (UEP Survey Team)
Corals "poor" (UEP Survey Team)
Seagrass (UEP Survey Team)
Fish Sanctuary (UEP Survey Team)
Coastal Settlement (VISCA Survey Team)
Municipal Boundary
Road Network
River System
Shoreline
Bathymetric Lines
Soundings in Fathoms
MAP 16
NOTE TO USERS
The source of the river system and shoreline features are from the National Mapping and Resource Information Authority. The location data for pollution source (except for DENR data) coastal resources or habitats (mangroves, coral reefs and seagrasses) were provided by the ESSC-CRMP team based on their field inventory and assessment activity. The location and the area extent of the coastal habitats are estimates based on their position and spatial extent on the ground.
PHILIPPINES
REGION VIII
CATBALOGAN CITY
JIABONG
MOTIONG
WRIGHT
MAQUEDA BAY
HINABANGAN
CALBIGA
VILLAREAL
PINABACDAO

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Plate 1 Effect of sand and gravel mining

When done too close to shore, extraction of gravel and sand leads to the loss of slope equilibrium causing the beach to slump away into the sea. Panalian, Ormoc City, Leyte.

Plate 2 Sand and gravel mining near riverbanks

The rampant extraction of sand and gravel widens the riverbed and threatens to erode rice fields near the riverbank. Coast of Leyte Gulf.

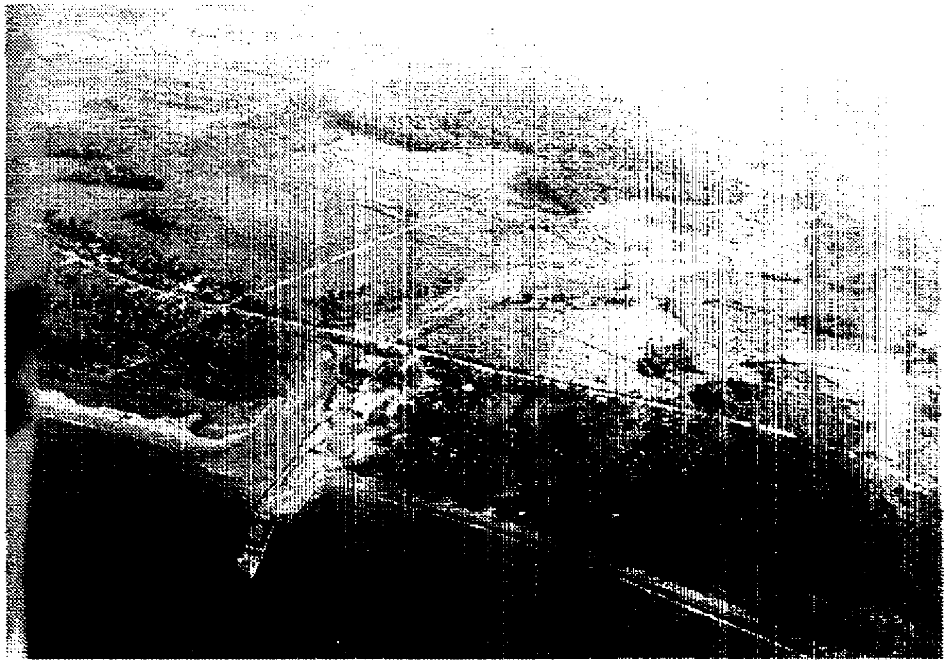

Plate 3 Sand and gravel mining at the mouth of Panilahan River

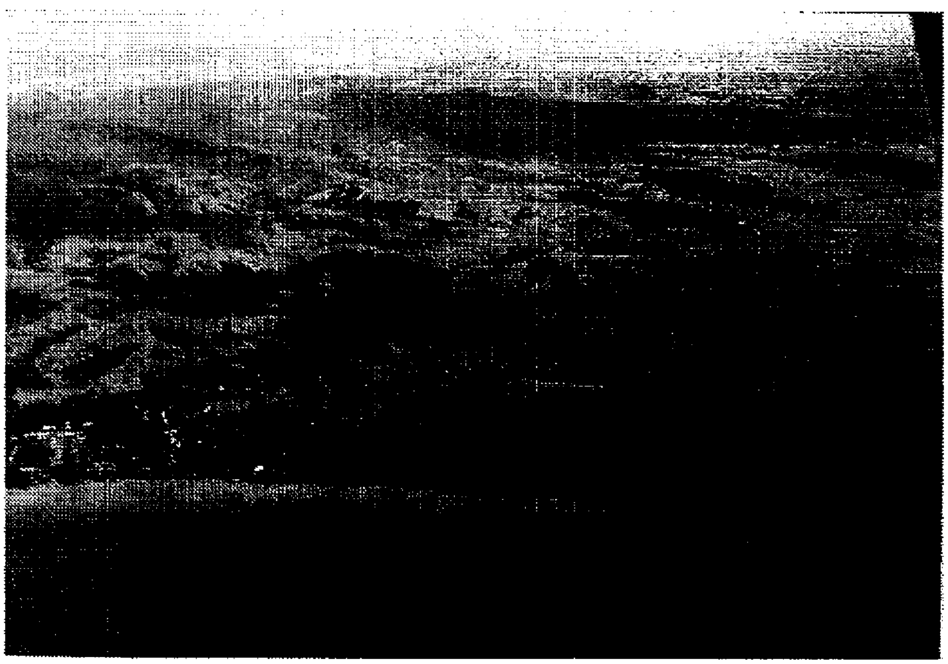

Plate 4 Burning and planting

The trees are burned and agricultural crops are planted. San Antonio, Basey, Samar.

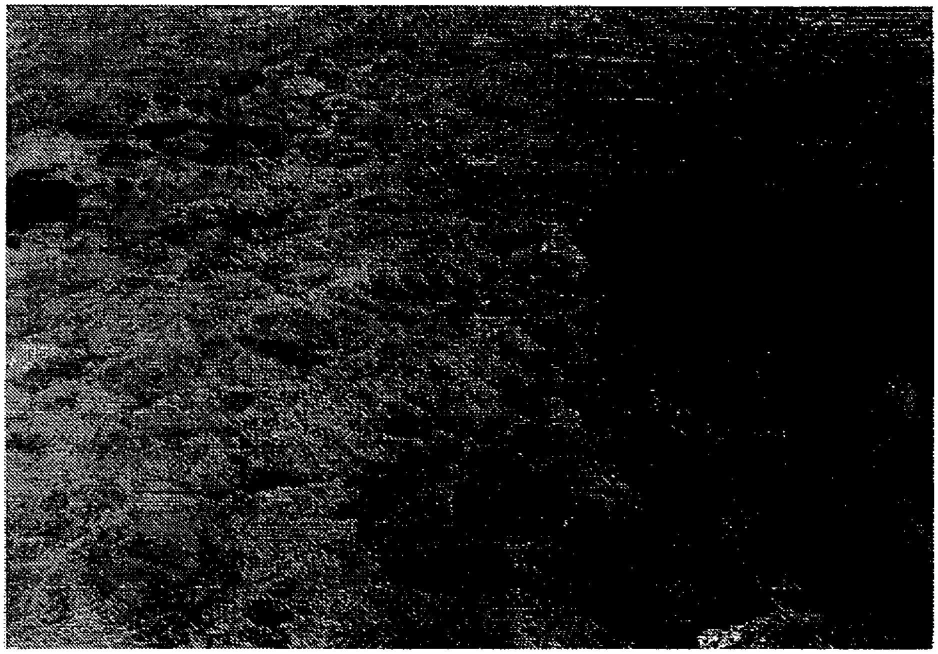

Plate 5 Land clearing

Clearing without replanting the used land with trees. Inland, off the coast of Villareal Bay, Western, Samar.

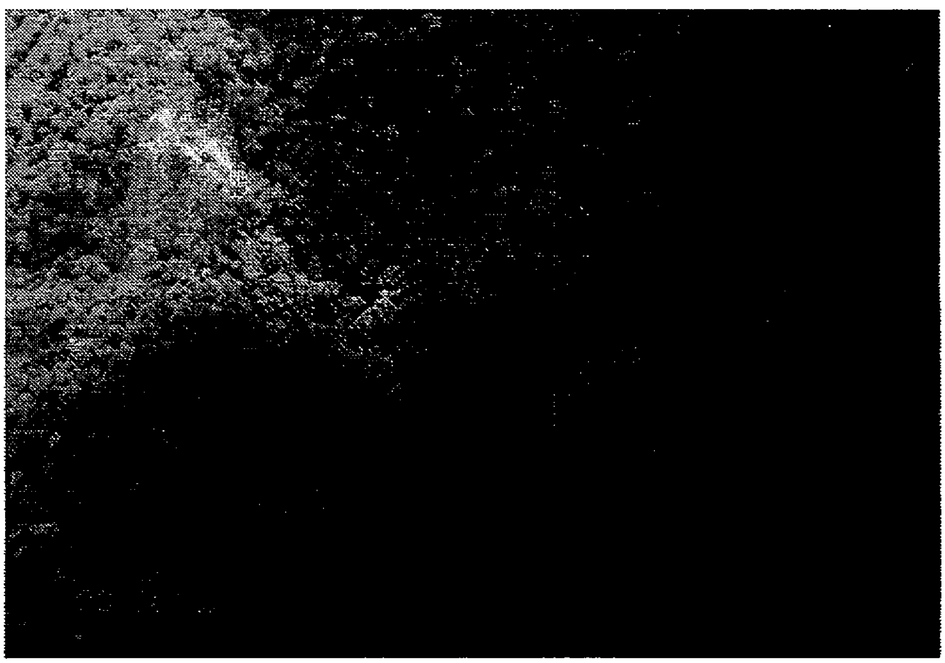

Plate 6 Logging

Another major cause of deforestation is logging. Interior of Samar Province.

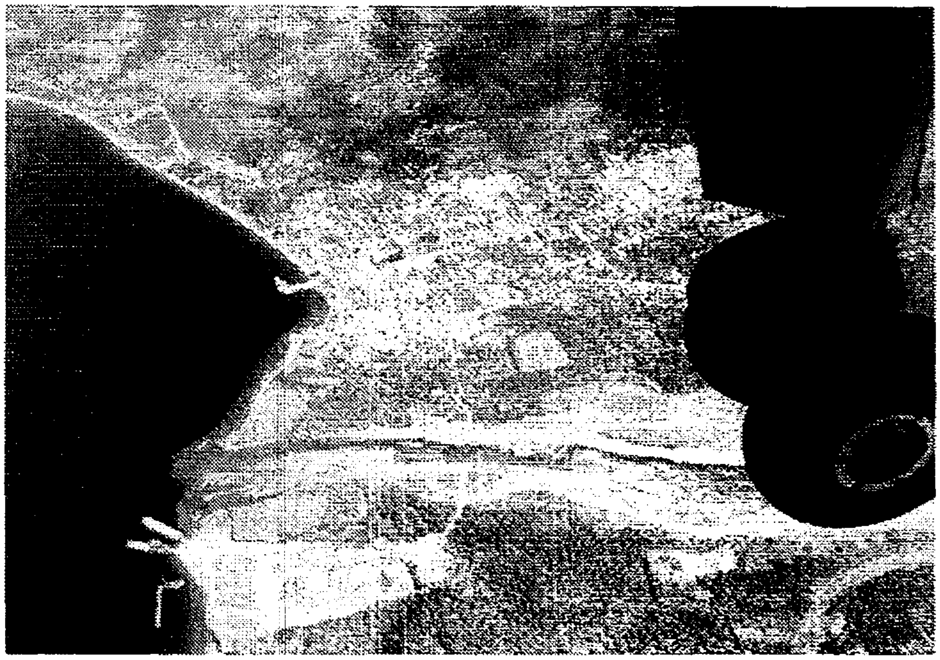

Plate 7 Siltation

High siltation load in the Pandan River. Sogod, Sogod Bay, Southern Samar.

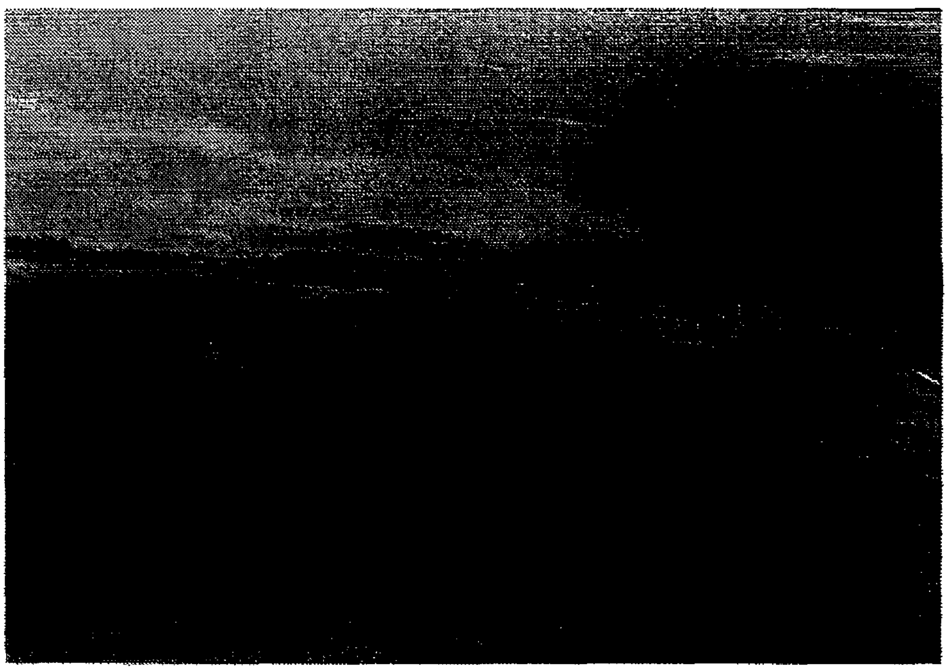

Plate 8 Open-pit mining in Manicani

Mining operations dig out and loosen rocks from the mountain, exposing them to further erosion. Manicani Island, Eastern Samar.

Plate 9 Open-pit mining in Palihon

Palihon Island, Northern Samar.

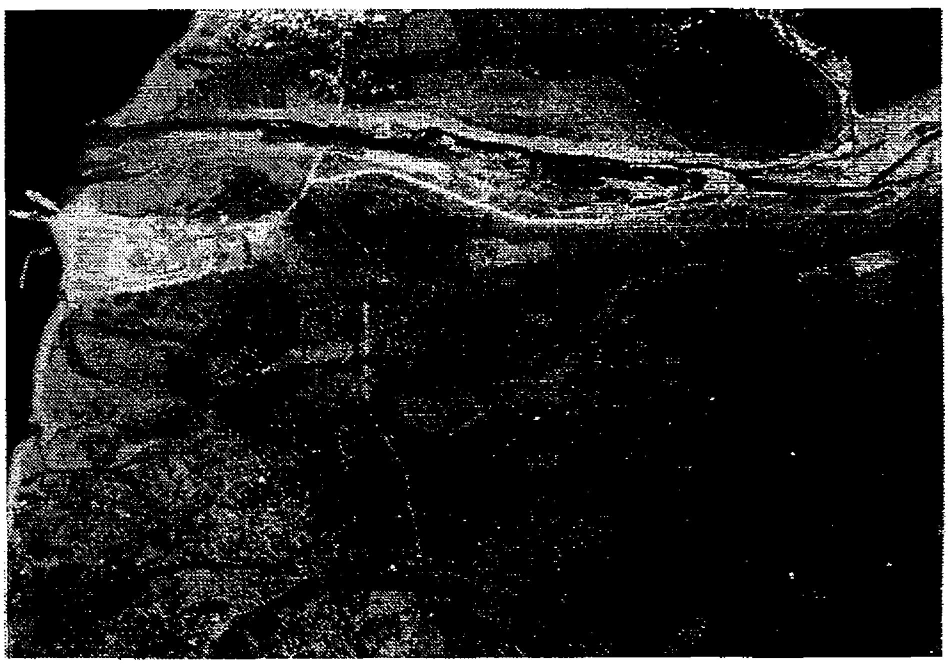

Plate 10 Mine tailings

Siltation and heavy sedimentation of a river in Sogod. Sogod Bay, Southern Leyte.

Plate 11 Barren land

Denudation of the land preparatory to open-pit mining. Homonhon Island, Southeast of Samar Island.

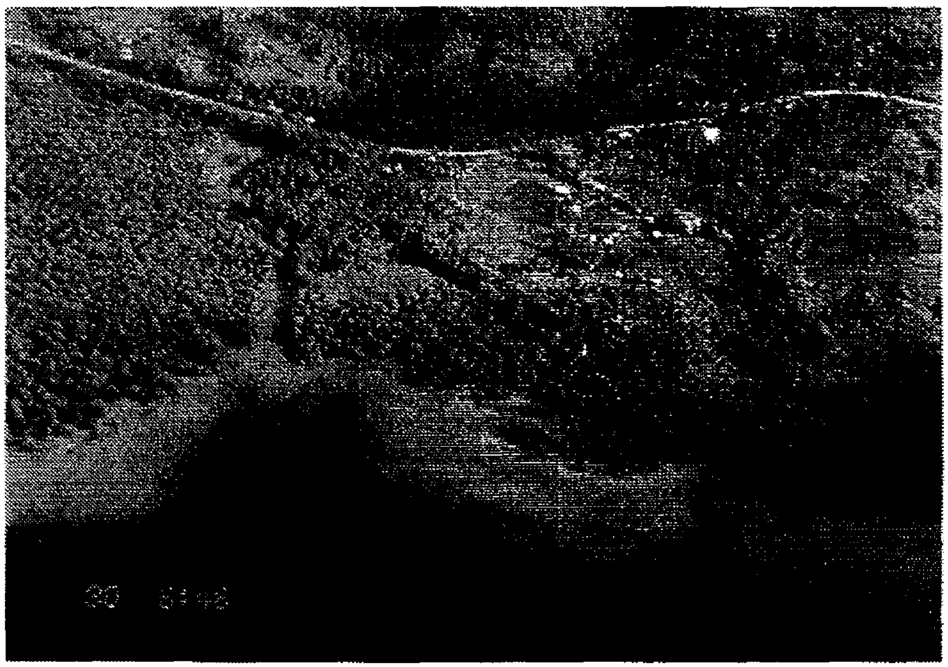

Plate 12 Threatened coral reefs

Shallow reef flats along the coast of the Camotes Sea. Isabel to Calunangan, Leyte.

Plate 13 Tourism at the coastal areas

Land development for tourist accommodation and services. Guindapuhan, Palo, Leyte.

Plate 14 Land development

Changes in nearshore environment due to land fill and reclamation. Dalupiri, Northwest of Samar.

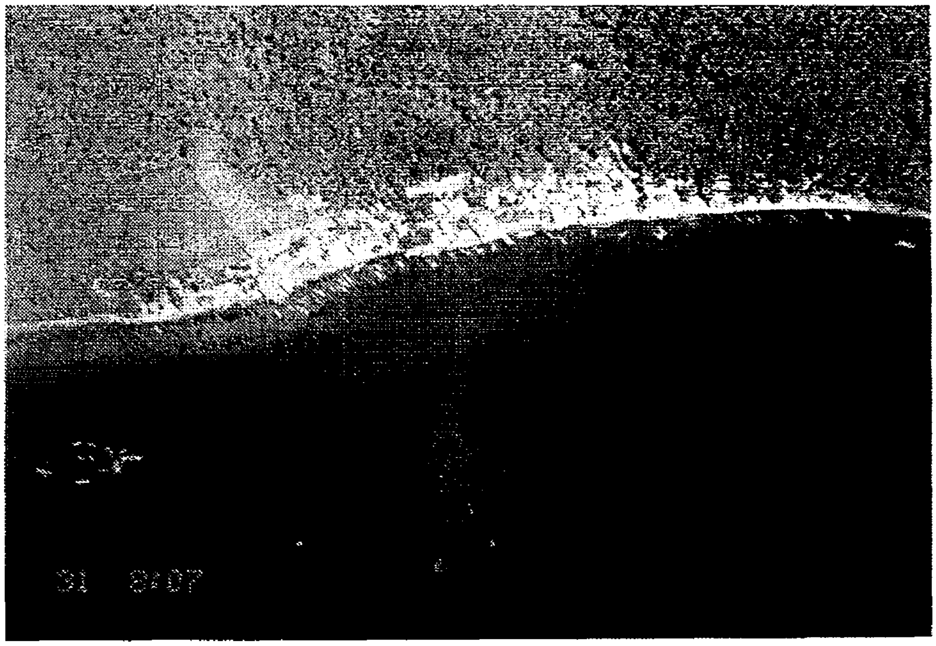

Plate 15 Impact of tourism

One direct impact of tourism in the environment is oil pollution brought about by the boats used for and by tourists. Takot, Limbang Cauayan Island.

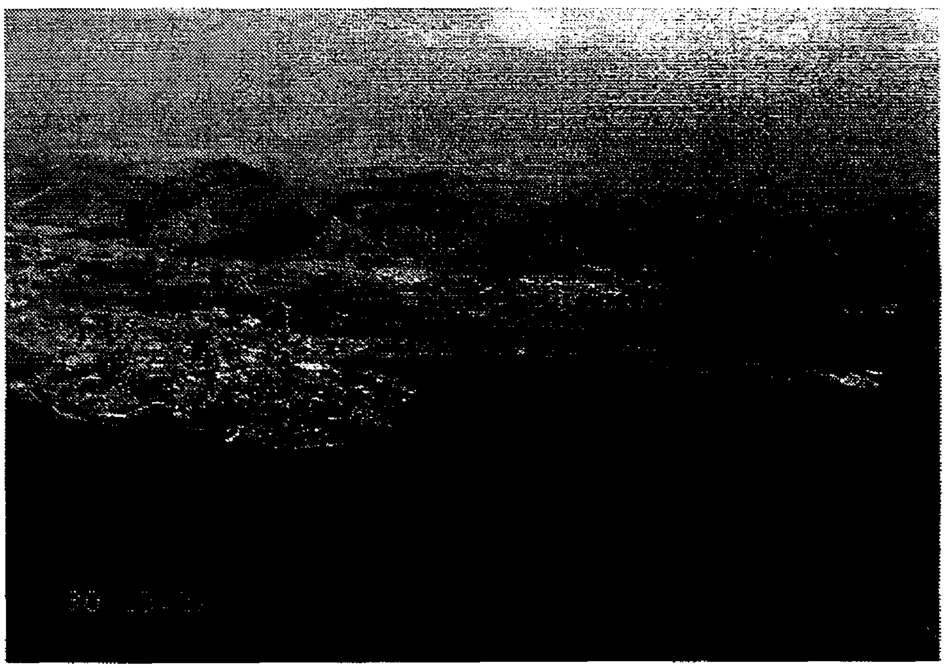

Plate 16 Large coastal settlements

Tacloban City, Leyte.

Plate 17 **Coastal settlement**

Basey proper, Samar Province.

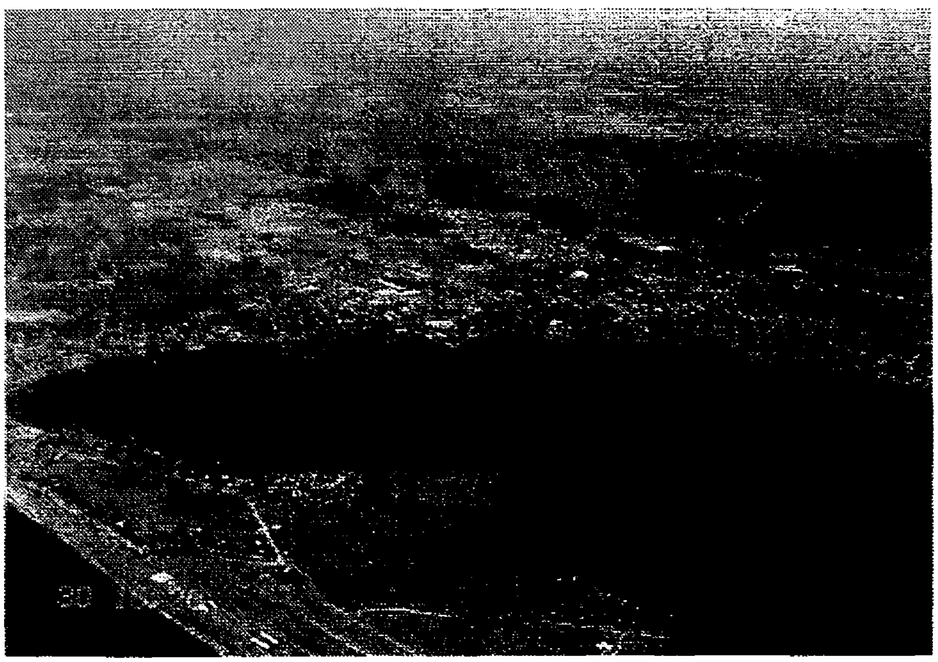

Plate 18 **A problematic bay**

Urban settlements, harbour and airport facilities, and industries thrive the shore. Metro Tacloban, Leyte.

Plate 19 Chemical industry by the bay

Industries contribute to water pollution. Coast of Ormoc Bay.

Plate 20 Industrial sites

PASAR site near Ormoc Bay.