LAND USE CHANGE AND SUSTAINABLE DEVELOPMENT IN SEGARA ANAKAN, JAVA, INDONESIA:

Interactions Among Society, Environment And Development

by

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ABSTRACT

Land Use Change And Sustainable Development In Segara Anakan, Java, Indonesia: Interactions Among Society, Environment And Development

This thesis is concerned with land use change and its relationship with sustainable development at a community and regional level. Increasingly, land use change has been associated with growing vulnerability of the human and physical systems, which has raised concerns about the well-being and survival of humans and other species. Communities are now faced with the challenge of planning and making decisions to achieve more sustainable use of land. While there has been a growing body of literature on land use change, particularly as it pertains to sustainable development, a good understanding of the causes and implications of these changes is still lacking. This thesis aims to help improve this understanding by studying an area undergoing rapid land use change. The area is a brackish mangrove estuary, the Segara Anakan, located in Java, Indonesia. The research is conducted from a human ecological perspective. The main objectives are: 1) to document changes in land cover and land use over a 27 year span from 1968 to 1995; 2) to identify the key interactions among society, environment and development associated with these changes; and 3) to explore the implications and challenges for planning and sustainable development arising from these changes.

The conceptual or human ecological approach is based on the interactions among society, environment and development. Central to this approach are the concepts of human adaptation and vulnerability. A review of the literature in various academic disciplines led to the identification of five elements key to human adaptation and vulnerability. They are: control; access; knowledge; productivity; and stability. A range of data collection methods was employed to acquire the information for the study. These methods include multi-temporal analysis of satellite data, group mapping of land use activities by local people, semi-structured interviews, participant observation, collection of existing data, formal and informal discussions with key informants, and a short survey. A geographic information system (GIS) has been used to combine these data and to facilitate spatial analysis of land use change. Overall, the approach aims to synthesize a variety of knowledge and views on land use change, and what it means to the human and physical environment and development of the communities.

The land use/cover changes in Segara Anakan reflect the interactive and cumulative impacts of sedimentation arising from the upland area, and the adaptive responses of the people and government of the three traditional fishing communities located in the estuary. Since the early

1980's, rice farming has been the main adaptive response by the fishing communities to the impacts of sedimentation The nature of land use change is characterized by its rapidity, magnitude and increasing intensity. From 1968 to 1995, the main changes in land cover and land use involved the conversion of estuary waters to new lands (4,400 ha) and to new mangroves (4,300 ha), and the conversion of the new lands and newer and older sections of the mangrove forest to rice agriculture, semi-intensive fishponds and new settlements (15,000 ha). These changes represent increased intensification and diversification of human activities in the area. These activities, in turn, reflect interactions among the main actors, bringing with them a range of perspectives, interests, values and capabilities.

The land use changes pose both opportunities and constraints for sustainable development in the area. The constraints are largely associated with the increased vulnerability of many members of the fishing communities. Economic and institutional factors are predominant in this vulnerability, and are associated with the ability of fisherfolk to participate successfully in farming. These factors include: the lack of access to training; credit and land; insufficient time and energy to fish and farm; the limited control over the use of the new lands arising from the constraints imposed by the institutional conflicts; relatively low income resulting from farming on marginal lands; minimal external compensation for the declining productivity in the estuary fisheries; and the opportunities arise from increased employment opportunities for both men and women, and the informal exchange of agricultural information between the immigrant farmers and fisherfolk.

The main contributions of this research arise from the historical and current account of the human ecology of land use changes in Segara Anakan, and the implications of these changes for sustainable development. On a conceptual level, the research highlights the complex and interwoven nature of land use change at the community level. Changes emanate from the conditions and circumstances of the people and place, as well as their interrelationships with the regional and national level. This study contributes to an increased understanding of the causal relationships between land use change and sustainable development. In this context, the elements of control, access, knowledge, productivity and stability are all found to be useful in increasing the understanding of the causes and implications of land use change. In terms of the methods, this research shows the utility, promise and challenge of bringing together various data sources and methods in order to provide for a broader range of understanding and responses.

ACKNOWLEDGEMENTS

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For my parents AR and DJ

whose spirit and sense of adventure have always been a source of inspiration and guidance.

.....and they said life was easy

TABLE OF CONTENTS

TABLES

FIGURES

EQUATIONS

BOXES

Chapter 1
INTRODUCTION

1.1 RESEARCH BACKGROUND AND MOTIVATION

Advancements in satellite image technology have provided human-kind with a bird's eye view of the surface of the earth, linking regional and global perspectives. These perspectives have undeniably shown the rapidity and extent to which human activities have altered the planet's surface. Humans have always manipulated land to provide for their survival and well-being. These human activities have involved the clearance of vast areas for agriculture and settlements, the replacement of indigenous species with new ones and the alteration of river courses to create sophisticated irrigation systems. These changes in nature have been accompanied by increases in population, changes in communities and in social systems in general. It is now difficult to find any place in the world that has not been altered, at least to some degree, by human activities. Changes in land use represent a continual adaptive process between human and physical systems which consequently reflect the interactions among society, environment and development.

It has only been in the past three-quarters of a century that human actions have had the ability to alter land use to the degree that we are witnessing today (Richards 1990). The emergence of a global economy, advances in technology, and increasing expectations of humans have created a dynamic and complex environment in which land is increasingly and more intensely utilized. Accelerating land use/cover changes have been associated with increased vulnerability of elements of both the human and physical environment (Turner et al. 1990; Turner 1991; Krummer and Turner 1994; Turner and Meyer 1994). While not all land use and land cover change produces negative effects, regions, nations and the international community must contend with the consequences which threaten the well-being of human and other species. Box 1.1 illustrates various trends associated with land use change.

Box 1.1: Selected Trends in Land Use Change

	Worldwide	Southeast Asia	Indonesia	Java
Population Increase	• 4,144 million from 1700 to 1985		• 59,024 thousand from 1970 to 1990	• 30,833 thousand from 1970 to 1990
Spread of Agriculture	• 331 million ha since the 1950's	• increase in croplands by 52 million ha from 1700 to 1985	• 22,200 thousand ha of croplands in 1991 • 0.7% increase from 1979 to 1991	
Urbanization	• 28.9% in 1950 • 43.2% in 1985	• 17.6% in 1960 • 24.0% in 1980	• 14.6% in 1960 • 22.2% in 1980	• 18% in 1971 • 35.1% in 1990
Increase in Industrial potential/growth	• 127 in 1750 • 11,041 in 1980		• 11.9% from 1965-80 • 2.1% from 1980-87	• na
Deforestation	• about 1.2 billion ha from 1700 to 1985	• 18 million ha from 1700 to 1985	• an annual rate of 937,000 ha/year from 1982-1990	• an annual rate of 16,100 ha/ year from 1982-90
Loss of Wetlands and Biodiversity	• about 5,000 plants have become extinct since 1700		• loss of wetlands in the 1980's accounted for 11,872 thousand ha, or 39% of total wetlands • loss of mangroves in the 1980's accounted for 2,101 thousand ha, or 45% of total mangroves	• na
Soil Degradation and Erosion	• about 3,928.8 million hectares of soil have been degraded by human activities from 1945 to the late 1980's	• about 1,494 million ha of soils have been degraded from 1945-90		• average annual rate of erosion is 123.2 metric tonnes/ha

Source: Richards (1990); World Bank (1992); WRI (1992-92); Jones (1993)

The importance of land use change is highlighted by numerous and long standing studies which examine the nature, rate, and extent of land use change, as well as its causes and consequences at a variety of spatial levels (Marsh 1854; Thomas 1956; Simmons 1988; Mather and Sdasyuk 1991; Munton et al. 1992; Krummer and Turner 1994; Turner and Meyer 1994). In this context, land use changes are not only of interest for their own sake, but also as a reflection of the interactions among society, environment and development. It is in this realm that important planning and management decisions must be made. Land use change analysis can provide a valuable platform for understanding, planning and managing associated changes in society, environment and development.

Land use changes are multiple and complex, emerging from the various circumstances of society, environment and development. The regional focus of this thesis is the coastal environment of Segara Anakan, which is located on the south coast of Central Java, Indonesia (Figure 1.1). Interest in this area arises from the rapid transformations in society, environment and development. In a broad context, the region of Southeast Asia, to which Indonesia belongs, has since the 1950's, been undergoing one of the most rapid

transformations in the world (Rigg 1991). This transformation is largely associated with the development path many of these newly independent countries are following as they strive to build their economy, raise the quality of life for their people, and find their place within a new world order. Land use change in Indonesia exemplifies many of the ongoing issues in society, environment and development in Southeast Asia.

Indonesia is an archipelago country comprising approximately 13,000 islands, of which 6,000 are inhabited by over 400 ethnic groups. Land use in Indonesia arises from the interactions of the range of physical and human systems, as well as adaptation to external influences (Donner 1987). Since the mid 1960's, the New Order Government of Indonesia has largely followed a development path of modernization, and government interventions have been aimed at intensification and diversification in areas such as agriculture, fisheries, industry and manufacturing. The majority of these development activities has been oriented towards the island of Java (Marshall 1993).

Java comprises about seven per cent of the land mass in Indonesia, and sixty per cent of its population. In the early 1990's, Java had a population of just over 100 million, making it one of the world's most densely populated areas, with an average of 815 people/km^2 (World Bank 1992). Land use on Java is still mainly rural in character, based on wet rice agriculture (*sawah*) in the lowlands and dryland agriculture (*tegal*) in the uplands. Rapid economic development and population pressures, set within the history of land use on Java, have exerted much pressure on the land (Donner 1987). Land use changes are now increasingly associated with an onslaught of environmental problems, for which the government and people of Indonesia are now attempting to find solutions (Hardjono 1986, 1991; Brookfield and Byron 1993) (Box 1.1).

The Segara Anakan is a brackish mangrove estuary located on the south coast of Central Java, Indonesia (Figure 1.1). The estuary is an ecologically and economically significant coastal environment, one that has been experiencing rapid land use changes typical of the modernization process in Java. These land use changes are associated with population growth, intensification of agriculture, and expansion of land use activities into the upland areas. Since the mid 1940's, and perhaps earlier, cumulative effects of sedimentation

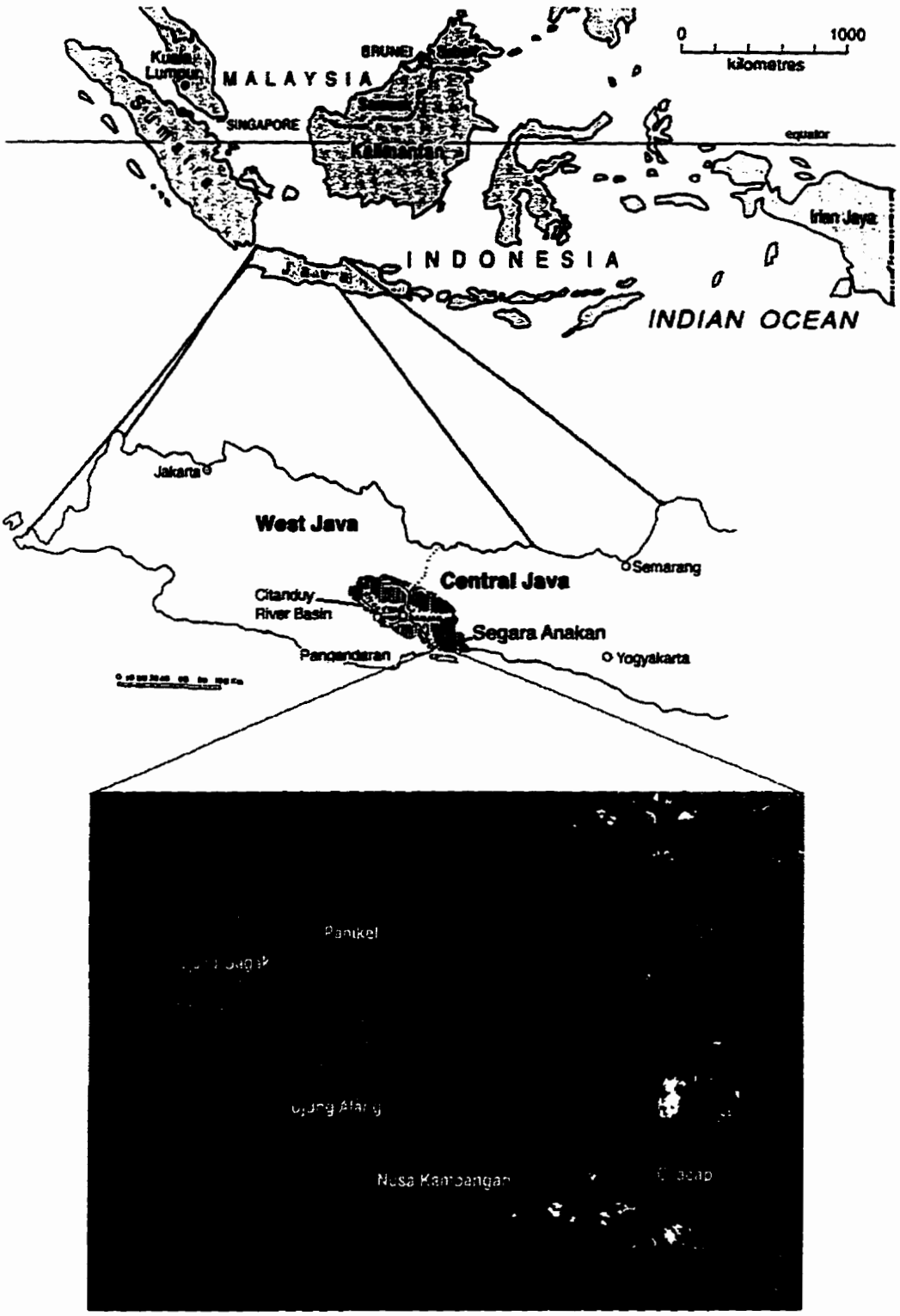

Figure 1.1: Location of Segara Anakan and Environs, Java, Indonesia

attracted much attention to Segara Anakan (PRC Engineering 1987). Upland activities in the Citanduy river basin have accelerated sedimentation of the estuary, forming new lands and decreasing both the surface area and depth of the waters. This change is associated with decreases in the productivity of the estuary fisheries. This decline in productivity is undermining the main economic livelihood of the three traditional fishing villages located in Segara Anakan. Since the early 1980's, the responses of local fishing villages and government have been to use the new lands and to clear mangrove forests, mainly for rice agriculture and other associated land uses. These land use changes have implications for village society, environment and development and associated public and private planning in the estuary. A better understanding of the nature, extent, and rate of change, as well as the causes and consequences is necessary to work towards sustainable development.

1.2 RESEARCH GOALS AND OBJECTIVES

The goal of this dissertation is to study land use change as a means of identifying, analyzing and understanding the key interactions among society, environment and development, and assessing the prospects for sustainable development. The focus is placed on the Segara Anakan, and more generally on Java and Indonesia. The specific questions addressed in this thesis arise from both conceptual and empirical issues of land use change. They are:

Conceptual

- How are society, environment and development linked to land use change, particularly at the village level?
- What data collection methods can be used to provide a better understanding of land use change and its interactions with society, environment and development at the village level?

Empirical

- What have been the nature, rate, and extent of land use change in Segara Anakan, Java, Indonesia?
- How have land use change, society, environment and development interacted in Segara Anakan
- What planning, management and decision-making challenges do these land use changes present and how can they be addressed with particular reference to sustainable development?

1.3 SIGNIFICANCE OF RESEARCH

The significance of this research is three-fold. First, it contributes to an increased understanding of the nature, causes and consequences of land use change in Segara Anakan, Java, Indonesia. This understanding will assist in formulating management policies in the area. The primary focus of the change analysis in Segara Anakan is on the land use changes prevalent in 1994, notably those associated with rice agriculture, the estuary fisheries, semi-intensive fishponds, new lands, rainforest, estuary waters, and the mangrove forest. A focus on these changes provides insight into development issues in the area. For example, will rice agriculture be an economically viable land use activity in the estuary? This focus does not negate the potential importance of other possible activities, such as tourism, but aims to provide an analysis and assessment of current development activities in the area. Second, this research provides an increased understanding of the interactions among land use change, society, environment and development. In doing so, it provides a better basis for planning, managing and making decisions about land use change, with particular reference to sustainable development. Third, this research provides for an assessment of the utility of conventional and more recent data collection techniques to the study of land use/cover change. In doing so, the advantages, limitations and challenges in using these data sources are identified for land use change analysis, and in a broader sense, for planning for society, environment and development. These contributions have specific reference to Segara Anakan, but can be applied more generally to other areas in Java, Indonesia and Southeast Asia.

1.4 RESEARCH JOURNEY

I have been fortunate to have had the opportunity to visit and conduct research in Segara Anakan since 1990. My studies began with my Masters research, which was conducted as part of the Segara Anakan Area Project[1]. A main interest of this project was to assess the implications of regional land cover change in the Segara Anakan for sustainable development (Nelson et al. 1992; Olive 1992). My Masters research was largely technically oriented as it focused on integrating satellite land cover change data with secondary data in the ABC Resource Survey framework (Olive 1992). My Ph.D. research

[1] The twinning arrangement was between *Pusat Penelitian Lingkungan Hidup* (PPLH) (the Centre of Environmental Studies) Universitas Gadjah Mada (UGM), Yogyakarta, Indonesia and the Faculty of Environmental Studies (FES), University of Waterloo, Waterloo, Ontario, Canada.

evolved from both my interests and experiences gained during my Masters research, and has expanded in terms of studying land use change within a broader context of the interactions among society, environment and development.

Table 1.1 provides a chronological summary of my research activities. In reality, the research process was not as "neat" as presented in the table, but actually occurred through an iterative process of collecting and analyzing the data, reviewing relevant literature, and

Table 1.1: Chronological Summary of Research Journey

Time Period	Activities	General Activities
1989/90 4 months	• first field season in Segara Anakan	• field checking satellite data • collecting secondary literature • participating in project workshop • language training (3 weeks) • visit to the Asian Institute of Technology in Bangkok, Thailand
1991 2 months	• second field season in Segara Anakan	• field checking refined land cover and land cover change map • discussions with government officials in Cilacap • participating in project workshop
1991-92	• data analysis and writing of Master's thesis	• refinement of image analysis • data analysis
1992 5 months (May-September)	• first field season for Ph.D.	• reconnaissance of study area • language training (3 weeks) • literature review and discussions with faculty • 2 months in field, conducting general interviews with government officials, NGO's and local people • visit to the Asian Institute of Technology in Bangkok, Thailand
1993	• preparations in Waterloo for research	• fulfilling class requirements • writing comprehensive exam • writing funding proposals • writing research proposal
1994 10 months (February-November)	• second field season for Ph.D.	• language training (3 weeks) • discussions with faculty at UGM • collecting secondary literature • 5 months in the field collecting data • presentation at UGM of preliminary findings of research • visit to ICLARM in Manila, Philippines
1995-1997	• data analysis and writing of thesis	• analysis of new satellite data • GIS analysis and mapping • analysis of interviews and surveys • writing thesis • review of relevant literature

interpreting and writing the results. The research approach was largely derived from a process of progressive contextualization, whereby the context of the study and study area provided the main directions for seeking and selecting relevant conceptual and methodological approaches (Vayda 1983). The research process involved both a positivistic approach, which focused on quantitatively measuring land use and land cover changes, as well as providing qualitative aspects about the land use activities, the people involved and the history of change in the area.

1.5 CONCEPTUAL APPROACH OF RESEARCH

The conceptual approach employed in this research directly relates to the objectives: 1) documenting and describing land use/cover change; 2) identifying the interactions among land use change, society, environment and development; and 3) assessing the prospects for sustainable development.

The documentation and description of land use change includes both use and cover. These represent different but complementary aspects of human interactions with the land (Turner 1991). Land cover refers to the physical manifestations of the use activity, such as forest, vegetation, and settlement. Land use, on the other hand, involves the purpose and means by which people engage the land, such as fishing, farming and transportation (Turner and Meyer 1994). Land use activities arise from the human and physical interactions over space and time, and relate to how societies organize themselves, their technological capabilities, and their values towards other people and nature.

In this study, documentation of land use change is based on a human ecological approach. Founded on the principles of ecology, human ecology emphasizes the interactions and relationships among components of a system (Bennett 1976; Rambo 1983; Glaeser 1995). A multi-method data collection approach was used to map land cover and land use change, as well as document the history of change. Documenting the history of land use change involved the identification of the main actors and their responses. The data collection methods used are remote sensing (Richards 1984; Bryant and LeDrew 1988), rapid rural appraisal techniques (Chambers and Carruthers 1983; Khon Kaen University 1985; Chambers 1992), collection and analysis of existing data, and geographic information

systems (GIS) (Aronoff 1989; Poole 1995). Each technique provides a different perspective on land use/cover. Their integration provides a means of bringing together aspects of land cover and land use change, and placing them within a context of society, environment and development.

A conceptual framework was devised to guide the analysis of the interactions among land use change, society, environment and development. The framework is eclectic in that it draws on various sources of literature, including community and rural development, hazards, sustainable development, human ecology and land use/cover change studies. The common theme of these literature sources is human-environment interactions and/or human adaptation and vulnerability. A further examination of the general linkages between land use change and modernization and sustainable development helped to identify key elements considered to be influential in the interactions among land use change, society, environment and development.

An underlying basis of this thesis is one of holism and synthesis. It attempts to bring together not only various perspectives on land use and land cover change in a meaningful way, but also data collection methods to support these perspectives. In doing so, it was necessary to draw on a range of academic areas and extract the concepts and/or methods most applicable to the research. As these areas represent broad academic areas, each a study in their own right, it is inevitable that some are addressed in more depth than others. These include, hazards research, community and rural development, and conceptual ideas from sustainable development and land cover change.

Modernization and sustainable development were selected as the focus for analysis, because although they are considered as development theories/approaches, they arise from and encompass relevant elements of society and environment (Table 1.2). Moreover, modernization has been a force of change in parts of Southeast Asia, including Indonesia, while sustainable development is relatively new on the political agenda. The elements identified as influential to human adaptation are: control, access, knowledge productivity, and stability (Table 1.3). Figure 1.2 presents a general overview of the conceptual framework employed in this research. While it is difficult to capture the reality of the

Table 1.2: General Principles and Characteristics of Modernization and Sustainable Development

Modernization		Sustainable Development	
Principles	*Characteristics*	*Principles*	*Characteristics*
• rational • reductionist • universalistic • premise of 'scientific objectivity'	• top-down • elite driven • production oriented • product oriented • blue-print • capital intensive	• holistic • integrated • systems approach • pluralistic • context driven	• participatory • bottom-up • social learning • indigenous knowledge • interactive and adaptive

Source: Taken from various sources of literature

Table 1.3 Elements Considered Influential for Human Adaptation

Influential Elements	General Characteristics
Control	• right to use and allocate resources • broad based participation in the designing, implementation and benefits of development activities
Access	• awareness and ability to use resources necessary to provide for a secure livelihood
Knowledge	• ways of knowing about the land and land management practices • sharing of information between scientific and local traditional knowledge
Productivity	• to maintain continued output from resources over time • can be measured in various terms, such as yields, income, biomass
Stability	• the ability of a system to maintain at a certain level of output in the face of small disturbances • ability of a system to recover from larger disturbances
Elements of Sustainable Development	**General Characteristics**
Economic Viability	• ability to economically provide a secure livelihood (i.e., fulfillment of basic needs) • self-sufficient • self-reliant
Social Equity	• ability to participate and benefit fully in community and development activities • to protect and enhance cultural diversity and way of life
Ecological Integrity	• to maintain resource productivity • to maintain essential ecological processes • to protect biodiversity

Source: Various sources in the literature

multiple interactions and feedbacks involved, the framework attempts to illustrate that land use change, which is placed at the centre, is a product of all of these interactions. Also central to the conceptual framework is spatial scales and the historical context in which land use activities change. Analysis in the Segara Anakan was conducted primarily at the village

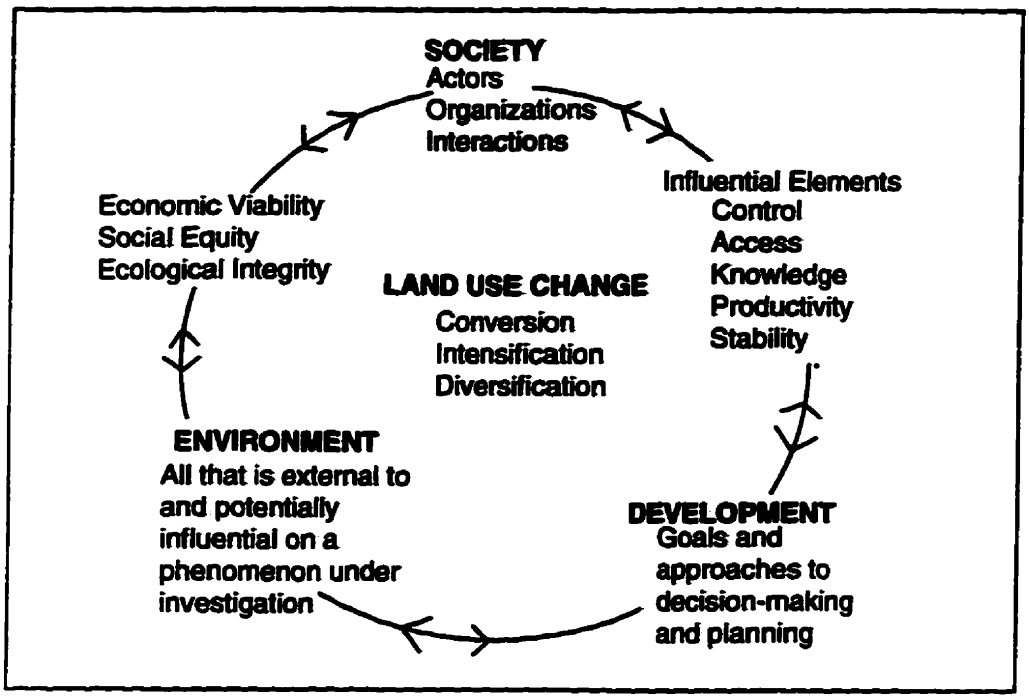

Figure 1.2: Conceptual Overview of Land Use Change Analysis

level, but includes interactions with the various levels of government, notably the district level.

Assessing the sustainability of land use changes was based on three indicators: economic viability, social equity, and ecological integrity (Table 1.3). Economic viability was addressed mainly in terms of how well the emerging land use systems provide for the economic livelihood of the fishing and more recent farming communities. Productivity and stability were the main focus of this economic analysis. Social equity mainly deals with the participation trends of the fisherfolk in rice agriculture and the semi-intensive fishponds. This mainly concerns control and access to the required resources. Ecological integrity is addressed only in a general sense, as social, economic, and institutional aspects of land use change were the main focus of the land use change analysis. Given the ecological significance of the Segara Anakan, and the thrust of balancing conservation and development within a sustainable development theme, general comments on both local and regional ecological concerns are provided, although more questions than answers are presented.

1.6 OUTLINE OF THESIS

This thesis is divided into eight chapters. In Chapter 2, a conceptual discussion on the interactions among land use change, society, environment and development is presented. This discussion begins by providing definitions of land use and land cover, society, environment and development. Conceptual linkages are then identified by examining land use change within the context of modernization and sustainable development. A conceptual framework is devised from key elements identified as influencing human adaptation, and arise from various spatial levels. Human adaptation generally relates to how people, groups and/or societies respond to, and cope with change or stress (Bennett 1976; Moran 1993). Key elements identified are: control, access, knowledge, productivity and stability. An important element often associated with the ability to adapt is vulnerability. Vulnerability refers to how sensitive various people and/or groups are to the effects of change and stress, and has been addressed in a variety of terms including, lack of resilience, disadvantage and powerlessness (Timmerman 1983; Chambers 1989; Blaikie et al. 1994; Hewitt 1997). Vulnerability is employed mainly in the final chapter to highlight the relationship between land use change and sustainable development in Segara Anakan.

In Chapter 3, the multi-method data collection approach employed in this research is presented. The methods employed are used to identify and describe various aspects of land use and land cover change. The methods are: remote sensing, rapid rural appraisal (RRA), collection of existing data, and geographic information systems (GIS). Each method is discussed in terms of its application and integration within this research.

In Chapter 4, an introduction to society, environment and development is provided, first in a general way for Java, Indonesia, and then more specifically for the study area of Segara Anakan. The general discussion begins with an overview of the government administration, the national planning process, a description of the Javanese village, and then trends of land use/cover change on Java. Given the complex nature of land use change on Java, the analysis focuses on the land use systems of wet rice agriculture (*sawah*) and brackish water fishponds (*tambak*), mainly because of their significance to the study area. Discussion on the Segara Anakan provides a more detailed account of society and environment for the Citanduy River Basin, the brackish mangrove estuary, and then the

three traditional fishing villages located in the estuary and collectively known as Kampung Laut.

Chapter 5 describes the nature, extent and distribution of land use/cover change in Segara Anakan from 1968 to 1995. The description includes each of the dominant land use types in the area in 1995 and how they have changed since 1968. They include: new lands; mangrove forest; estuary waters; agriculture; rice fields and fish ponds; settlements; and rainforest.

Chapter 6 identifies the main interactions among society, environment and development that have given rise to the land use/cover changes ongoing in Segara Anakan. In doing so, the key actors are identified, as well as their adaptive responses to the ongoing changes in the estuary. The chapter ends with an examination of access by the fisherfolk to elements required to participate in rice agriculture, notably land, training, credit, and leadership.

Chapter 7 assesses the sustainability of land use change in Segara Anakan. Sustainability is assessed in terms of economic viability, social equity and ecological integrity. Opportunities and constraints to sustainable development are identified within the scope of these indicators.

Chapter 8 concludes the thesis by revisiting the main goal and objectives of this research and highlighting the key findings. This includes summarizing the ongoing land use changes in Segara Anakan from 1968 to 1995, identifying the key interactions among land use change, society, environment and development, particularly as they pertain to vulnerability and sustainable development. General findings are then presented which can be applied in a more general manner to other parts of Java and Indonesia, as well as recommendations for land use change in Segara Anakan and additional research needs. An assessment of the conceptual framework and multi-method data collection approaches is also presented, as well as avenues for future research.

Chapter 2
LAND USE CHANGE: SOCIETY, ENVIRONMENT AND DEVELOPMENT

Among material resources, the greatest, unquestionably, is the land. Study how a society uses its land, and you can come to pretty reliable conclusions as to what its future will be (Schumacher 1973, 95).

2.1 INTRODUCTION

The main purpose of this chapter is to present the conceptual framework employed in this research. The conceptual framework is addressed in three sections, each section building on the previous one. The first section defines the key concepts employed in this research. They are: land, land use and land cover; land use/cover change, society; environment; and development. The second section then explores the conceptual linkages between the two development approaches of modernization and sustainable development, and land use change. In this section the concept of adaptation and vulnerability are introduced, as well as the five elements--control, access, knowledge, productivity, and stability--which are thought significant to human adaptation. The third section deals more specifically with the community level, and identifies the conceptual linkages between the land use change and community development issues.

2.2 LAND, LAND COVER, LAND USE, AND LANDSCAPE

The concepts of land, land cover and land use are closely interrelated. Land is generally presented as the physical environment, including relief, soils, hydrology, climate and vegetation (Turner and Meyer 1994). Land cover refers to the physical attributes of the land's surface, such as forests, water and vegetation, and is often the focus of remotely sensed analysis, including interpretation of air photographs and satellite data (Vink 1983; Turner and Meyer 1994). Land use, on the other hand, involves human manipulation of the land to fulfill a need or want, such as arable agricultural lands for growing crops, pasture lands for grazing cattle, industrial complexes and urban and rural settlements to

house people (Vink 1983). Table 2.1 indicates examples of land use characteristics for agriculture.

Land use activities arise from the co-evolution[2] of social, economic, technological, cultural and institutional elements, and are often referred to as a "human signature" or "foot print" (Crumley and Marquardt 1987). The relationship between land cover and land use is not always direct, but generally land cover does gives some indication of the land use.

Landscapes can be defined, in very basic terms, as groupings of land cover and land use activities. The concept of landscape has a long and varied tradition. Emerging from several sources, landscape has been presented as both an abstract and concrete concept, employed to study the aesthetic quality of a place, vernacular culture, or ecological functions arising from the landscape mosaic (i.e., patches and corridors) (Sauer 1963; Meinig et al. 1979; Godron and Forman 1986; Daniels and Cosgrove 1988; Forman 1995). Landscapes evolve over time, partially in response to land use activities.

Land is a resource of central importance to human survival and well-being. Humans have used land to provide for their basic needs, such as food, shelter, clothing and recreation. The relationship between humans and the land varies in association with a range of activities, including: reliance on the physical/ecological resources (e.g., farming, mining); space for houses or work; and human/spiritual renewal through recreation (e.g., hiking, camping). Land is a relatively finite resource. As such, land use activities often compete in

Table 2.1: Characteristics of Agricultural Land Use

• Crops grown	• Infrastructure requirements
• Market orientation	• Cropping characteristics
• Capital intensity	• Material inputs
• Economic information	• Cultivation practices
• Power	• Livestock
• Size and shape of farms	• Forestry
• Land tenure	• Mechanization
• Technical knowledge and attitudes	• Yields and production

Source: FAO (1983, 30)

[2] The term 'co-evolution' was taken from Norgarrd (1994, 82) and refers to "an ongoing positive feedback between components of evolving systems".

what is sometimes regarded as valuable space. The value associated with land varies among individuals and groups, and involves the interactions among society, environment and development (Mather 1989).

Land use activities have become increasingly complex as they have been integrated into regional, national and international systems. As suggested by Richards (1990, 165) "in any society, at any time, human use of the land is regulated by one of the most complicated set of relationships entered into by human beings". This has resulted in an "ecological expansion,...a process that introduces an entirely new set of opportunities and constraints with which the farmer [land user] must be concerned" (Clay and Magnani 1987, 146). As part of this expansion, land use activities are influenced by the convergence and interaction of a greater number of actors, who bring with them varying goals, values, capabilities, knowledge and methods.

2.2.1 Land Use/Cover Change

Changes in land use/cover are associated with the co-evolution of human and physical systems, whereby one or more traits are altered or replaced by another (Norgarrd 1994; Turner and Meyer 1994). Changes in land cover are often discussed in terms of modification and conversion. Modification refers to an alteration in the structure or function, whereas conversion is the replacement of one cover by another (Skole 1994). Changes in land use are generally referred to in terms of intensification, expansion and diversity.

Changes in land use/cover can also be characterized by their dimensions (Table 2.2). Key dimensions of change have been identified as: duration, magnitude, intensity, frequency, rate of onset, predictability and reversibility (Kates 1978; Hewitt 1997). Hazards research has indicated that how change occurs can influence the perceptions of, responses to, and the consequences of the change process.

Causes of land use/cover change are often discussed as drivers, which are described as either proximate or underlying (Adger and Brown 1994; Blaikie et al. 1994; Turner and

Table 2.2: Dimensions of Change

Dimension of Change	Characteristics of Dimension
Duration	• short to long
Magnitude	• temporary/seasonal to permanent
Intensity	• low to high
Frequency	• rare, seldom to often
Rate of onset	• slow and gradual to rapid
Spatial dimension/extent	• small to large area
Predictability	• low to high
Reversibility	• low to high

Source: Kates (1978); Hewitt (1997)

Meyer 1994). Proximate drivers are associated with activities which directly interact with and modify the physical environment, such as deforestation, urbanization, and agricultural expansion (Turner and Meyer 1994). The underlying drivers, or root causes, influence how individuals or groups interact with and change the land (Blaikie et al 1994). These are more subtle and complex as they are built into the human system underlying a land use activity (Adger and Brown 1994; Blaikie et al. 1994; Krummer and Turner 1994). Underlying drivers include local power structures, access to resources, corruption, and land tenure arrangements.

Driving forces of land use change operate at local to global levels. Driving forces at the global level have been described as "those which transcend the lower levels and drive behaviour regardless of the local particularities" (Turner 1991, 10). At the regional and local levels, driving forces are more dynamic and complex, reflecting the local particularities of the area. Main drivers of land use/cover change have been identified in the literature as population, technology, affluence/poverty, political economy, political structure, and beliefs/attitudes (Krummer and Turner 1994; Turner and Meyer 1994) (Table 2.3). These drivers have been discussed in detail elsewhere, and as such will not be discussed here (Turner et al. 1990; Turner and Meyer 1994). An important reoccurring theme is that these drivers of change do not, on an individual basis, provide a complete view of change, and that they more likely "operate interactively, and in a way that is conditioned by socioeconomic and environmental context" (Turner and Meyer 1994, 262). Moreover, Gallopin (1991) has suggested that land use change has become increasingly interconnected at various spatial scales.

Table 2.3: Examples of Key Driving Forces of Land Use/Cover Change

Driver	Characteristic
Population	• substantial global and regional increases have increased demands on food, water, land, housing, clothing etc. • views on impacts of population run along a (neo)Malthusian and Boserup continuum
Technology	• increased means for humans to control, manipulate and change land • intensification (organic to fossil fuel) and extensification of land use activities
Affluence/poverty	• expectations and demands of the public have increased • wealth • the size of the population able to fulfill basic needs has decreased
Political Economy	• control over decision-making, allocation, use and benefits of resources
Institutions	• type of management regimes (e.g., contextual, universalistic/traditional, modern)
Beliefs and Attitudes	• values and behaviour towards nature and other people (e.g., control, harmony).
Social Organization	• social rights and responsibilities, power structures, urbanization
Economic Organization	• spheres of production and consumption

Source: Turner et al. (1992); Krummer and Turner (1994); Turner and Meyer (1994);

Krummer and Turner (1994) suggest that driving forces of change that are prevalent at the global level are often not reflective of change at the regional and local levels. For example, they suggested, based on their study of deforestation in Asia, that economic and institutional variables were more useful to explain land use changes than was population increase. Moreover, while many similarities exist in the change process at the regional and local levels, it is suggested that nowhere are the exact forces of change repeated (Turner 1991; Bennett 1993).

Changes in land use/cover carry with them consequences. The consequences or impacts, can be either positive or negative, or some combination of the two. Moreover, a positive consequence for one person, group, community, society or system, may well be negative for another (Bennett 1976).

The general thrust of land use/cover change studies have been to gain an increased understanding of the human causes and consequences of change. This interest has been stimulated by the increasing magnitude of change that human activities have had on the planet's surface, and the potential threats that these changes hold for human survival and well-being, as well as for other living species (Burton and Timmerman 1989; Houghton 1994). Associating land use/cover change with issues of sustainable development has required a broader scope for the land use/cover change studies. Riebsame et al. (1994) reaffirm this when they suggested a need for a transition from the conventional approaches

Box 2.1: Overall Goals of the Human Dimensions of Global Change Program

- to improve scientific understanding and increase awareness of the complex dynamics governing human interactions with the total Earth system
- to strengthen efforts to study, explore, and anticipate social change affecting the global environment
- to analyze policy options for dealing with global environmental change and promoting the goal of sustainable development

Source: Burton and Timmerman (1989, 300)

to land use studies, which have relied heavily on theoretical classification and mapping, to more analytical approaches based on theory and modeling. As part of this transition, researchers, professionals and planners are striving to find conceptual approaches and methods to increase our understanding of how humans cause and are impacted by changes in land use/cover (Burton and Timmerman 1989; Clark 1989). In fact, this is the overall goal of the Human Dimensions of Global Change Program (1990-2000) (Burton and Timmerman 1989) (Box 2.1).

To provide a broader perspective of land use change, the following section examines society, environment and development, and how their interactions have influenced land use change.

2.3 LAND USE CHANGE: INTERACTIONS OF SOCIETY, ENVIRONMENT AND DEVELOPMENT

2.3.1 Society

This research mainly focuses on society at the village or community level in a Southeast Asian context. A more specific description of the village in Java is provided in Chapter 4. The purpose of this section is to provide a more generic discussion of community, focusing on its structure and function.

Society can be viewed as an assemblage of people and organizations whose everyday activities and interactions with other people and nature are guided by a set of norms, values and behaviour, generally referred to as a world view (Robinson et al. 1990; Reid 1995). The norms and social rules guiding human behaviour become codified in traditional and modern institutions, and are passed on through generations.

Individuals survive mainly through their collective activities, of which communities are a prime focus. Community has been defined as "people that live within a geographically bounded area who are involved in social interaction and have one or more psychological ties with each other and with the place in which they live" (Christenson et al. 1989, 9). A community can then be conceptualized as the interaction of actors, leaders, and organizations (Christenson et al. 1989).

2.3.1.1 Actors

Actors are basically the community groups and members. Each fills various positions in the socio-economic structure, and has various interests, values and capabilities in interacting with the rest of the community.

2.3.1.2 Leaders

A leader is someone who supports and guides group activities and interests, maintains group cohesion, as well as manages group dynamics (Garkovich 1989). This role may be performed on either a formal or informal basis. Formal leadership is often instated through a recognized process, such as elections, and duties are generally performed within a specified time frame. Informal leaders are people within a community who have obtained a level of power or prestige and are called upon for advice or assistance, such as religious leaders and prominent business people. Leadership characteristics are associated with personal traits, interests and knowledge, and individual interactions with the interest group, and their effectiveness "is a function of fit with the situation in which it occurs" (Garkovich 1989, 203). If a leader is too controlling, then group interest may diminish and/or undermine public participation. On the other hand, if a leader is too indecisive, then the group may become directionless (Garkovich 1989). An effective leader should be able to guide the community to identify their needs and concern, and assist in solving problems (Fischer 1989).

2.3.1.3 Organizations

An organization is basically a group or an association of people that provides services or coordinates efforts (Garkovich 1989). A common distinction between organizations is whether they are formal (i.e., government derived and supported) or informal (locally

derived and supported-traditional). Both types can be further distinguished by characteristics, such as goals, membership, available resources, and function. Formal organizations are mainly associated with modern institutions, which are guided by government regulations and policies and are generally enforced from the top-down. The purpose of these organizations is often to promote and/or enforce government policies and programs at the local level. Hazards research has identified three main ways in which formal organizations respond to community change: 1) setting laws, regulations, incentives and penalties; 2) making decisions concerning the use of resources and responses to change and 3) dispensing adjustment services (Barton 1969; Burton et al. 1993).

Informal organizations are based largely on traditional or local institutions, and emerge from local self help activities oriented to satisfying a need or concern. Membership is usually voluntary and decision-making is based on consensus, guided by social rights and obligations (Esman and Uphoff 1984). Informal organization have, perhaps, more similarities to traditional institutions, which are based on local values, beliefs, systems of social rights and obligations, and rituals. Informal, or local organizations, are viewed as beneficial to rural or community development because they are often based on local knowledge, local resources and needs and self-help initiatives. Both formal and informal organizations are interested in mobilizing resources, such as labour or capital. The main differences arise in the processes and desired outcomes (Esman and Uphoff 1984; Korten 1986).

2.3.1.4 Interactions

Interaction involves the action or influence of persons or things on each other (Young 1974). The ecological literature identifies several types of interactions which occur among species, which can be applied to a human community. These include:

1) *competition:* each population adversely affects the other in the struggle for resources

2) *cooperation*: all actors or associations work together towards a common goal and each benefit from the interaction

3) *dependency*: actors cannot work self-sufficiently, but rely on inputs (e.g., capital, land) from another actor or organization.

4) *domination*: the activities of actors or organizations are controlled by another.

The context in which these interactions occur, such as family, institutional or business, could influence their nature and intensity.

Long (1996), in a study of tourism impacts on a Balinese community, identified three general characteristics of a community that influence the level, nature and degree of social impacts. The characteristics are: territorial/spatial, social, and psychological. Territory/spatial deals with location, environmental processes and development status. Social characteristics involves social structure, economy and history. Psychocultural relates to the nature of the society (e.g., sophistication, education, and strength of traditional culture) and local attitudes to the change agent.

2.3.2 Environment

The term environment is ambiguous, often used to mean a variety of things. It has been used to represent only nature, and in broader terms "whatever is external to and potentially or actually influential on a phenomenon under investigation" (Hawley 1968, 53). This thesis adopts the latter definition of environment and employs a human ecological perspective for the analysis of land use change.

The term, ecosystem, was first introduced by the biologist Arthur Tansley in 1935 (Moran 1990). Ecosystem analysis emphasizes the study of interactions among living and non-living components of an area. Interactions, or what has often been referred to as "the web of life", involve the flows of energy, material and information (Odum 1971). The concept of ecosystem involves the notion that living components survive and evolve through their constant and various forms of interaction with other elements of the system (Odum 1971). These interactions are multiple and circular, consisting of feedbacks which regulate the system (i.e., cybernetics) (Odum 1971). As a living system, ecosystems are open, meaning that there is an exchange of flows with other systems.

Ecosystems operate over a variety of hierarchical spatial scales. Hierarchy theory suggests that a system consists of organized levels, where each level is both an autonomous and functioning part of the whole system (Allen and Starr 1982; O'Neill et al. 1986; Allen et al. 1987; Urban et al. 1987; O'Neill et al. 1989; Gallopin 1991). A common hierarchical

organization employed in ecology, starting at the smallest level, is: genes, cells, organisms, populations, communities, and ecosystems (Odum 1971). Higher levels of a system are considered to be larger in scale and constrain the behaviour of the lower levels, mainly through the asymmetrical flow of information (Allen and Starr 1982). Lower levels, on the other hand, are generally smaller in scale and interact to generate higher level behaviours (Urban et al. 1987). This hierarchical construction of systems suggests that activities at one level influence, and are influenced by, activities at another. Interactions among levels are bi-directional, and the key interactions are those that have the most strength and significance to a system (Palm 1990).

An ecosystems perspective suggests that the system as a whole is greater than the sum of its parts (Odum 1971). That is, to understand a system requires more than adding components together, because at each level properties emerge which are particular only to that level (Allen and Starr 1982; Conway and Barbier 1990). The ecosystem approach has highlighted the complexity of living systems, as well as the difficulty in fully understanding their interactions and behaviour (Clark et al. 1995).

Human ecosystems have often been defined as ecosystems that are centred around humans (Moran 1990). Basically, a human ecosystem, or human ecology, represents the melding together of social and physical systems, what Bennett (1976) referred to as the ecological transition, or the absorption of nature by society. The general focus of human ecology is how an individual or group interacts with its surrounding environment (Bennett 1976; Rambo 1983). Human actions have consequences for the social and physical environment, which feed back into human actions and the values, goals and norms underlying these actions (Bennett 1976). Human ecosystems exhibit the continuous adjustments and re-adjustments of human and physical systems, which are particular to a people, place and time.

Models of interactions among subsystems of the environment have evolved from simpler linear cause-effect approaches of environmental and cultural determinism, to multi-causal systems approaches derived from ecological principles (Bennett, 1976; Rambo, 1983; Norgarrd, 1994). This transition in thought was fueled by the recognition that humans are

not separate from nature, but rather parts of a whole unitary system. A similar concept has been presented under various other names, such as socio-natural systems, sociobiophysical systems, and regional situations (Nelson 1974; Mann 1978; Boyden et al. 1981; Gryzbowski et al., 1987; Bennett, 1993; Norgarrd, 1994; Turner and Meyer, 1994). The commonality among these, and other human ecological models, is the key components which comprise a human ecosystem. While often discussed under a variety of titles, they incorporate social, economic, institutional, technological, cultural and physical elements. The multiple interactions among these elements occur over a range over spatial and temporal scales (Figure 2.1).

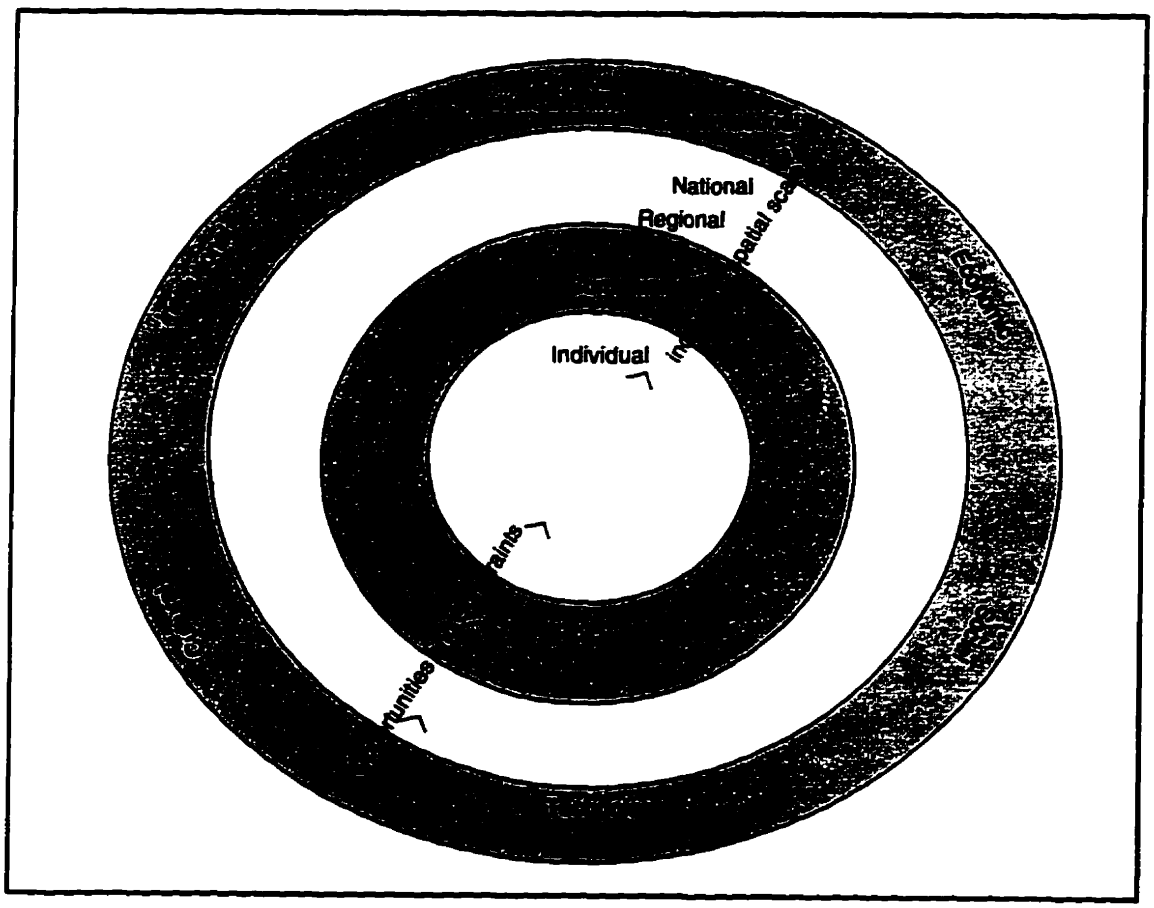

Figure 2.1: A Human Ecological Perspective of Environment
Source: Adopted from Nelson (1974) and Mann (1978).

2.3.3 Development: An Overview Of Major Theories

Development is likely to mean very different things to different individuals and groups (Black 1991; Gabriel 1991). Since the end of World War II, development has become of increasing interest to academics and professionals, and emerging theories have reflected their thoughts and visions of what constitutes development. The main development theories that have influenced the thinking of academics, professionals and government officials include modernization theory, dependency theory, and sustainable and other alternative development approaches. Neither socialist nor communist approaches to development have been included in this discussion. The main reasons for their exclusion are for simplicity, and because modernization, dependency theory and sustainable development are most relevant to the area of study in Indonesia.

2.3.3.1 Modernization

Modernization is a development theory that emerged from Western countries in the early 1950's. Modernization theory is said to have arisen from the post World War II economic optimism of America, and as a way to combat the perceived threat of communism entering into newly independent colonial countries (So 1990; Black 1991). The main assumption underlying classical modernization theory is that societies evolve along a development continuum beginning with traditional societies, which were viewed as rural, backward and underdeveloped, to modern societies which were characterized as urban, industrial and developed (Larrain 1989). The path from traditional to modern was thought to be gradual, unidirectional, and positive as it represented progress, humanity and civilization (So 1990). Under the right conditions, it was thought that all undeveloped countries (i.e., South) could pass from traditional to modern if they adopted the American and Western European models of development (Larrain 1989; So 1990; Webster 1990).

The "right conditions" for this transition were based on social, psychological and economic factors, all working towards economic growth and the accumulation of capital (Blomstrom and Hettne 1984). The social transition from traditional to modern societies was perceived to involve the division and specialization of labour, particularly the replacement of family-oriented work relationships with business relationships (i.e., paid labour) (So 1990). The required psychological condition was a motivated and entrepreneurial attitude, largely

associated with the Protestant work ethic of Western countries (Larrain 1989). One significant view of the economic transition from traditional to modern was established by W.W. Rostow's five stages of economic development: 1) traditional societies, characterized as simple and with low productivity and limited technology; 2) preconditions for take off; 3) take off, indicated when growth becomes a permanent feature of society; 4) road to maturity when every aspect of society becomes modernized, and the use of new technology and imports are substituted and exports increase; and 5) age of mass high consumption (Larrain 1989, 96).

The main barriers to moving forward along the "modernization continuum" were seen as internal to a society, mainly its traditional ways, knowledge and organization (So 1990; Webster 1990). These barriers could be overcome by the transfer of new technology, capital and skills from America and Western European countries. The key conduits for planned change emanated from a top down approach, and involved the transfer of capital intensive technology, intensification of production, import substitution policies, industrial development, and the use of elites to diffuse technology and methods that were eventually to trickle-down, along with their benefits, to the masses (Webster 1990; Black 1991; Norgarrd 1994). The overall goal was to increase economic productivity, which would increase employment and income, in order to induce pre-take-off and take-off stages of development. Success of development was based on measurable yardsticks, such as gross domestic product (GDP).

Revised modernization theory emerged in the late 1970's in response to much external (i.e., dependency theory) and internal criticism (So 1990). Some assumptions of modernization remain central to this revised view on development, but others have been dramatically changed. Traditional and modern characteristics are no longer treated as mutually exclusive concepts, but rather they can exist and work together. Development is viewed not as a unilinear path ending with the model of Western countries, but multiple paths with each country forging its own way. External factors are now included in shaping the development path, although internal factors are still given the greatest weight (So 1990).

Modernization is based on a Western world view. This world view has been associated with the philosophical and scientific thinking that arose since the Renaissance (Norgarrd 1994; Reid 1995). The main themes associated with this world view have been the belief in progress as material growth; the role of science to extract more from, and to control, nature; the use of, and belief in, technology to find all solutions to all problems; the belief that science is objective; reductionism; and the belief that progress, science and technology developed in the West is superior to all other world views (Reid 1995). This thinking has permeated societies that have adopted modernization approaches, often supplanting local value systems, beliefs, and forms of social and economic organization (Norgarrd 1994).

2.3.3.2 Dependency Theory

Dependency theory, often referred to as "development of underdevelopment", arose in response to both classical modernization and Neo-Marxist development theories (Larrain 1989; So 1990). Dependency theory emerged in the 1960's largely as a product of the thoughts and writings of Andre Gunder Frank. His academic training in economics in American Universities during the 1950's and 1960's and his subsequent experiences in Latin America laid the foundation for viewing development in the South[3] as a process of accumulation and exchange (Frank 1996). Dependency theory provided a development perspective from the South, based on experiences and history of these countries, notably colonialism (Larrain 1989; Black 1990; So 1990). As a theory, it provides an explanation for underdevelopment based on unfair accumulation in the world system, and as such saw "delinking" from the external system and adapting self-reliant internal development as a necessary development process (Frank 1996).

In a basic summary, dependency theory is based on the perspective that development in the North was contingent upon underdevelopment in the South and that the two were part of the same process. Unlike modernization theory, underdevelopment was attributed to external processes, explained through core-periphery interactions (So 1990). The core, or

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[3] The terminology of North and South is used in this thesis in place of developed, developing and underdeveloped countries. The terms have emerged to better portray the notions and differences of over and under consuming of resources, which occur within and among regions. As Korten (1992, 60) suggests, "we are coming to recognize that the terms of North and South do not really define geography so much as class".

North, created a dependency in the periphery through unfair exchanges and the extraction of surplus profit (Larrain 1989). This core-periphery relationship is thought to exist on several levels, in that a core can also be a periphery. For example, an urban area of a developing country is a core within the country, but becomes part of the periphery in North-South relations. Thus, the South was underdeveloped, not because of a lack of forward progress to a modern society, but because of its linkages with the North. That is, "underdevelopment developed right along with economic development" of the core (Larrain 1989, 116). Moreover, dependency of the periphery increased as it became more absorbed into the capitalist system, losing autonomy over its resources. The only way to stop underdevelopment was to sever ties with the core.

Associated with dependency theory is the concept of marginalization (Watts 1983; Blaikie 1985). Through the unequal exchange of power, control and wealth, the people of the periphery are pushed into less viable ecological, economic and political-economic options (Blaikie 1985; Blaikie and Brookfield 1987; Conway 1986). Ecological and economic marginalization are associated with subsistence, in that the ecological conditions permit plants or animals to just survive, while the economic conditions permit the land user to just cover the costs of production (Conway 1986). In a political economic context, marginalization refers to the lack of power to participate or influence decision-making in political and economic systems (Conway 1986).

Neo-dependency theory, like that of the revised modernists, examines underdevelopment as historical concrete situations in the South (So 1990). Main changes in the neo-dependency theory include: 1) a focus on internal structures of dependency, notably class structures and the interests of the elites, some of which are derived from external linkages (i.e., foreign trade), and 2) the view of dependency as mainly a socio-political process, as opposed to the earlier concentration on economic phenomenon (So 1990).

World systems theory proposed a buffer between the core and periphery countries, adding the concept of a semi-periphery country (Larrain 1989; So 1990). Development and underdevelopment occurred through systematic exchanges among core, semi-periphery and periphery countries. These exchanges maintained a world economy balance, in that for

a country to move up to semi-periphery or to core, another country had to move down (Larrain 1989).

2.3.3.3 Sustainable Development

In the 1970's, alternative development theories began to emerge in response to the onslaught of environmental degradation and the corresponding emergence of environmentalism, as well as the increasing gap between the rich and poor, not only on a North-South continuum, but also within each of these regions (WCED 1987; Korten 1992). These development issues have been addressed from a variety of alternative development approaches, such as basic needs approach, agro-ecosystems, eco-development, people-first approaches, world conservation strategy, heritage conservation, and sustainable development (IUCN 1980, 1991; Glaeser 1984, 1995; Chambers 1985; Korten and Klaus 1986; Redclift 1987; WCED 1987). It was largely the concept of sustainable development, as outlined in the Bruntland Commission's *Our Common Future* (1987), which brought environment and development issues into the international political arena. The underlying message of these concepts is that environment and development are intrinsically interconnected and that development perspectives and approaches need to incorporate both human and physical circumstances and costs (Reid 1995). Regardless of some of the differences in the message and approach of these alternative development approaches, a common theme is the need for an alternative development path to modernization.

Sustainable development was defined by the Bruntland Commission's as "*...meeting the needs of the present without compromising the ability of future generations to meet their own needs*" (World Commission on Environment and Development 1987, 43). The Bruntland Commission's approach to sustainable development draws from the accumulation of knowledge from previous alternative development approaches, and incorporates dimensions of ecology, economy and society. Table 2.4 illustrates the principles advocated under sustainable development, indicating the range, complexity and interconnectiveness of the issue. A central theme to sustainable development is that there are multiple paths, and as such, development is context driven and involves values and concerns of the local population. For example, the Bali Sustainable Development Project

Table 2.4: Principles and Approaches Advocated for Sustainable Development

Principles	Approaches
Satisfaction of Basic Needs • quality of life and security • development as a qualitative change • organizational response to societal change	**Strategic** • normative, policy-oriented, priority setting, goals definition • proactive, innovative, generates alternatives • considers range of alternative impacts • consensus • bottom up approaches
Maintenance of Ecological Integrity • ecological process and genetic diversity • awareness of ecosystem requirements • ecological principles to guide decision-making	**Systems** • focused on key points of entry into a system • recognized linkages between systems and dynamics • recognized linkages within systems and dynamics • importance of spatial and temporal scales
Achievement of Equity and Social Justice • equitable access to resources, costs, and benefits • equality and justice within and between generations • ethical and ecologically appropriate development • democratic political decision making	**Adaptive** • anticipatory, preventative, dealing with uncertainty • experimental, learning, evolutionary, responsive • maintaining diversity of options for resilience • moderating, self-regulating, monitoring • development as a process of social learning
Determination and Cultural Diversity • individual development and fulfillment, self-reliance • endogenous technology and ideas • culturally appropriate development • locally initiated and participatory decision making	**Integrative** • participatory and consultative • collaborative for the synthesis of solutions • integration of societal, technical and institutional interests • integration of management processes
Integration of Conservation and Development • multiplicity of perspectives, means and strategies • blending of sectors • resource management for social and economical change • accommodation and compromise	**Pluralistic** • multi-sectoral • equal attention afforded stakeholder issues • encouragement of broad-based public participation • regional and/or local level of involvement • empowerment and enabling of local people

Source: adopted from Stacey and Needham (1993); Chambers (1995)

identified cultural integrity as one of the key concerns in Bali, Indonesia, whereas in Sulawesi, Indonesia, central concerns for sustainable development were associated more with the resource base and development (Gertler 1993). These differences arose from the distinct human and physical circumstances of these two places, as well as the development pressures they were experiencing.

The vagueness in the definitions of sustainable development, as the one given above, has spurred much criticism and debate (Redclift 1987; Norgarrd 1994; Reid 1995). The debate

ultimately deals with the level, nature and methods to achieve and maintain sustainability. To some, sustainable development means the status quo, in terms of how business is done. Another view of how to achieve sustainability holds to a belief that continued economic growth is necessary in order to "afford the luxury" of conservation. Still others have called for a complete overhaul of the world view which underlies and supports modernism (Norgarrd 1994; Reid 1995). The basis of development is to focus on people and more non-material aspects of development, such as self-realization, security, love, understanding, participation and freedom (Reid 1995). Development is looked upon not as an end product, but rather as an interactive, adaptive and ongoing learning process that acknowledges the complex and dynamic range of local perspectives, local or indigenous knowledge, visions, needs and conditions (Korten 1985; Gabriel 1991; Nelson 1989 Chambers 1992, 1993a).

New approaches to development are advocated to support principles of sustainable development (Table 2.4). The approaches are based on participation in decision-making by the local people and communities, adaptation to emerging circumstances, and a process of social learning and cooperation among local people, professionals, government workers and nongovernment organizations (NGOs). Sustainable development provides guiding principles and ideas on how society, environment and development should interact, but their actual implementation is dependent upon the context on the ground. That is, different areas are faced with different problems, as well as varying physical and human circumstances from which they arise. Approaches and solutions to alter current interactions among society, environment and development must be assessed and designed from the particulars of the context in which it occurs. Sustainable development promotes a development process which is derived from interrelationships, human compassion and needs, ecological integrity, pluralism, contextualism, holism, and nonmaterial growth (WCED 1987; Norgarrd 1994; Reid 1995).

2.4 LAND USE CHANGE: MODERNIZATION AND SUSTAINABLE DEVELOPMENT

In an attempt to formulate conceptual linkage among interactions of land use change, society, environment and development, the development theories of modernization and

sustainable development are used as a point of departure. It is not intended to negate the significance of context, but to provide a general conceptual framework to study these interactions. These development theories provide a useful starting place because they each contain a view on how society and environment do, or should interact, as discussed above. Moreover, modernization has been a driver of change in many parts of the world, including Indonesia, but many countries are now faced with the challenge of using land in a more sustainable manner. Chapter 4 provides a historical regional account of land cover/use change on Java. Table 2.5 provides a summary of the interactions among land use change, society, environment and these development theories.

Table 2.5: Summary of Conceptual Linkages Among Land Use Change, Society, Environment and Development

	Modernization	Dependency Theory	Sustainable Development
Society	• bias towards modern ways • belief in science and technology • philosophy based on reductionist thinking • materialistic views of progress	• a set of core-periphery relationships	• significance of traditional ways • holistic thinking • scaling down • growth in material and nonmaterialistic ways
Environment	• use of natural resources for human needs and wants • greater external control over local resources		• importance of other maintaining habitats for other living species • decentralization
Development	• production-oriented • top-down/trickle-down • transfer of technology and know-how from west to east/north to south • capital intensive • sectoral approaches	• surplus extraction of resources from the periphery by the core • underdevelopment in the periphery	• based on the local social and physical conditions of the area • integrated • self-reliance • bottom-up approach • broad-based participation • combination of local and scientific knowledge
Land Use Change	• expansion and intensification of human use activities • driven by economic values	• land use changes are largely dictated by the core	• balancing conservation and development • based on ecological limits

2.4.1 Land Use Change and Modernization

The modernization process is associated with production/growth-oriented activities. Land use changes have involved intensification of human land use activities, including a process of expansion and conversion (Richards 1990). The main focus of modernization is on increasing the productivity of land use activities in order to fuel emerging industries with raw materials, and to satisfy the growing demand for food and material goods from an increasing urban population. Land is viewed mainly as a production unit to be used to fulfill human needs and wants, and economic values and forces are the main determinants of how it is used. Agriculture is a good example of changes driven by modernization. The "green revolution", designed by scientists, promoted the application of technology to increase agricultural yields. The technology involved high yielding varieties (HYV) of grains, tractors, fertilizers and pesticides, and irrigation and drainage (Rigg 1991). While generally the efforts of the green revolution were successful in increasing agricultural yields, it has also been associated with many negative social impacts, particularly on the small farmer in many Southeast Asian countries (Hansen 1981; Fox 1991). As suggested by Rigg (1991), on the surface the green revolution did not greatly alter the Asian agricultural landscape, but below the surface there were tremendous modifications in its social, economic, technological and biophysical characteristics. Box 2.2 illustrates general activities and trends associated with modernization and land use change at the global level[4].

Modernization has also been associated with the transfer of land use control from the local to the national, and in some cases the international level (Richards 1990). This is particularly prevalent in Southeast Asia, where State laws and regulations have largely replaced traditional management practices (Bennett and Dalhberg 1990). The universal policies and programs emanating from the national level are often associated with achieving national development goals, as opposed to supporting local needs and efforts (Bennett and Dalhberg 1990). Richards (1990, 166) suggests that:

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[4] For a more detailed overview of the changes in land use over the past three hundred years, consult Turner et al. (1990).

Box 2.2: Activities and Trends Associated with Land Use Change: A Global Overview

- world population has increased by 4,144 million from 1700 to 1985
- the world's forests and woodlands have diminished by 1.2 billion ha, or 19% of the total forest area of 1700
- croplands have increased by 331 million ha since the 1950's
- use of chemical fertilizers in agriculture has increased from 73 kg/ha in the mid 1990's to 97 kg/ha in the mid 1990's
- irrigated areas increased from about 98 million ha in 1949 to almost 240 million ha in 1984
- replacement of traditional land tenure systems with private land ownership
- the number of people living in urban areas has increased from 28.9% of the total population in 1950, to 43.2% of the total population in 1985
- total industrial potential increased from 127 in 1750 to 11,041 in 1980
- 18% increase in world energy consumption from 1979 to 1989
- chemical types in the atmosphere has increased from approximately 24 known types in the 1950's to almost 3,000 known types in the 1990's
- the global climate has increased by approximately
- life expectancy increased from 58.5 years in the early 1970's, to 65.5 years in the mid 1990's
- infant death rates decreased from 93 per 1,000 in the mid 1970's to 63 per 1,000 in the mid 1990's.
- about 15% of all plant species are now threatened with extinction, and approximately 5,000 plant species have become extinct since 1700
- external debt almost doubled from 1979 to 1989, increasing from $US 450,435 million to $US 899,345 million (for 107 countries throughout the world)
- approximately 1,964.4 million ha of soil have been degraded by human activities from 1945 to the late 1980's

Source: Richards (1990); Graedel and Crutzen (1990); World Bank (1992); World Resources Inc. (1992-93)

> The accelerating impulse toward mastery of the land and its resources has its origin in a complex set of interlinked causes: state power and organizational momentum, expanding economic demand expressed through increasingly integrated world markets, and population growth. Another variable-technological advances-facilitates, but does not drive, transformations in the land. It is the interaction between these variables that has shaped modern consumption of natural resources and uses of the land.

A major consequence of land use change associated with modernization has been an increase in the vulnerability of both human and physical systems, as indicated in Table 2.6 (Blaikie 1985; Blaikie and Brookfield 1987; WCED 1987; Chambers 1991). Interactions have become just as significant as people-on-nature interactions in the analysis of both vulnerability and environmental degradation (Li 1992; Chambers 1993; Blaikie 1994).

Vulnerability arising from the interactions of land use change and modernization have generally been discussed as environmental or structural factors. Increasingly both views have been combined to provide a more complete picture of the complex realities of human-

Table 2.6: Selected examples of vulnerability of physical and social systems associated with land use change

Spatial Level	Drivers of Land Use Change	Impact of Change	
		Physical Systems	Social Systems
Individual	• illegal cutting of wood • use of hill slopes and other marginal lands	• soil erosion • deforestation or degradation of existing forests	• loss or decline of livelihood • marginalization • unsustainable land use practices • debt and/or loss of economic assets • decrease in self respect and dignity
Group and/or Community	• commercialization of local crops • national development policies and/or programs • natural events (e.g., flooding, hurricanes) • human events (e.g., war, dams, climate change) • population growth	• loss of habitat • depletion of soil nutrients and minerals	• marginalization • poverty • unsustainable land use practices • seasonal and permanent migration to other areas for work
Regional	• monocropping • deforestation • desertification • urbanization • chemical inputs • trade arrangements • external development forces • population growth	• alteration of essential physical processes (e.g., hydrological cycle) • loss of genetic diversity and resilience	• decline of regional development and revenues • increased expenditure on relief • increased dependency on national level assistance
Global	• climate change • trade arrangements • foreign aid and debt • population growth • globalization	• alteration of essential physical processes (e.g., hydrological and atmospheric cycles)	• depletion of resources and resource productivity (e.g., deforestation, desertification, hole in the ozone layer) • decline in national economic growth • dependency on foreign aid and loans

Source: Examples taken from the literature to illustrate vulnerability

environment interactions (Dixon 1990; Palm 1990; Krummer and Turner 1994). Environmental factors have emphasized local conditions, such as shortage of resources, poor environmental conditions, education, and population pressures (Dixon 1990). Structural factors, on the other hand, involve issues of power, which emphasize control over, and access to resources (Blaikie 1985; Korten 1986; Brookfield and Blaikie 1987; Dixon 1990; Bennett and Dalhberg 1990; Chambers 1993; Reid 1995). Increasingly, people-on-people have become just as significant as people-on-nature interactions in the analysis of both vulnerability and environmental degradation (Li 1992; Chambers 1993; Blaikie et al. 1994).

As indicated above, it is difficult to unravel the interactions and factors which give rise to land use change. Key global variables driving land use change have been identified as

population growth, technological capacity, economic development, socio-economic organization, and beliefs/attitudes (Turner et al. 1990; Turner 1991; Grubler 1994; Rockwell 1994; Sage 1994; Sanderson 1994). These drivers have been studied independently, but with the acknowledgment that only when combined do they begin to provide an adequate view of the causes of land use change (Krummer and Turner 1994). At the regional and local levels, driving forces are multiple and complex, and as such difficult to generalize. Some of the drivers mentioned in the literature include: poverty, marginalization, labour arrangements, land tenure, commercialization and corruption (Krummer and Turner 1994).

2.4.2 Land Use Change And Sustainable Development

Interactions associated with sustainable development are more normative, in that they works towards achieving and maintaining sets of interrelationships among society, environment and development that produce sustainable land use patterns and changes. The conceptual linkages among land use change, society, environment and sustainable development are based on the principles and approaches discussed earlier. Sustainable use of the land involves both human and physical elements, and encompasses the ideals of economic viability, social equity, and ecological integrity.

Economic viability is associated with the ability of individuals, communities, regions and/or nations to have sufficient economic means for social reproduction, and includes fulfilling basic needs such as food, shelter, clothing and education. Within a sustainable development context, community economic development has been associated with self-sufficiency and self-reliance (Ekins 1990). While total self-reliance is not conceivable in the current global economy, certain levels should be attained to decrease dependency on and vulnerability to external forces. The "certain" level will depend upon community circumstances. Increased diversity of the local economy is one means of increasing economic viability.

Social equity addresses the issue of who benefits from development. A more equitable distribution of access to, and benefits from, development is required to work towards

sustainability. Equal distribution of resources must be addressed on all spatial levels, ranging from the household, community, regional, national and international (Reid 1995).

Ecological integrity, in a general sense, deals with the continued functioning and maintenance of a system at its optimum operating point under normal environmental conditions (Kay 1993). This state is often associated with the health of a system. The challenge arises when attempting to establish a baseline from which to measure integrity. Measurement involves identifying indicator processes or elements that are deemed important to the functioning of the ecological system. These indicators will vary depending upon the scale of analysis, such as species, community, bioregions, and the planet.

How land use change is linked with sustainable development depends largely on the context from which it is derived. That is, the concepts of economic viability, social equity and ecological integrity are each value-laden, and must be defined and addressed by the people and place in which it is being implemented. Central to sustainable development is the concept of adaptation.

> ...the natural environment of man [sic] has been constantly changing, either on its own or as a result of human activities, and of course the human environment of man [sic] (socio-cultural behaviour) has also been changing over time. It follows that the long-term survival (or extinction) *of any particular group of humans is perhaps more related to its ability to cope with uncertainty and change, [adapt] and to generate appropriate responses*, than to the optimality of its precise behaviour at a given time (italics added) (Clark et al. 1995, 29).
>
> External and internal changes are the norm, and therefore a key attribute of a sustainable environment is adaptability, a pliable capacity permitting a system to be modified in response to a disturbance (Forman 1995, 502-3)

2.4.3 Adaptation

Similar to development, the concept of adaptation[5] has been used in a variety of ways, but generally within a common context of coping (Bennett 1976; Watt 1983; Bovin and Manger 1987). Originating from biology, adaptation was associated with both genetic and

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[5] The term adaptation generally refers to the long-term acceptance and continued use of adjustments, which refers to the initial responses to change or stress (Bennett 1976). In this thesis, the term adaptation encompasses adjustments.

behavioural feedbacks which allowed an organism to cope with the environment, first by alterations in the gene pool, and second through cognitive and perceptual processes (Bennett 1976, 248). These adaptive processes were viewed as coping mechanisms that were built into the system's properties, with the goal of achieving and maintaining an equilibrium within the system (Watts 1983; Bennett 1993). Human adaptation differs from ecological systems in that values and intentions are attached to human activities, and because humans can adapt in a variety of ways, as well as can direct change to fulfill needs and wants (Bennett 1993). Defined as "the manner in which people act within existing resources and a range of expectations of a situation to achieve various ends", human adaptation is associated with behavioural, social and institutional processes (Blaikie et al. 1994, 62).

Adaptation, at the individual level, involves the selection among a myriad of coping strategies aimed at recovering from stress or change (Chambers 1992). At the group level, adaptation involves the mobilization of resources:

> [G]roup adaptation is simply the state of management of physical resources at any given time...any change in adaptive patterns in the group usually involves a collective decision, or at least a degree of discussion and often a considerable element of leadership, the exercise of power, or concession by leaders for the purpose of satisfying popular needs or demands. That is, adaptation at the group level is coincident with social action, interactions, and the dynamics of social organization and change. The use of the environment is taken inside society and the physical substances are transformed into "resources" (Bennett 1993, 49-50).

For both individual and group-level adaptation, the adaptive responses are contingent upon the opportunities and constraints arising from the local and external environments. That is, there is always an element of individual or group choice, but these choices are conditioned by the opportunities and constraints arising from the larger system in which they participate (Bennett 1993).

Selection of adaptive strategies is based on a sequential decision-making process which selects among a series of available responses (Palm 1990; Burton et al. 1993). Influences on the selection of adaptive responses arise from expectations (e.g., maximizing profits,

social prestige, survival), experience, skills, ethnicity, gender, religion, beliefs and socio-economic status, access to resources, salience of the change or stress agent, and the degree to which knowledge about the environment can and is translated into action (Scott 1976; Doorman 1991; Palm 1990; Bennett 1993).

External influences are viewed as those that transcend the local level, and involve "the way in which authority is distributed within society, cultural values that pervade all of our thinking including beliefs about the 'purpose' of nature and the role of the environment as a constraint or resource; assumptions about individual or collective responsibility for well-being; views about the safety of the environment; and the impacts of ethnic and gender roles in response to environment" (Palm 1990, 158).

Adaptive strategies are multiple, complex and diverse, often representing an ongoing process of adjustment among society, environment and development (Butzer 1990; Chambers 1991; Blaikie et al. 1994). A general typology of adaptive responses was devised by hazards research, which includes: 1) do nothing and bear the loss; 2) reduce the loss by moderating the change agent; 3) reduce the loss by changing the environment; 4) reduce the loss by changing human behaviour; and 5) reduce the loss by sharing the loss (Burton et al. 1993). Successful adaptation may not necessarily result in a return to the pre-stress condition, but instead involves "the ability to absorb and use change to explore possible evolutionary pathways which it could follow, defined in terms of different regimes of operations" (Clark et al. 1995, 23).

Central to adaptation is the notion of uncertainty. That is, people, groups, communities and societies must adapt to change and stress within a realm of incomplete understanding of past, current and/or future conditions. As such, adaptation often involves an element of risk, in that the end result is not assured and could produce negative elements. While the above discussion on adaptation has centred around people as individuals and groups, the significance of adaptation for institutions has been increasing, particularly in the field of resource management (Holling 1978; Mitchell 1979). Holling (1978) suggests that resource management needs to embrace uncertainty and variability in order to more

effectively manage resources, rather than to ignore it. In this context, adaptation is directed towards institutions and how they manage resources.

2.4.4 Vulnerability

Where human adaptation is the coping strategy of individuals, groups, societies and/or systems, vulnerability is the circumstances and conditions which largely determine the range of available strategies. Vulnerability generally refers to the inherent capabilities of a person, group or system to anticipate, cope with, resist, and recover from change or stress (Timmerman 1981; Chambers 1989; Blaikie et al. 1994). Chambers (1989, 1) suggests that vulnerability consists of an external side, which involves the exposure to risks, shocks and stress, and an internal side which relates to defenselessness and the ability to cope with damaging loss. Loss can be manifested in economic, social, psychological and/or physical terms.

Vulnerability arises from a range of factors and circumstances which vary among places and people. Watts and Bohle (1993, 45) suggest that the space of vulnerability in the context of famine can be defined in terms of several key elements: exposure, capacity and potentiality. More specifically:

1. exposure to risk, crises and shock
2. the risk of inadequate capacities to cope with stress, crises and shock, and
3. the risk of severe consequences of, and the attendant risks of slow or limited poverty (resiliency) from, crises, risk and shocks.

Hewitt (1997) provides a similar list of the basic forms of vulnerability which include, exposure, weakness, lack of protection, disadvantage, lack of resilience and powerlessness (Table 2.7). Elements of vulnerability have been associated with variables such as age, gender, ethnicity, physical condition/disability, political power, socio-economic status and geographic location (Chambers 1989; Wisner and Luce 1993). Chambers (1989) is careful to suggest that vulnerability is not equal to poverty, but that poorer people often are more vulnerable. While a set of indicators and measurements for vulnerability has not been well defined in the literature, Wisner and Luce (1993) suggest that the above elements form a good basis.

Table 2.7: Some Basic Forms of Vulnerability

- **Exposure** to dangerous agents and environments
- **Weaknesses**: predisposition of persons, buildings, communities or activities to greater harm
- **Lack of protection** against dangerous agents and for weaker persons and items
- **Disadvantage**: lack of the resources and attributes to affect risk or respond to danger
- **Lack of resilience**: limited or no capacity to avoid, withstand or offset and recover from disaster
- **Powerlessness**: inability to influence safety condition, or acquire means of protection and relief

Source: Taken from Hewitt (1997, 27)

Vulnerability is associated with the daily routines which arise from the conditions and circumstances of a people and a place (Hewitt 1983, 1997; Chambers 1991; Blaikie et al. 1994).

> Vulnerability is a product of the circumstances that put people and property on a collision course with given dangers, or that make them less able to withstand or cope with disaster. It depends, in large measure upon ongoing conditions of material and social life, or their transformations. For that reason, this perspective also draws attention to cultural and ecological contexts that constrain or enhance people's abilities to respond and cope (Hewitt 1997, 167).

In the context of change, vulnerability is not the product of the change agent, such as natural calamities, but instead as suggested in a hazards context, arises from "the activities of daily life [which] comprise a set of points in space and time where physical hazards [change or stress], social relations and individual choice converge. Patterns of vulnerability emerge at this convergence, at which point several socio-economic and personal characteristics of people have a bearing on vulnerability to disaster [change]" (Blaikie et al. 1994, 13). Vulnerability is then a social product derived from the context in which it was born. Thus the focus on vulnerability illuminates the internal conditions of households, groups, communities, societies and/or systems, and arise from everyday living conditions (Hewitt 1997). As highlighted in more recent hazards research, vulnerability analysis has required a shift in focus from the events, such as floods or earthquakes and technical responses, to the social conditions and people impacted by the event. "Vulnerability is reproduced by the activities that sustain unsafe living conditions for some, or disempower them, and change only if these conditions are transformed" (Hewitt 1997, 153).

2.4.5 Key Elements Influencing Human Adaptation

Elements which influence adaptation arise are numerous sources, involving social, economic, technological, cultural, institutional, and physical elements. A review of the literature from various fields indicated five key elements which are paramount, in that they transcend the vast range of influential elements. They are control, access, knowledge, productivity and stability (Conway 1986; Korten 1986; Li 1992; McGee 1992; Bennett 1993; Chambers 1993; Blaikie et al. 1994). With the exception of productivity and stability, these elements deal specifically with the human factors, although productivity and stability are discussed here primarily in terms of how they relate to economic viability. Physical factors are not included in this discussion mainly because the emphasis of this research is on the human aspects (e.g., social, economic and institutional) associated with land use change.

2.4.5.1 Control

Control refers to who has the right to use and regulate resources (Korten 1986; Chambers and Ham 1995). Control is largely associated with issues of autonomy and participation, and is often related to empowerment (Chambers and Ham 1995). The modernization process throughout the South has largely resulted in the control over resources being transferred from the local environment, such as villages, to the national government. With greater control over decision-making for the use and allocation of resources, many national policies, which are designed to benefit the nation, are often insensitive to the needs and conditions of the local community (Korten 1986; Bennett and Dalhberg 1990; Sullivan 1992).

It is increasingly suggested that local control over resources and community-based planning approaches are necessary for sustainable development, because: 1) universal development policies and programs initiated by the state cannot take into account or respond to the multitude of social and physical conditions at the local level; 2) local mobilization of resources tends to employ more effective and efficient management strategies, than those employed by external programs; 3) there is greater accountability for resource use if the spatial and temporal links between decision-making and consequences are shortened; 4) it promotes more democratic approaches to decision-making, and 5)

commitment to local development projects is often higher because the responsibilities are more clearly defined, and there is a sense of local ownership (Chambers 1985; Korten 1986; Blaikie and Brookfield 1987; Chambers and Ham 1995).

Participation is viewed as a necessary foundation to provide a broad base of control over decision-making for land use change and development (Cohen and Uphoff 1980; Korten 1986; Nelson and Wright 1995). Varying degrees and types of participation influence, and are influenced by, the nature of control, often determined by the political-economic structure of a society (Mitchell 1979; Cohen and Uphoff 1980). At one end of the "participation continuum", local people are viewed as merely receptors of policies and programs, such as the adoption of new technology. The approaches to participation are sometimes forced, and when failure results, blame is often placed on the local people for being backwards, traditional, and conservative, rather than the inappropriateness of the project (Chambers 1995). Further up the continuum, participation involves obtaining information prior to designing policies and programs, but not including local people in the full decision-making process.

More recent views of participation, largely associated with people-first development approaches, involve empowerment of people through not only involvement, but also through control of decision-making by all community members (i.e. generation of ideas, formulation and assessment of options, and making choices), implementing and monitoring, as well as benefiting from development (Cohen and Uphoff 1980; Chambers 1985, 1993; Korten 1986; Nelson and Wright 1995). The differences among these types of participation are the extent to which local people are permitted and/or encouraged to participate, reflecting the equality in the exchange of information and responsibilities with other actors and organizations (Chambers and Ham 1995). Co-management of local resources is the optimum participation level, because it is deemed necessary to ensure equal, or at least accountable use of resources, and to provide a sense of ownership by the local people (Chambers and Ham 1995; Nelson and Wright 1995).

2.4.5.2 Access

Access has been defined as "the ability of an individual, family, group, class or community to use resources which are directly required to secure a livelihood" (Blaikie et al. 1994, 48). Access is largely determined by the availability to, and awareness of resources. When access to a necessary resource is lost and not compensated for, the range of available adaptive responses can decrease (Blaikie et al. 1994). The fact that availability of access is not equally distributed among a population has become widely accepted (Chambers 1991; Blaikie et al. 1994). A criticism of many development projects is that they reinforce structures of unequal access to resources, increasing the vulnerability of certain members of the community. Access is contingent upon economic, social, political and cultural factors, such as age, gender, and social and economic status (Chambers 1991). Blaikie et al. (1994) devised an "access profile" for a household, which involved analysis of four components: 1) class relations and change in the political regime, 2) household or community budget, 3) income opportunities, and 4) structures of domination (Blaikie et al. 1994).

2.4.5.3 Knowledge

Knowledge represents ways of knowing, which arise from different sources, such as experiences, traditions and new information. The various ways of knowing underlie the range of social organization, values and goals which guide how people interact with other people and the physical environment (i.e. their world view). In development and environment, knowledge has been categorized into two broad classes: scientific and indigenous (Chambers 1985; Norgarrd 1994). Scientific approaches have been based largely on mechanical, objective, rational and reductionist approaches, which have attempted to take apart and measure systems in order to understand and predict them (Norgarrd 1994; Clark et al. 1995). Indigenous knowledge, on the other hand, provides alternative ways of knowing based on the experience and know-how of local people who have, through an extended trial and error process, learned to use and manage land use systems (Wickham 1993). Through the development process, notably modernization, scientific approaches have largely replaced indigenous ways of knowing, as the latter were often viewed as backwards and barriers to development (Jamieson 1985; Dove 1983). As suggested earlier, environmental degradation has been increasingly associated with the

scientific approach applied within a modernization framework. It has been suggested that indigenous knowledge has, in many cases, provided a better "societal fit" with the surrounding environment (Jamieson 1985). Sustainable and people-first development approaches have advocated the combination of these two ways of knowing, mainly through a process of social learning (Chambers 1993). Also significant is the inclusion and sharing of information and knowledge with local people in a way that is useable to them. This is essential if they are to participate successfully in the regional, national and international systems, as knowledge is power (Clay and Magnani 1987; Chambers 1993; Davies 1993).

2.4.5.4 Productivity and Stability

Productivity, stability and sustainability have been suggested as three indicators for agro-ecosystems analysis (Conway 1986). In an ecological context, productivity of resources is associated with various factors, such as soil fertility, biomass and energy. Maintenance of ecological productivity is essential to sustained use of land, particularly in agro-ecosystems. When these elements are used in an unsustainable manner, vulnerability of the system increases. Agro-ecosystems analysis has defined productivity of land use as the system output, which may be measured in terms of yields or income generated (Conway 1986). Stability is associated with the ability of a system to remain at a certain level of output, or at an equilibrium, in the face of small disturbances (Clark et al. 1995). In agro-ecosystems analysis, stability is defined in terms of maintaining a specific level of productivity over time (yield or gross income), when faced with environmental perturbations such as the normal fluctuations in climate or the amount and type of pests (Conway 1986). Sustainability of a system relates to the ability of a system to "maintain its productivity when affected by a large disturbance" (Conway 1986, 11). A disturbance may be the result of the accumulation of smaller stresses, or it may result from a sudden, large and unexpected perturbation, such as floods, earthquakes and wars (Conway 1986; Clark et al. 1995). "A highly sustainable system can recover from perturbations; a poorly sustainable system collapses" (Conway 1986, 22).

2.4.6 Land Use Change, Sustainable Development And Communities

The above discussion has placed land use/cover change analysis within a broad framework of sustainable development. The key components of this conceptual framework are the interactions among land use change (nature, dimensions and consequences of change), society, which is addressed in terms of community (actors, organizations, social organization and resources), environment (local and external), and development (goals and approaches of interventions) (Figure 2.2). Adaptation and vulnerability are included in the "circle of integration" as they arise from, and influence the interactions among land use change, society, environment and development. The ideas and elements presented in this conceptualization are not new, but the challenge now is to bring them together in a manner that helps us to better understand the drivers and consequences of land use change.

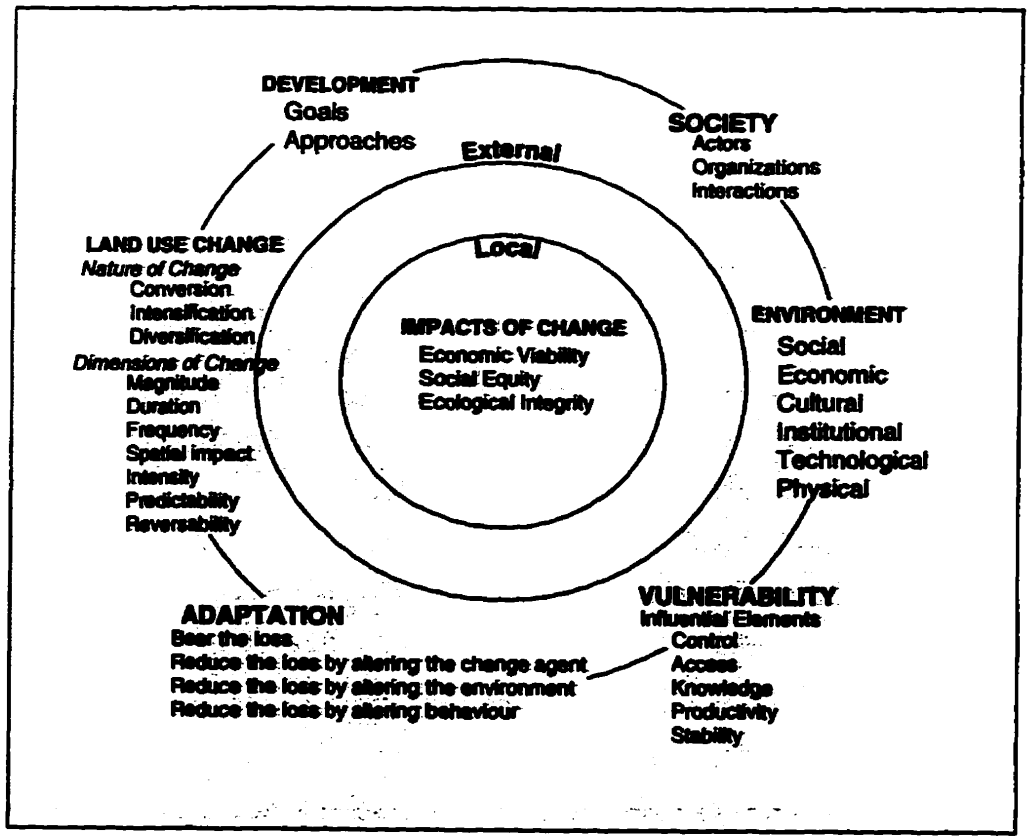

Figure 2.2: Conceptual Framework for Land Use Change Analysis

2.5 SUMMARY

Land use change is a complex and dynamic phenomenon, and in no time in history has the rapidity and magnitude of change surpassed that which we are witnessing today. In simple terms, land use is a complex process of human adaptation which aims to fulfill needs and wants. The complexity arises from the interactions among society, environment and development, which drive human actions. In many parts of the world, land use changes are largely the product of policies and actions derived from the process of modernization. Modernization encompasses a set of relationships among society, environment and development, which is based largely on economic values of growth and material driven progress. Within this relationship, land is viewed as simply a production unit to be used freely for economic gains. The result of modernization has been intensified land use activities, associated with economic growth, such as the expansion of urban, industrial and agricultural land use activities. Increasingly, many of the derived land use changes have been associated with increased vulnerability of human and physical systems ranging from local to global levels.

In response to the externalities of the interactions between land use change and modernization, a new set of interrelationships among society, environment and development is now being sought under the guise of sustainable development. Sustainable development is based on emerging societal values which encompass ecological integrity and human compassion (e.g., social equity, economic viability, justice, cultural diversity, and spiritual growth). Sustainable development is a normative process, in that it provides guidelines and principles of how land use should change. Elements thought influential in the interactions of land use change, society, environment and sustainable development are control, access, knowledge, productivity and stability. How these elements manifest themselves is largely dependent upon the historical human and physical circumstances and the spatial scale of analysis.

Adaptation focuses on the actions of the actors involved in land use change, and vulnerability emphasizes the local circumstances which underlie these actions. As such, the understanding of the interactions among land use change, sustainable development and communities is drawn from the context from which it evolves. Moreover, the focus on

vulnerability more strongly links land use change with the welfare of the people, as opposed to solely the productivity of the land use activity.

Chapters 4 provides a general overview of the context for land use change analysis in Segara Anakan, a brackish mangrove estuary located in Central Java, Indonesia. Prior to this, Chapter 3 presents the multi-method data collection approach employed in this research to identify, analyze and better understand land use and land cover change in Segara Anakan.

Chapter 3
METHODS

3.1 INTRODUCTION

The purpose of this chapter is to describe the methods of data collection employed. Several methods were employed to collect data on both land cover and land use change and to study these changes within the context of society, environment and development at the regional and community levels. The methods include, remote sensing, rapid rural appraisal techniques, and the collection of existing data. Each of these techniques provides different perspectives on land use change, and their integration provides a more comprehensive view. A geographic information system (GIS) is used to integrate the data into a common database and to facilitate the spatial analysis of land use change. This chapter outlines the application of each of these techniques for land use change analysis, and how they were employed in this research. The chapter ends with a discussion of data integration in a GIS, highlighting the advantages, limitations and challenges encountered.

3.2 CONDUCTING RESEARCH IN A FOREIGN CULTURE

An important issue that confronts all researchers who conduct study in a different culture or subculture is sensitivity to this foreign culture. To enhance my sensitivity to the people of Segara Anakan, and more specifically of those in Kampung Laut, I lived in the fishing villages for five months while conducting field work, studied the national language Bahasa Indonesia, and hired Javanese research assistants. Nine weeks (270 hours) of language training were completed over a four year period. The language training was completed at REALIA, located in Yogyakarta. A working level of Bahasa Indonesia was obtained so that it was possible for me to conduct conversations and interviews. Even with some knowledge of Bahasa Indonesia, language was still a barrier. This barrier was partially overcome by hiring a female Indonesian research assistant, Ani, for the entire five months.

Ani spoke Javanese, Indonesian and English, and had considerable experience in community development issues and village life in Java. Ani grew up in a Javanese village near Yogyakarta, and has worked extensively with non-government organizations involved with community development. Ani was an indispensable part of the field work. To maximize understanding and to minimize misunderstandings, a continuous dialogue was maintained between Ani and myself, regarding the research issues and information obtained during the field work. Additional local research assistants were hired from each of the fishing villages to assist liaison with the local people and to collect data.

The majority of field work was conducted during the dry season (May to October) in 1994. Because of the lack of fresh water during this time, rice was not being cultivated, with the exception of a few areas. As a result, it was not possible to gain first hand observations of rice agriculture in Segara Anakan, although this is not considered to be a major hindrance to the thesis. The previous field visit in 1992, although much shorter (2 months), was conducted during the rainy season. At this time, the area was experiencing flood conditions which were suggested by the local government and local people to be the worst in many years. The flooding did impede discussions on everyday life situations in certain areas of the estuary, in particular in the villages of Ujung Gagak and Panikel. Nevertheless, the field season did provide me with first hand experience of the very real issue of flooding in the area.

During the research, an attempt was made not to be obtrusive in the communities. This involved selecting appropriate times to interview fisherfolk and farmers so as not to interfere with their working schedule, as well as to involve only those willing to participate. I also attempted to lessen my "outsider" status by participating in village activities and ceremonies and by partaking in informal discussions in the evenings with various people.

3.3 SELECTION OF THE STUDY AREA

Selection of Segara Anakan as the research study area arose from my participation in the UGM-FES Segara Anakan Area Project[6] during my Masters research (Nelson et al. 1992; Olive 1992). My Masters research assessed regional land use change in Segara Anakan, and was technically oriented as it focused on integrating satellite land cover change data with secondary data in the Abiotic, Biotic and Cultural (ABC) Resource Survey framework (Olive 1992). The initial interest of this Ph.D. was to continue with the Master's research, and focus on the fishing communities as a resource use system in an environment of change. When the impacts of sedimentation on the estuary and estuary fisheries became more apparent through additional ground surveys, interest shifted to a second economic activity which had been emerging in the area. Rice agriculture has been growing at an increasing rate since the early 1980's, largely in response to sedimentation and the availability of new lands in the estuary. These land use changes have consequences for both local development and regional conservation of Segara Anakan, and it was within this context that land use change analysis was conducted.

Continuation of my doctoral research in this area had several benefits, notably: established contacts; familiarity with the area; availability of secondary data (e.g., reports); and previously acquired satellite data. More importantly, Segara Anakan provided a dynamic case study for land use change analysis at both the regional and local level. Delineation of the study area was based on the administrative boundaries of the three traditional fishing villages located within the estuary. Selection of this boundary was based on the direct impacts of sedimentation on the fishing communities, obtaining research permission, and the availability of statistical data on a village basis.

3.4 THE ORGANIZING FRAMEWORK FOR DATA COLLECTION

A human ecological perspective was adopted as the organizing framework of this research. Human ecology aims to provide an understanding of human interactions with the surrounding environment (Rambo 1983; Nelson 1989; Nelson and Serafin 1992; Moran

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[6] The twinning arrangement was between *Pusat Penelitian Lingkungan Hidup* (PPLH) (the Centre of Environmental Studies) Universitas Gadjah Mada (UGM), Yogyakarta, Indonesia and the Faculty of Environmental Studies (FES), University of Waterloo, Waterloo, Ontario, Canada.

1993; Glaesar 1995). Based largely on ecological principles, human ecology focuses on the interactions and interrelationships among the various human and physical components which make up the environment. Within this research framework, land use became the main focus. Data needs were identified by the conceptual framework, but also through a process of progressive contextualization, in which data needs are incrementally identified during the research (Vayda 1983). In a similar context, an interactive and adaptive approach was also employed to learn about and obtain relevant information based on the various perspectives (Nelson 1989). Organization of the data is based loosely on the framework of the Abiotic, Biotic and Cultural (ABC) Resource Survey. The ABC Resource Survey organizes data in various theme maps and areas of significance and constraints, which are identified based on the goal of the study (Bastedo et al. 1986; Nelson et al. 1992).

A variety of data collection techniques was employed in this research to collect spatial and aspatial data on land cover and land use change at the regional and village levels. Table 3.1 indicates the data collected from each of the methods, as well as their application in land use/cover change analysis. A brief description of each of the methods is provided below as well as how they were applied within the context of this research.

3.5 REMOTE SENSING

Remote sensing involves "obtaining data from a device that is not in contact with the object, area or phenomena under investigation" (Lillesand and Kiefer 1982, 1). A variety of remote sensing devices is available to measure various aspects of the physical environment. This research deals only with optical satellite data, and analysis is primarily concerned with land cover and land cover change mapping. Satellite data analysis has proven useful for land cover and land cover change studies, because it provides: 1) quantitative historical and current land cover data, often not available elsewhere; 2) a synoptic view of an area in a short time span; 3) an inventory of the location, distribution and nature of land cover change; and 4) a range of spatial and temporal scales for analyses (Richards 1984; Jensen 1986; Campbell 1987). It should be noted that the information derived from satellite data is land cover, but land use information can often be inferred and verified by field checks and ancillary data.

Table 3.1: Matching Data Sources and Analyses Techniques with General Data Needs for Land Use Change Analysis

Data Collection Method/Sources	Techniques	Type of Data Collected
Remote sensing (satellite data)	**Land Cover Mapping** • supervised classification with spectral and texture data **Land Cover Change** • principal components analysis	**Inventory** • Identify the location and extent of land cover types • Identify the nature, rate and distribution of land cover change
Rapid rural appraisal	**Land Use and land use change** • mapping of land use activities by small groups of local people • semi-structured interviews • participant observation • short survey	**Inventory, Description and Explanation** • Identify the distribution of land use characteristics • Identify aspects of the social, economic, cultural, technological, institutional and physical characteristics of land use • Identify the historical processes of land use change in the area • identify local perspectives on land use change
Collection of Existing data	**Village and Land Use Characteristics** • government statistics (village, subdistrict and district) • government development reports • consultants reports • historical maps	**Inventory, Description and Explanation** • Identify and measure the rate, nature and distribution of land cover change • Identify and measure land cover types • Identify aspects of the social, economic, cultural, technological, institutional and physical characteristics of land use change • Identify the history of land use change
Geographic information systems	**Land Cover and Land Use Change** • ARC/INFO GIS • integration of spatial and aspatial data from various sources	**Inventory and Description** • social, physical, cultural and economic aspects of land use and land use change (i.e., land use theme maps)

3.5.1 Land Cover Classification

One of the most common applications of remotely sensed data is the extraction of land cover data (Jensen 1986). Electromagnetic radiation (EMR) reflected from the surface of the earth is collected by satellite sensors over various portions of the electromagnetic spectrum. The reflectance information is then used to create spectral signatures for physical features of interest, such as land cover types. Two main approaches, supervised and unsupervised classification, have been used to classify these spectral signatures into land cover types (Box 3.1). The classification algorithms used by these two approaches have not been as successful with the higher resolution satellite data, such as Landsat TM and SPOT (Jensen 1986). To deal with this problem, alternative approaches have been emerging, such as hybrid classification approaches, which use a combination of supervised

Box 3.1: Supervised and Unsupervised Land Cover Classification

Supervised Land Cover Classification

Supervised classification produces a land cover classification based on training data provided by the researcher. Through an interactive process, the analyst selects samples of pixels from known land cover types. Statistics extracted from these informational categories are used by a classification algorithm to match every pixel in the image to a selected land cover class. Various classification algorithms are available, and in order to select the most appropriate one, the researcher must be familiar with both the data and assumptions of these algorithms (see Jensen 1986 for in-depth descriptions of the main classification algorithms). As the informational land cover categories are forced on the spectral data, misclassification can occur. This often is the result of mixed pixels (i.e., high variance) in the training classes. The main benefit of this approach is that the analyst can match the classification results to real land cover types. This also means, that to perform a supervised classification, the analyst must have a priori knowledge of the study area (Jensen 1986; Chuvieco and Congalton 1988).

Unsupervised Classification

Unsupervised classification differs from supervised classification in that the training sites are derived from spectral groupings of the pixels, not informational categories provided by the analyst. Classification is conducted by a clustering algorithm which divides the image into arbitrary classes based on the spectral values of each pixel (Jensen 1986). A variety of clustering algorithms is available (Jensen 1986). The researcher has no influence in which classes are selected, and as such the class types need to be identified. A disadvantage of this approach is that the land cover map may not include the informational classes of interest to the researcher (Campbell 1987; Chuvieco and Congalton 1988).

and unsupervised approaches (Pilon et al. 1988; Chuvieco and Gungalton), the inclusion of ancillary data into the classification process, such as elevation and texture (Franklin and Peddle 1990; Peddle and Franklin 1991; Baraldi and Parmiggiani 1995), as well as image segmentation (Fung and Chan 1994; Johnsson 1994).

3.5.2 Land Cover Change Detection

Land cover change detection is based on the ability to measure differences in the spectral response of the same area from images collected at different times (Jensen 1986; Fung and Zhang 1988; Gong 1993). A variety of change detection approaches is available and can be subsumed under two main types: post classification and enhancement (Wiesmiller et al. 1977; Howarth and Boasson 1983; Jensen 1980; Fung and Zhang 1988; Gong 1993). Post classification change detection involves the comparison of classified land cover images (Jensen 1986; Campbell 1987). The main advantage of this approach is that the nature of the land cover change is identified. The main disadvantage is that accuracy of the change image is only as good as the accuracy of the land cover classifications, and the errors

accumulate when combining the images (Jensen 1986; Chuvieco and Congalton 1988). Enhancement techniques involve a mathematical combination of multi-temporal data to highlight areas of potential change (Howarth and Boasson 1983; Pilon et al. 1988). A variety of enhancement approaches is available, ranging from simpler techniques, such as image subtraction and ratioing, to more complex applications, including principal component analysis and tasseled cap (Howarth and Boasson 1981; Fung and LeDrew 1987; Richards 1984; Olive 1992). Selection of the most appropriate technique depends largely upon the nature of the study area, nature of the data, and the researcher's familiarity with the study area.

Three main conditions are recommended for successful change detection analysis. First, researchers should possess prior knowledge of the study area characteristics. Second, researchers should have an understanding of the limitations of the change detection techniques. Third, influences on the spectral response not associated with land cover should be minimized, such as differences introduced from atmospheric conditions, the sensors, seasons (i.e., use anniversary dates) and preprocessing of the data (e.g., resampling and mis-registration between images) (Jensen 1986).

3.5.3 Analysis of Remotely Sensed Data for Segara Anakan, Java

Satellite data were employed in this research to update previous regional land cover change analysis, as well as provide current land cover mapping in Segara Anakan (Figure 3.1) (Nelson et al. 1992; Olive 1992). Two SPOT XS[7] images were acquired for October 11, 1987 and July 7, 1995 (Figure 3.2). A 1968 Government of Indonesia topographic map was also used in the land cover change analysis to provide more of a historical context of change ongoing in the area. All digital analysis of the satellite data was completed in PCI's Easi Pace (version 5.2), and all computer mapping on ARC/INFO geographic information

[7] The SPOT satellite is owned and operated by the French government, and was first launched 1986.

Sensor	Spatial Resolution	Spectral Resolution		Radiometric Resolution	Temporal Resolution
		Band	width & location		
SPOT XS	20 x 20 metres	MLA1	0.50 to 0.59 um	8 bit	2.5 days
		MLA2	0.61 to 0.70 um	8 bit	
		MLA3	0.79 to 0.89 um	8 bit	

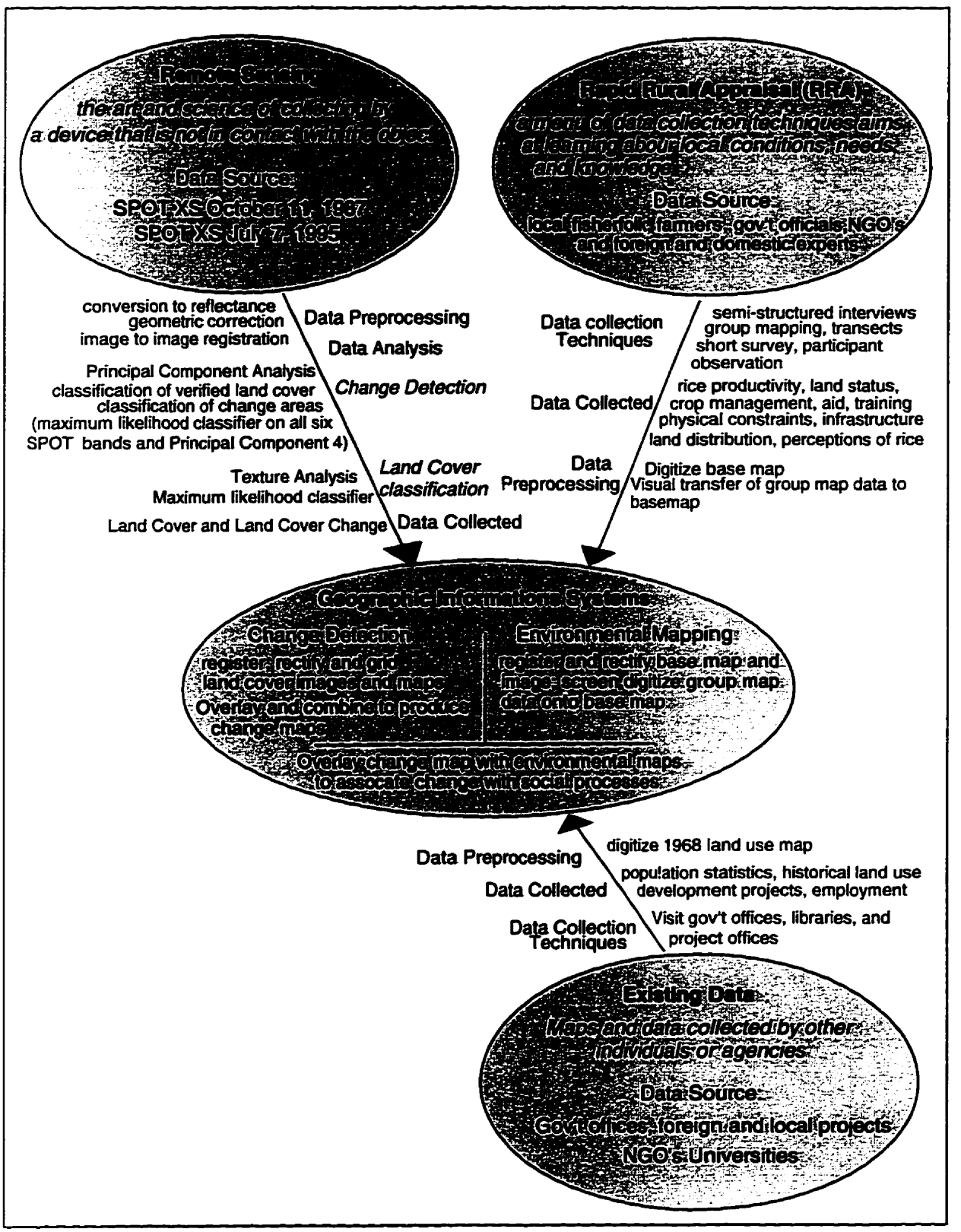

Figure 3.1: Methods Framework

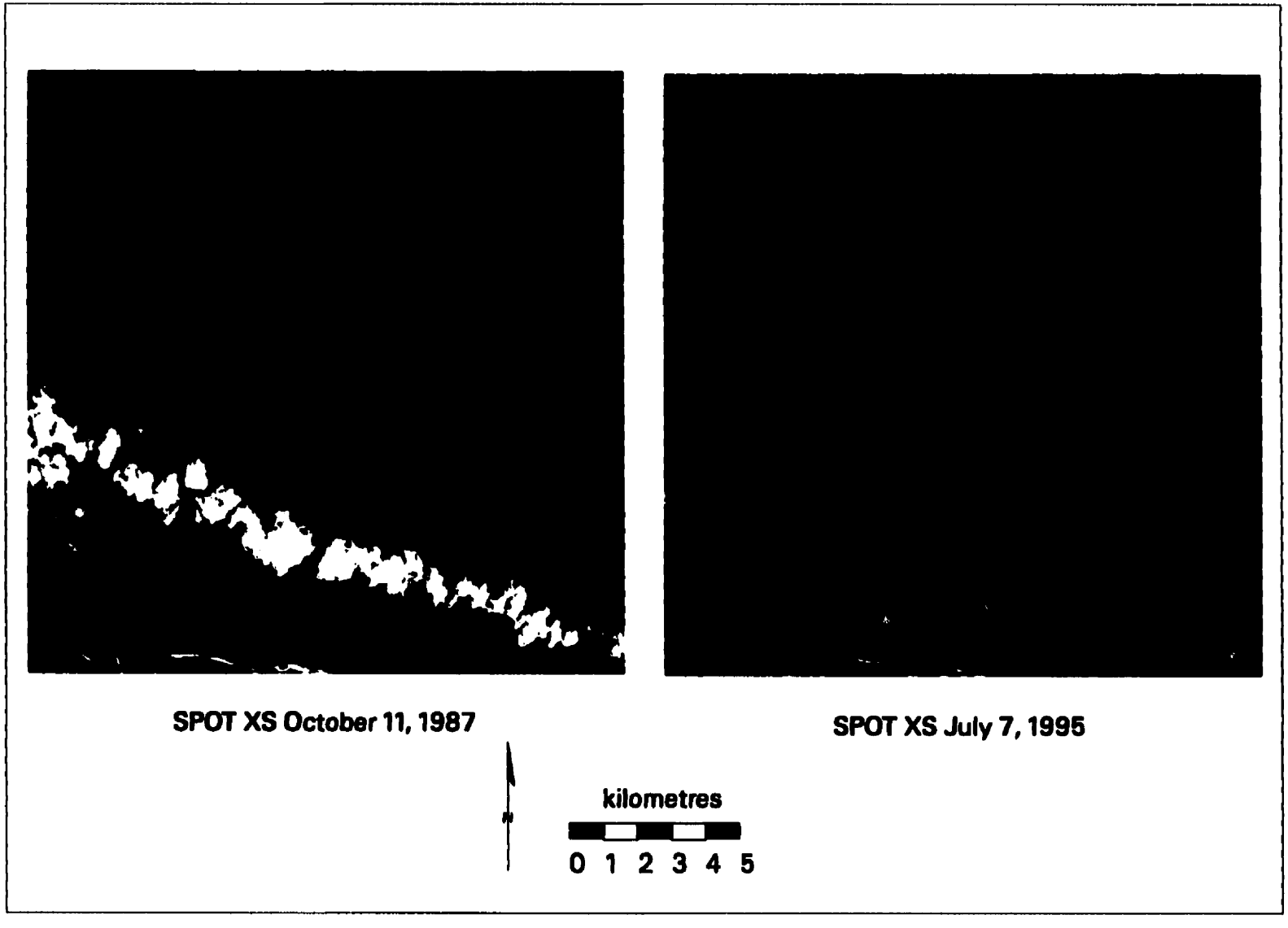

Figure 3.2: SPOT XS Images of Segara Anakan, Java, Indonesia

system (ESRI version 6 and 7) both located in the Faculty of Environmental Studies, University of Waterloo.

3.5.3.1 Characteristics of the Study Area for Digital Land Cover Land Cover Change Analysis

Prior to discussing the land cover and land cover change techniques employed in this research, it is useful to describe some of the environmental characteristics of the study area as they pertain to the analysis of the satellite data. The Segara Anakan is a rural, coastal, wetland environment situated on a low-lying, flat alluvium plain at sea level. The island of Nusa Kambangan, which protects the estuary from the Indian Ocean, is comprised of a rugged limestone outcrop. The area experiences two main seasons: wet (November to March) and dry (May to September). The estuary is also influenced by diurnal tides, which range from 0.4 to 1.9 metres, rising and falling approximately every five hours (Sujastani 1986). Although the area has been increasingly manipulated by human activity, it still dominated by vegetation. In 1994, the dominant land covers in the area were: estuary waters; mangrove forest; wet rice agriculture; newly constructed fish ponds; new lands; linear and nucleated villages; and rainforest located only on Nusa Kambangan.

3.5.3.2 Land Cover Mapping for 1987 and 1995

Land cover classifications of coastal wetland environments has been accomplished in various ways, as indicated in Table 3.2. An initial supervised classification of the SPOT 1987 image was conducted, based on training sites identified during field work and from existing data. A maximum likelihood classifier was employed using eight training sites: mangrove forest, estuary waters, new lands, settlements, rice fields, new rice fields, rain forest and mangrove encroachment. The land cover classes correspond with a land cover/use classification system devised for remote sensing for Indonesia (Malingreau 1981).

Visual assessment of the land cover classification indicated confusion (i.e., mixing) among certain land cover classes, in particular the mangrove forest and rainforest. The overlapping of spectral signatures is characteristic of coastal wetland environments, as environmental factors, such as soil moisture and tides, can increase confusion. Figure 3.3 illustrates the relatively narrow spectral range that these land cover types encompass, indicating the

Table 3.2: Digital Land Cover Classification Techniques Employed in Coastal Wetlands

Authors	Location, Data and Purpose of Study	Techniques Used
Blasco, F. et al. (1985)	• Kenya, West Africa • land cover classification of mangrove, urban and other vegetation • simulated digital Spot XS data	• vegetation index of bands XS2 & 3 • brightness index of XS1 & 2
Jensen et al. (1991)	• Marco Island, Florida • SPOT XS data • mapping per cent canopy closure of mangrove forests	• simple ratio (XS3/XS2) • normalized difference • perpendicular vegetation index
Patterson, S. and J. Rehder (1985)	• Southwest Florida • high and medium altitude black and white and colour infra red imagery • (scale of 1:24,000) • mapping extent and changes in extent of mangrove forest	• manual mapping and digitizing of boundary extent of mangroves types based on spectral signature, tone and texture • overlaying in a GIS to identify changes in extent
Gilabert, A. and J. Melia (1990)	• Valencia, Spain • Landsat-5 TM • to map land cover, with special reference to rice and surrounding classes (i.e., urban, water and other crops) • to select the most optimum time in the year to map rice	• normalized difference vegetation index (NDVI) with TM3 & 4
Ringrose, Susan (1986)	• Landsat MSS • Sierre Leone, Africa • to map land cover, with special reference to rice and mangroves/swamps	• colour composite • linear contrast stretch • high filter pass : band ratio 5-7, and ratio stretch 5-7 • principal component transformation • Martin Taylor transformation • unsupervised classification
Jensen, J. et al. (1987)	• Pen Branch Delta, • land cover change detection in wetlands • aircraft MSS data	post classification • unsupervised classification using channels 3, 7, 8 and 10, and 'cluster-busting'
Pulich, W. and J. Hinson (1995)	• Texas • land cover classification • Landsat TM data	• hybrid classification approach using a cluster-busting procedure
Massasati, A. (1995)	• Mississippi Delta • Landsat TM • land cover classification	• tasseled cap approach • hybrid classification
Spell, R et al. (1995)	• Columbia River estuary • Landsat TM • land cover classification	• hybrid classification approach and stratification of image into ecoregions (uplands and lowlands) prior to classification
Raabe, E. and R. Stumpf (1995)	• Florida • land cover classification • Landsat TM, SPOT and aerial photography	• normalized vegetation index • hybrid classification approach

closeness of the spectral values. A supervised classification of the 1995 SPOT data presented similar findings. In this classification, seven land cover classes were employed, based from field reconnaissance: mangrove forest, estuary waters, rice fields, rice fields and semi-intensive fish ponds, new lands and rain forest. To try to increase the accuracy of the land cover classification, texture analysis and a hybrid approach were investigated. Based on preliminary, visual analysis of these two approaches, the texture analysis indicated to produce better results.

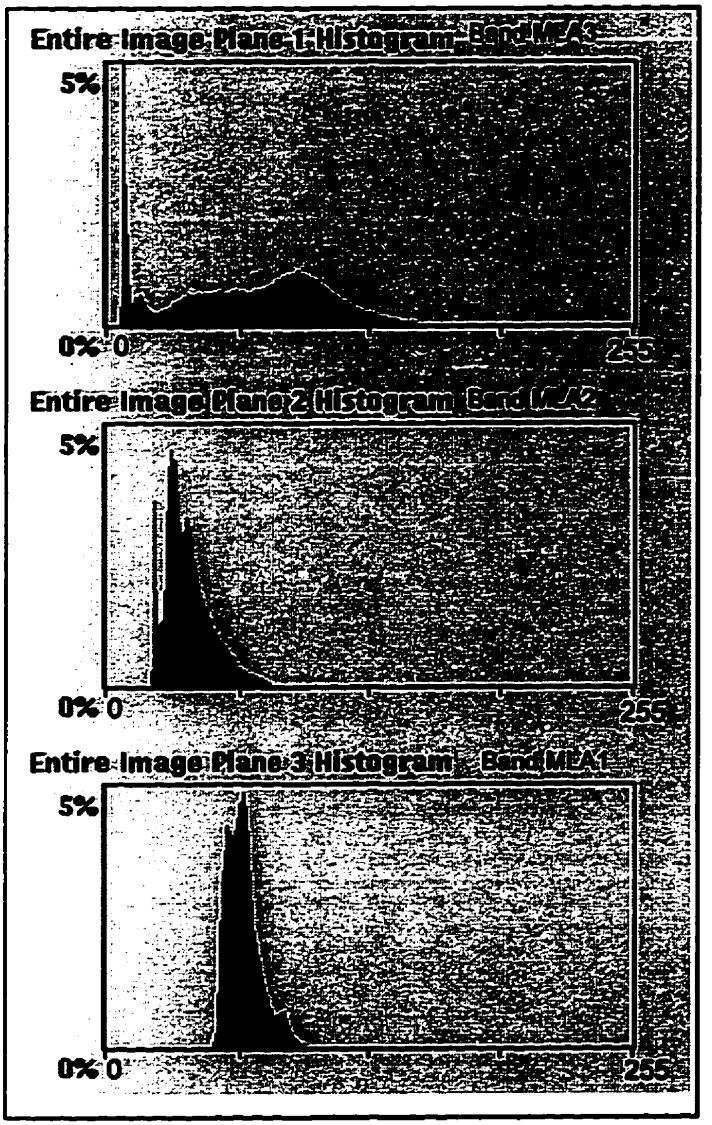

Figure 3.3: Histograms of SPOT 1995

It should be noted, however, that it was never the intent of this thesis to test or compare the utility of land cover classification procedures for this wetland environment. The reality of working with satellite data is that a large experimental component is involved. That is, although previous research provides valuable guidelines, the actual utility of a procedure will largely depend upon the characteristics of the study area, the nature of the data, and the feature of interest. It is in this context that remote sensing has been called both a science and an art (Lilesand and Kiefer 1987). A more detailed comparison of the classification procedures employed in this research will require additional research, and as such will remain for future papers.

Texture has been defined as the "spatial variation within a contiguous group of pixels which contribute to the overall appearance of the image", or more simply, the variation of tonal features (Marceau 1989, 20). Texture analysis was selected because of the differences in tones between the mangrove and rainforest class. The rainforest is located on the

limestone outcrops of Nusa Kambangan, and the variation in relief gives it a more "patchy" appearance than the mangroves.

For both the 1987 and the 1995 data, texture analysis was completed within PCI's X Pace module (Task: Radar TEX) [8]. A co-occurence matrix was produced based on an 11 x 11 pixel window (the largest available size in version 5.2 of Easi Pace), a one pixel distance, and an average of four directions. The homogeneity algorithm was selected through a trial-and-error process of the six texture algorithms available in X PACE and was used to generate texture images for each band based on the co-occurence matrix. A supervised land cover classification was rerun using the initial training sets, but using both the spectral and texture bands.

The result of the classification was an increase in discrimination between various classes in both the 1987 and the 1995 data, although misclassification did still occur. Accuracy of the 1987 land cover classification was checked on a qualitative basis because of the lag time between the date of the imagery and field reconnaissance. The main causes of error are the confusion between the mangroves and rainforest, and the new rice fields and new lands, mainly located amongst the mangrove forest. The overall accuracy of the 1995 SPOT land cover classification was 42.4 per cent, while the Kappa Coefficient[9] assessed the accuracy at 30.8 per cent. Table 3.3 is the confusion matrix used to generate the accuracy assessments. The main areas of confusion arose between the rice and fishpond class and rice class, and the rice and mangrove and rainforest and mangrove. The unclassified pixels

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[8]For this research, PCI's X Pace texture program (TEX) was employed (Version 5.2). TEX produces texture data using Haralick's texture measure which is based on the co-occurence matrix of tonal values. The co-occurence matrix measured the number of times a pair of brightness values occur at a specified separation number (e.g. 1, 2 or 3 pixels) in the image, in a specified direction and window size. Statistical measures of texture are then employed to extract texture information. TEX provides six measures: 1) homogeneity; 2) contrast; 3) mean; 4) standard deviation; 5) entropy; and 6) dissimilarity (PCI 1996).

[9] Accuracy assessments are based on confusion matrices which show the correspondence between ground samples ("truth") and the image data. Matches are presented in the diagonal of the matrix. Errors of omission (i.e., it has been omitted on the map) and commission (i.e., assignment of a "ground" class to the wrong class on the image) are indicated in the rest of the matrix. The Kappa Coefficient is suggested to be a more robust assessment statistical procedure because it takes into account all cells in the confusion matrix, incorporating chance agreement (Barber 1989). In doing so it "deflates the percentage

Table 3.3: Confusion Matrix of Accuracy Assessment of the 1995 SPOT Land Cover Classification

Reference Data/ Classified Data	mangrove	estuary	rice	rainforest	new lands	fishponds and rice	settle-ments	Total
mangrove	54	0	1	0	0	0	0	55
estuary	0	17	0	0	0	0	0	17
rice	39	0	69	0	1	1	32	142
rain forest	15	0	1	0	0	0	0	16
new lands	0	0	0	0	6	0	0	6
fishponds and rice	0	0	28	0	3	9	4	44
settlements	0	0	2	0	0	0	12	115
Total	189	23	115	0	10	12	71	420

also decreased the accuracy of the land cover image, particularly for the mangrove and rice classes. The high levels of confusion among these classes are associated with the high spectral similarities among some of the classes. As such, the accuracy obtained on the 1995 land cover classification is lower than the suggested minimum of 85 per cent for land cover classification in general (Jensen 1986).

3.5.4 Land Cover Change Analysis: 1968-1995

Land cover change analysis involved both post classification (1968-1987) and enhancement (1987-1995) change detection techniques. Post classification change analysis involved comparison of a 1968 Government of Indonesia topographic map with the 1987 land cover classification. The classified land cover image was imported into points and generated a root mean square (RMS) error of 0.91 metres along the X axis and 32 metres along the Y axis. An RMS error represents the amount of difference between the original and new coordinate locations. The registered map and image were digitally integrated using the GRID module of ARC/INFO to produce a land cover change map. To conduct analysis, the digitized topographic map (in vector format) was coded the same as the land cover image (i.e., the land cover classes were given the same value) and then transformed into raster format. The change map was produced with the RECLASS task which assigns the same code to matching pixels and the code of the topographic map to the pixels that do not match (i.e., they are different classes). The results of the change analysis will be discussed in Chapter 5.

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correct by the amount which could be expected to fall into the diagonal under an independent rule of joint probability" (Chrisman 1992 171).

It was not possible to assess statistically the accuracy of this change map because of the big difference between the dates of both the map and image, and the time of field work. Based on logical consistency of data (i.e., field checks completed in 1992, a 1989 air photograph, interviews, and a review of reports), a visual accuracy assessment of the change map is deemed a "good" representation. This means that the overall location, extent and nature of land cover changes on the 1968-1987 land cover change map are consistent with the support data. The main error in the change map is the classification of estuary to new lands, when they should have been classified as rice fields. This confusion arises from the 1987 land cover classification, and is likely associated with the similar spectral signatures of the rice fields and new lands, particularly if the rice fields are wet. The class representing a change from mangrove to rainforest was collapsed into the no change class. This was done because this change class was the result of classification error, as opposed to real change.

An enhanced land cover change detection procedure was employed for the multitemporal analysis of the 1987 and 1995 SPOT images. Prior to analysis, data preprocessing involved three steps: 1) geometric correction of the SPOT XS 1987 image to the topographic map (UTM); 2) image to image registration (RMS error of 0.55 of a pixel along the X axis and 0.55 of a pixel along the Y axis using a second order nearest neighbour algorithm based on 59 ground control points), and 3) conversion of digital numbers to reflectance values to compensate for differences in the sun angle and sensors (Messina 1996) (Equation 3.1). Atmospheric correction was not completed on either of the images because of the lack of environmental information (e.g., haze, atmospheric moisture) and dark objects in the images that could be used to normalize the images (Schott et al. 1988).

Principal component analysis (PCA) was used as the change detection technique. The principal component analysis (PCA) is a data reducing mathematical procedure which linearly combines the data into new principal components, which are orthogonal to each other. The first and second principal components generally contain 90-95 per cent of the

Equation 3.1: Conversion of Digital Numbers to Reflectance Values

Step 1: Conversion of DN to radiance values

$$L = QCAL/(A*GM) + B$$

Where:

L	=Spectral Radiance
QCAL	=Digital Number
(A*GM)	=Absolute calibration gain
B	=Absolute calibration offset

Step 2: Conversion of radiance values to reflectance values

$$\rho = \frac{\pi L * d}{ESUN * \cos\theta}$$

Where:

ρ	=Satellite planetary reflectance
L	=Spectral radiance at sensor aperture in mW cm^{-1} $ster^{-1}$ μm
d	=Earth-Sun distance in astronomical units
ESUN	=Mean Solar exoatmospheric irradiance in mW cm^{-1} μm
θ	=Solar zenith angle in degrees

information, which is associated with regional variances, such as atmospheric haze (Richards 1984; Fung and LeDrew 1987). The minor principal components are of interest to change studies. These components highlight localized variances, which are often related to change. The main assumption of PCA for change detection is that areas of no change are greater in area, than areas of change (Richards 1984; Fung and LeDrew 1987; Gong 1993). PCA was selected because: 1) it incorporates information from all bands (Gong 1993); 2) it may reduce effects of atmospheric differences in the principal components containing land cover change data (Bryne et al. 1980); and 3) it has been successfully employed in other land cover change analysis (Bryne et al. 1980; Richards 1984; Fung and LeDrew 1987; Fung 1988; Olive 1992; Gong 1993).

Six principal components were derived from the six SPOT XS bands. The first and second principal components accounted for 85 per cent of the information, principal component 3 (PC3) accounted for 8.9 per cent, and principal component 4 (PC4) 4.8 per cent (Table 3.4). Examination of the eigenvectors and eigenimages indicated that the fourth principal component (PC4) contained most of the land cover change information. The use of PC4 for change information is supported by other research (Byrne et al. 1980; Richards 1983; Fung and LeDrew 1987) (Figure 3.4).

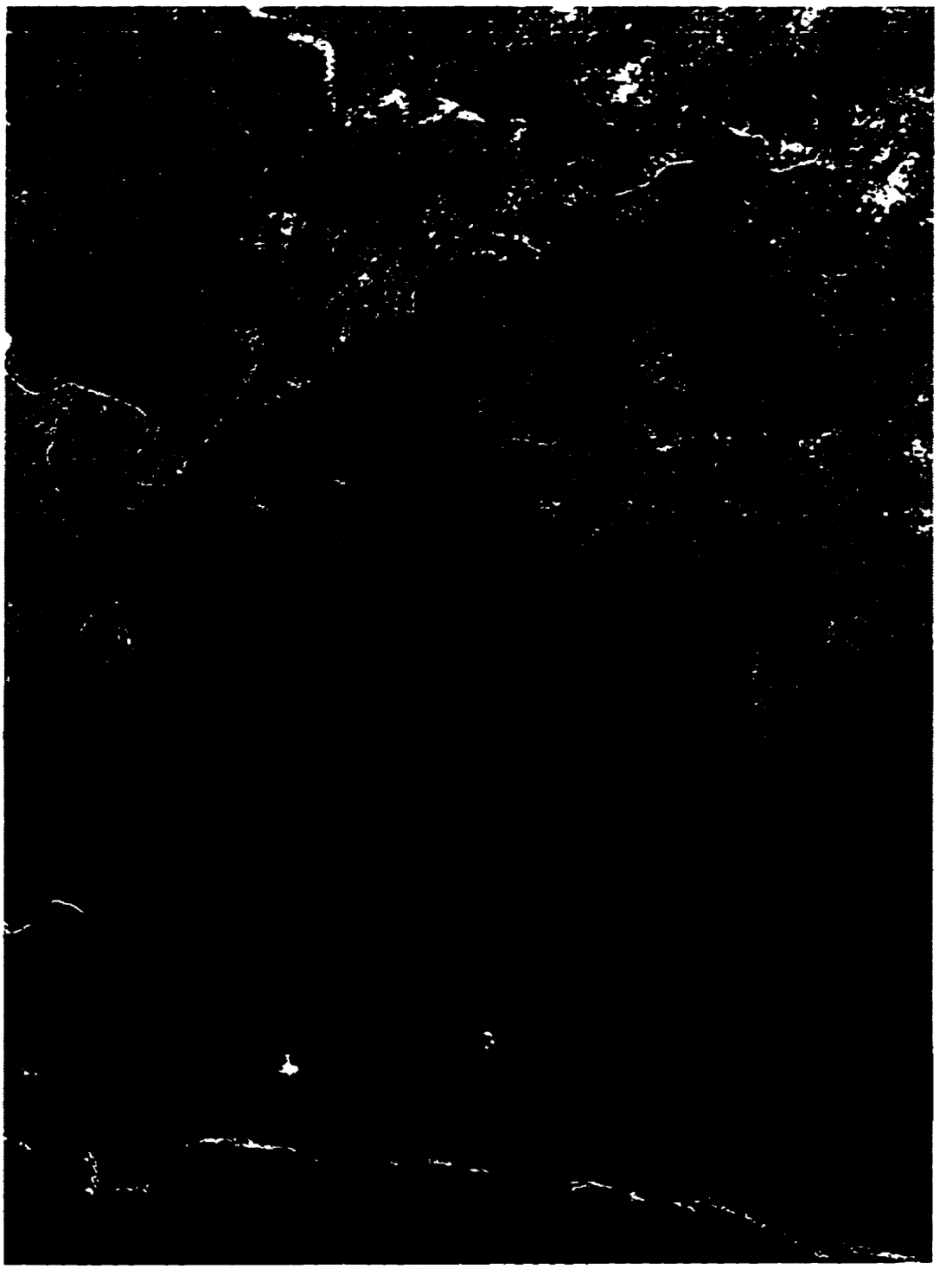

Figure 3.4: **Principle Component 4 of the merged SPOT 1987 and 1995 Data**

Table 3.4: Eigenvalue and Eigenvectors of Covariance Matrix SPOT XS 1987 and 1995 data

	Eigenvalue	MLA3 1995	MLA2 1995	MLA1 1995	MLA3 1987	MLA2 1987	MLA1 1987
PC1	576.4311	0.70485	0.10352	0.09670	0.61611	0.22307	0.23187
PC2	428.2333	0.62240	0.00924	-0.01274	-0.34484	-0.49704	-0.49639
PC3	104.7090	0.13199	0.55797	0.51457	-0.51776	0.29385	0.22813
PC4	56.2388	-0.31294	0.51555	0.37578	0.47966	-0.39497	-0.33014
PC5	3.9160	-0.00220	0.43399	-0.52280	0.01667	0.52190	-0.51543
PC6	1.1670	0.02098	0.47299	-0.55783	-0.05543	-0.43411	0.52262

In order to identify the nature of the land cover change types, the areas of change were classified using a supervised approach. The training sites were selected from field work. A maximum likelihood classifier was applied to all six spectral bands and PC4. Use of principal component information in the classification has been shown to increase the discrimination of change from non-change classes (Richards 1983). Based on 627 field checks conducted along routes throughout Kampung Laut, the accuracy of this change was assessed using a Kappa Coefficient program as eighty (80) per cent (Table 3.5) (Barber 1989). Errors of omission were the greatest source of error, and were mainly associated with rice encroachment. This mainly occurred because the actual land cover changed from new lands to newly cleared rice fields, both land cover types possessing similar reflectance values. This error was confirmed by field checks and the visual analysis of a 1991 Landsat TM image available during the 1994 field season.

Table 3.5: Correlation Matrix for the 1987-1995 Change Image

Field Checks / Image	Change	No Change	Total
Change	221	33	254
No Change	25	348	273
Total	246	381	627

3.5.5 Limitations of Satellite Data Analysis

The main limitations of the satellite data for regional land cover change analysis arose from: 1) seasonal differences between the images, 2) acquisition of the data after the field season and the inability to return to conduct additional field checks, and 3) the low land cover classification accuracy of the 1995 SPOT image. It was not possible to obtain anniversary dates of the SPOT data, introducing potential error from seasonal differences. The main reason was the limited availability of feasible images because of the high cloud content, which is typical of tropical coastal environments, as well as the frequency with which the area is imaged. Given that satellite data were being employed for regional land

cover change analysis, it was assumed that seasonal differences would not create too much confusion between the broader areas of change and nonchange.

Not being able to field check the 1995 image raises the possibility that additional land cover change may have occurred in the rice areas since 1994, for example the reversion of rice lands to mangrove. Field checking of a land cover classified 1991 Landsat TM image, group mapping, and walking transects, provided valid 1994 land cover data. This was used to assess the 1995 data visually, which indicated that significant additional changes had not occurred.

The low classification accuracy of the 1995 SPOT image was largely associated with the high spectral confusion among many of the cover types. This problem is characteristic of coastal wetland environments (Aitken and Borstad 1995; Spell et al. 1995). As the interface between terrestrial and marine systems, the complexity and underlying environmental factors, such as soil moisture and tides, have resulted in similar spectral signatures. This has created some difficulties in distinguishing among the various land cover signatures. While the inclusion of the texture data helped to increase the separation among some of the classes, it did increase the number of unclassified pixels. The highest incident of confusion occurred between the older mangrove communities and the rainforest. Blasco and Lanvenu (1985) noted similar problems when trying to distinguish between mangroves and other dense forest types using simulated SPOT data in Kenya. Other sources of confusion arose from the very similar nature of various land cover types, notably the semi-intensive fishponds, new lands, and newly cleared rice fields. The high water and soil content in each of these classes make them difficult to separate. Given the misclassification which occurred in the land cover classification, quantitative analysis, such as the aerial extent should be taken cautiously.

3.6 RAPID RURAL APPRAISAL (RRA)

Rapid rural appraisal (RRA) emerged in the 1970's largely in response to the dissatisfaction with results from rural development projects as well as the disillusionment with the data collection process (Chambers and Carruthers 1983; Chambers 1985; Somluckrat et al. 1987; Chambers 1992; Wickham 1993). Part of this dissatisfaction and

disillusionment arose from the lack of adequate and timely information to indicate the variability in rural conditions and needs. It was in this spirit that RRA was devised as:

> ...essentially a process of learning about rural conditions in an intensive, iterative and expeditious manner. It characteristically relies on small multidisciplinary teams that employ a range of methods, tools and techniques, specifically selected to enhance understanding of rural conditions, with particular emphasis on tapping the knowledge of local inhabitants and combining that knowledge with modern scientific expertise (Grandstaff et al. 1987, 6).

The menu of RRA data collection techniques, which were borrowed from various academic disciplines, aims to not only provide more flexible approaches to data collection, but also a new conceptual context for learning and development (Grandstaff et al 1987). Table 3.6 presents the core principles as well as a sample of data collection techniques of RRA. It is not intended to discuss each of the data collection methods used in RRA, as indicated in Table 3.6 there are many. For those interested in exploring more of these methods there are several useful sources to consult, including Kon Kaen University (1985) and Chambers (1993).

Participatory rural appraisal (PRA) emerged in the 1980's, building on RRA approaches. The main difference between RRA and PRA is the intent and process of data collection. RRA is predominantly **extractive** with the goal of producing an end **product** (e.g., solutions to rural problems) largely by outsiders. PRA, on the other hand, is promoted as a **process** of social learning aimed at **facilitating** and **empowering** local people to investigate and design their own development paths based on their own findings, values and interests (Chambers 1993; Wickham 1993)[10]. The use of PRA and RRA does not promote the replacement of well defined and implemented research.

Assessing the accuracy of data collected from RRA techniques is often based on qualitative measurements. Table 3.7 identifies twelve approaches to achieve "trustworthy" data, with special reference to RRA data collection techniques. These techniques involve cross-

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[10] For a more indepth discussion on the differences between RRA and PRA, consult Wickham (1993).

Table 3.6: RRA Core Principles & Selected List of Data Collection Techniques

Core Principles:	
• Interactive	• Exploratory
• Adaptive	• Participatory/Community based
• Learning by doing	• Iterative
• Interdisciplinary Approach and Team Work	• Incorporation of Local knowledge
• Informal	• Rapid and Progressive Learning
	• Innovative
Methods:	
• Activity sequence	• Semi-structured interviews
• Ad hoc local research	• Identifying & learning from key informants
• Aerial photographs	• Informal surveys
• Aerial inspection	• Labour schedules
• Calendars	• Local terms, folk taxonomy, sayings
• Combining insights of different disciplines	• Logic/decision trees
• Cross-sectional studies	• Group and individual mapping
• Direct observation, looking for and questioning the unusual	• Participant/direct observation
	• Rural people as investigators
• Existing data (reports, statistics)	• "Six helpers": who, when, what, where, how and why
• Family profiles	
• Group interviews with informal or select groups	• Systematic observation using key indicators
	• Crop management practices

Source: Grandstaff et al. (1987); Chambers (1992); Wickham (1993).

checking information from a variety of sources, consideration of the researcher's biases, and the utility of the data for development (i.e., does it make a difference?).

3.6.1 Application of RRA Techniques in Segara Anakan, Java

A variety of RRA data collection techniques was employed in this research to provide both spatial and descriptive data on land use/cover change, as well as to identify the key interactions among society, development and environment. The application of these techniques over a longer period of time was necessary to obtain the level of detail necessary for a more indepth research study. During this time a continual exchange and sharing of information with the local people occurred. As such, the approach in this study could be considered a hybrid of RRA and PRA, although on the whole, given the nature of the study and the tension rising over the ongoing changes, the process remained primarily extractive. The RRA data collection techniques employed in this research were: key informants; semi-structured interviews; group mapping; participant observation; and, a short survey (Figure 3.1).

Table 3.7: Methods to Achieve Trustworthy Data Using RRA Techniques

Prolonged and/or intense engagement of the various actors	• to build trust and rapport with the context--place and people--in which the study is being conducted
persistent and parallel observations	• Through observation, increased understanding can be obtained and realities encountered
triangulation of sources, methods and investigators	• Use multiple sources to verify the data collected
analysis and expression of difference	• Include a wide range of actors in the analysis to obtain a variety of perceptions and concerns
negative case analysis	• the process of sequential revision of hypothesis as more information and knowledge is obtained. This process is equated with the error variance used in quantitative analysis
peer checking	• periodic checks with peers not directly involved in the data collection process. This helps to expose biases of the researchers
participant checking	• test the data regarding interpretations and conclusions with the people who you derived the information from
reports with working hypothesis, contextual descriptions and visualizations	• using descriptions, including visuals and direct quotes to provide the context for the working hypothesis
parallel investigations and team communications	• using group meetings to bring together sub-groups to discuss and compare findings. Similar findings among the various groups provides greater verification
reflexive journals	• individual daily notes/diaries to record the thoughts and feelings of the researcher, which can help keep track of reasons for decisions made throughout the data collection process
inquiry audit	• Is conducted to confirm the findings of the data by people/workshop outside of the process (i.e., disinterested)
impact on stakeholders capacity to know and act.	• To show that the study results in some action and/or understanding

Source: Pretty (1994,43-45)

3.6.1.1 Key Informants

Key informants are people considered to have a broad scope of knowledge and insight into community issues (Beebe 1995). Key informants were identified from the semi-structured interviews, as either participants or identified by participants, and from observing and participating in daily life in the villages. Discussions occurred throughout the field season, and were used to identify main issues associated with land use change and to provide supplemental information where details were missing, incomplete or uncertain. The key informants included school teachers (5), NGO fieldworkers (3), government officials at the

subdistrict (5) and district levels (5) and male (10) and female (4) informal leaders in the villages, which also included RW and RT leaders[11].

3.6.1.2 Semi-structured Interviews

Semi-structured interviews are open-ended interviews guided by a checklist of data needs, but are also flexible enough to allow the exploration of new or unexpected information (Chambers 1992). Semi-structured interviews were conducted in Ujung Alang (65 interviews), Ujung Gagak (45 interviews) and Panikel (30 interviews)[12] (Appendix A). The interviews were conducted in participant's homes or the field by myself and Ani, and they lasted from thirty minutes to two hours. The interviews provided information on the local level activities of the fishing communities, the rice development process, and the emerging rice land uses.

The sampling strategy used to select respondents involved a purposive and random selection, but not in a strict statistical sense. The purposive aspects involved targeting certain groups and subgroups, in particular the fisherfolk, farmers and fishpond developers. The subgroups involved accessing people, mainly the fisherfolk, over a range of socio-economic levels. The various groups and subgroups were often located in "geographical clusters" within the villages, so the sampling strategy involved visiting these areas. The selection of the actual participants depended upon who was available at the time of our visit. The application of a more stricter random sampling procedure would have been difficult given the need to cover a range of geographical areas throughout the villages, as well as accessing people to interview while there. As such some caution must be exercised in inferring the results of the statistical tests to the entire population.

3.6.1.3 Group Mapping

Group mapping involves a group of local people mapping various physical and/or social aspects of the environment. This process provides a medium in which to obtain visual and

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[11] The number in the brackets indicates the number of informants.

[12] The participants of the semi-structured interviews for each of the villages included: Ujung Gagak: 27 male and 6 female fisherfolk, and 5 male and 4 female farmers; Ujung Alang: 33 male and 6 female fisherfolk, and 22 male and 3 female farmers; and Panikel: 10 male fisherfolk and 11 male and 1 female farmer.

spatial information from people about local resources, concerns and needs. As the name suggests, group or individual mapping involves having local people draw spatial representations of various themes, such as hunting grounds, animal migratory grounds, and land claims (Freeman 1976; Brody 1988; Forbes 1995; Flavelle 1995). Poole (1995) identifies various purposes for group mapping, such as gaining recognition of territorial rights, demarcation of traditional territories, gathering and guarding traditional knowledge, management of traditional lands and resources, and community awareness, mobilization, and conflict resolution. The mapping process provides an opportunity to "interview the map" by discussing various issues as they arise during map making (Chambers 1992).

The medium for drawing can vary, but it has been suggested that use of local materials such as chalk and the ground, may be less inhibiting (Chambers 1992). Other materials include existing maps, air photographs and blank sheets of paper.

For this research, group mapping was conducted at the subvillage level (*dusun*), and ten maps in all were completed for Kampung Laut (the digitized version of the nine group maps are included in Appendix B). A main contact person was located in each *dusun*, often the *Kepala Dusun* or an informal leader, to assist in organizing and conducting the group map meeting. In most of the *dusuns* there was some resistance to the idea of group mapping in that many of these people wanted to produce the maps themselves. After explaining the purpose of the group maps, which in some cases required time, patience and persistence, they were willing to assist, and organized a small group of people (5-10) (Figure 3.5).

Organizing the group mapping meetings was done simultaneously with the semi-structured interviews. This was beneficial in that it allowed for Ani and I to identify and invite local people, and to allow the local people to become more familiar with us before the group meeting. It was important to have a few people that would act as leaders and initiate the group mapping, but at the same time not dominate the meeting. It was found that a series of questions was useful to assist with the mapping process as well as obtain a level of information consistency among the ten group maps. The questions addressed rice land use issues, notably productivity, physical constraints, physical infrastructure, and land

Figure 3.5: Group Mapping Session in dusun Bugel, Panikel

status. Care was taken not to allow the questions to control the mapping process. Prior to the mapping meeting, a walking transect was conducted through the area to be mapped with the main contact person. This was done to gain more familiarity with the area.

The original plan was to produce the group maps on a basemap. This approach was not feasible because the rapid changes in the area resulted in the lack of a current and complete basemap. Instead, the group participants were asked to map on large sheets of blank white paper. While the maps all addressed the questions suggested above, they also brought forward issues of special concern to each of the areas, such as the need for dikes.

The group maps were not drawn to scale nor proportion, and in order to integrate them with other data, a scale was imposed on the maps. This was completed by manually transferring the mapped data onto a basemap at a scale of 1: 50 000. This basemap was produced by updating a map obtained from the district level government (1990; 1:50,000) with the 1995 SPOT XS image in ARC/INFO. The image was registered and rectified to

the map. RMS errors of 0.91m along the X axis and 32.3m along the Y axis were obtained with a second order cubic convolution transformation. Land boundaries, roads/dikes, and rivers were added to the map from the 1995 SPOT XS image by screen digitizing the data[13]. Data from the nine group maps were transferred onto this basemap in two steps. First, the group map data were manually drawn on the updated basemap (i.e., paper form). Second, this basemap was used as a guide to screen digitize the information in ARC/INFO. The boundary positions for the group map data, such as rice productivity, physical constraints, and land tenure, were drawn based on their relative proximity to landmarks (e.g., rivers and dikes). During the group mapping process, local people were asked to include stable landmarks that could be used to transfer the data onto a basemap. In some cases, approximate distances were also included. It was then possible to overlay the transferred group map data on the satellite land cover change data.

3.6.1.4 Short Survey

A short survey was conducted to collect data related to employment activities and the size of land holdings (Appendix C). The survey was conducted near the end of the field season when I had a better understanding of the key variables in the process of land use change. The survey was necessary because the village statistical data were old and much change had occurred since they had been collected in 1988. Three *dusuns* were selected, one from each village. These *dusuns*, Motehan, Karang Anyar and Mara Dua, were selected because they were still dominated by fisherfolk, and a better understanding of how many fisherfolk were involved in agriculture and how many were still dependent on fishing was desired. The surveys were conducted by three local people in each *dusun* (150 surveys in each *dusun)*. The sampling procedure involved a similar process as the semi-structure interviews. The local people hired to conduct the survey were assigned various sections of the village, so there would be no duplications, and interviewed on a basis of who was at home during the time. One of the three people hired in each of the villages had assisted

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[13]Screen digitizing is a data capture process available in ARC/INFO GIS. Basically, it involves digitizing information from the screen, as opposed to a digitizing tablet. In this research, the SPOT image was used as a backdrop on the screen, and paths and boundaries were digitized (i.e., electronically traced) from the image.

with the semi-structured interviews, so were able to inform the other two which fisherfolk had already been interviewed.

Chi square tests were conducted on the survey and semi-structured interview data to indicate if the differences that occurred among the villages were statistically significant at the 95 per cent confidence level. Only frequencies are shown with the questions that involved the respondents selecting one or more categories, such as secondary employment. Since these data are not independent, statistical tests are not applicable (Harvey, 1997). The results are shown in each of the appropriate tables. The Chi square test is used with nominal and nonparametric data. It tests if there is a significant difference between the observed and expected values of the sample data (e.g., the short survey data). That is, if the differences in the data reflect a real difference in the population, or is more an element of chance. A restriction of the test, for three or more samples, is that no more than 1/5 of the expected frequencies should be less than the critical value of 5, and none should be less than 1 (Edbon 1977). In the statistical analysis of the survey and semi-structure interview data, a problem was encountered with the low number of frequencies in some of the categories. As suggested by statistical literature (Edbon 1977), several classes were collapsed into one to increase the number of frequencies in each cell. In several cases, it was not possible to collapse the data without losing information. In some of these cases, a certain percentage of the cells was lower than the critical value of 5, and as such the Chi Square test may not be valid. The data are still useful in indicating that there is a **possible** difference, **but it is not possible to state if there is a statistical significance difference among the classes being examined** (e.g., employment types in the each of the villages). Again, caution must be exercised when interpreting the data, although they still provide valuable information on various aspects of land use change, giving indication of the types of responses and the frequencies in which they occurred in each of the villages.

3.6.1.5 Participant Observation

Participant observation is an approach that employs observation and participation, in varying degrees, in everyday life situations and settings to provide insight into activities from the viewpoint of a member of the group being studied (Jorgensen 1989, 10). Living in the fishing communities provided insight into everyday activities, the impacts of

sedimentation on the fisherfolk, and the process of rice development. Living in the villages also provided a stronger liaison with members of the communities, generally through informal contacts and discussions, and participation in communities events (e.g., circumcision parties, Catholic church meeting, and the annual offerings to the sea ceremony by the fisherfolk). Living in the villages also helped the researcher to experience and better understand some of the constraints of living in Kampung Laut, such as the isolation and lack of fresh water.

3.6.2 Issues and Limitations of RRA Data Collection Techniques

The group maps, as with all maps, are abstracts of reality based on perceptions, experience and knowledge of the map makers (Gould and White 1974). Differences of experiences and knowledge between some of the fishermen and farmers was highlighted during one group mapping session which consisted only of fishermen. The fishermen could all draw the rivers with much detail, but they lacked knowledge about land issues. This information had to be filled in later by farmers during the semi-structured interviews. The participants in the group mapping sessions were key, both in terms of knowledge, but also willingness and comfort with the mapping process. It should be noted that women were not active participants in the group mapping sessions, although it was requested by me to invite them.

Accuracy assessment of the group maps is based on a qualitative approach, comparing the information from the various themes with that obtained from the semi-structured interviews. Accuracy among the group maps must surely vary, but it is difficult to ascertain to what degree. Cross checking data from the consensus of the mapping group, walking transects, semi-structured interviews and key informants, indicated that the maps, overall, showed greater homogeneity than was indicated during the interviews, particularly in reference to rice productivity. That is, the maps indicate the general trends and variations from place to place, but within these areas there are some variation.

3.7 COLLECTION OF EXISTING DATA

The collection of existing data generally provides a means to obtain a range of other perspectives of land use activities. Existing data for Segara Anakan were collected from several sources, notably village, subdistrict and district level government offices,

consultants, and universities (Figure 3.1). The collection process mainly involved visiting government and consultants offices, and university faculty and libraries. The existing data included government statistics, development plans or proposals, historical topographic maps, and consultants reports, which are mainly associated with development proposals. The long standing interest in Segara Anakan has resulted in a plethora of consultants reports, by both domestic and foreign agencies. These reports, somewhat dated now (1980-1989), provided little information on the development of rice agriculture. Existing data were employed to support and supplement both the regional satellite land cover change analysis and the RRA data on local level activities. Statistical data were collected at the village offices regarding employment, land tenure, and immigration.

3.7.1 Limitations of Existing Data

The main limitation of the existing data was the incomplete nature of the statistical data associated with immigration and land ownership. To obtain data on immigration levels, it was necessary to visit every *Rukun Tetangga* (*dusun* subdivision) to collect the list of names and to identify the number of immigrants. It was not possible to collect statistical data on land ownership. The semi-structured interviews and short surveys did provide an indication of ownership trends, but certain groups, such as outside land owners, were not included.

3.8 GEOGRAPHIC INFORMATION SYSTEMS

In simple terms, a geographic information system (GIS) is a computer environment in which spatial and attribute data are entered, manipulated, analyzed and outputted (Burrough 1986). It is best thought of as a tool to assist in supplying information for decision-making and management purposes (Aronoff 1989; Taylor 1994). As a spatially-based information system, GIS has great value to land use/cover studies. A main asset is the ability to integrate and analyze spatial and attribute data from various sources, which often have different scales and projections.

3.8.1 Application of GIS in Segara Anakan, Java

GIS was used in this research for two main purposes (Figure 3.1): first, to facilitate land cover change through the digital comparison of the 1968 topographic map and SPOT XS 1987 image, and second, to map various environmental aspects of land use activities,

mainly rice agriculture. This was mainly achieved through the aggregation of data from the nine group maps. ARC/INFO was selected as the GIS for this research for several reasons, the main being the technical support available within the Faculty of Environmental Studies, University of Waterloo. Furthermore, ARC/INFO is a popular and powerful GIS that is currently available throughout the world, including Indonesia. ARC/INFO also possesses a GRID module that supports the integration of raster data (e.g., satellite data) with vector data (e.g., traditional map data).

3.8.2 Issues Of Data Integration: Remote Sensing, Rapid Rural Appraisal And Existing Data In A GIS

> ...the synthesis [integration] of geographic information in a computer system which depends for its effectiveness on information linkages (i.e. of spatial and attribute data) within a coherent data mode. This involves bringing together diverse information from a variety of sources (information exchange), requires the effective matching of supposedly similar entities in these sources, and demands information consistency across the source data sets (Shepard 1991, 338).

Bringing data together from various sources into a common database is not often a straightforward process, as certain conditions must be met. This is particularly the case in the highly structured computer environment such as a GIS. When these conditions are not met, the data are said to be inconsistent. It has been suggested that data inconsistency is usually the main barrier to an integrated database and GIS analysis, not data availability (Shepard 1991), although this was not the case in Segara Anakan. The more common forms of data inconsistency, all of which were encountered with data in this research, are: data structure, spatial scale, temporal scale, and geometric referencing and projection. Each will be discussed below in general terms and then more specifically in terms of how they relate to this research. Table 3.8. provides a summary of these data integration issues. The actual application of GIS in this research has been discussed in earlier sections, particularly the combining of the group maps, and as such, they will not be discussed here.

3.8.2.1 Data structure

In a GIS, raster and vector are the main data structures (Burroughs 1986; Aronoff 1989). Map data are generally stored in a vector format (i.e., lines, points and polygons), while satellite data are in raster format (i.e., grid). Earlier GIS packages supported either raster or

Table 3.8: Summary of Data Integration Issues in a GIS

GIS & Data Integration	Maps	Remotely Sensed Data	Rapid Rural Appraisal
Data Structure	• maps (vector) • statistics (tabular)	• images (raster) • requires raster capabilities to store & analyze without loss of resolution or radiometric precision	• maps (vector) • statistics (tabular) • qualitative data (written)
Scale	• generally have projection & scale, but not always clearly or completely stated	• no established projection, but can be relatively easily geo-referenced • reflectance variations due to seasonal and/or atmospheric changes • spatial, spectral, radiometric differences between sensors	• no projection or scale • information reliability may vary amongst mapping groups • may be drawn on basemaps, blank sheets of paper, or the ground
Geometric Referencing and Projection	• set geometric coordinate system and projection, but it is not always stated clearly and complete stated on the map	• no "built in" geometric coordinate system or projection, but can be referenced to an existing system with relative ease and speed.	• has referencing and projection if use a referenced basemap for mapping • if do not use a referenced base map, need to be able to transfer the data to a referenced map
Spatial Scale	• varies from large to small scale	• varies with sensor • regional to global emphasis (medium to small scale)	• local emphasis (i.e., large scale maps)
Temporal Scale	• varies depending upon the agency needs, & financial and human resource constraints	• varies with sensor parameters • varies with the financial ability to purchase image, and availability of cloud free images	• flexible, depending on the RRA team members
Accuracy	• varies with the map	• high positional accuracy • statistical analysis based on ground truthing data	• dependent on researchers and approach • positional accuracy of maps may be very low; possibility of GPS to increase positional accuracy

vector data structures. This barrier has largely been overcome with the enhanced capability of some GIS packages which now support both data structures. For example, ARC/INFO,

which was initially a vector-based package, has developed the GRID module which facilitates analysis with raster data.

To facilitate land cover change analysis from 1969 to 1987, the map data were transformed from vector to a raster (grid) format. The map was then digitally integrated with the satellite data in the GRID module of ARC/INFO.

3.8.2.2 Spatial Scale

Data integration requires that the scale be common for all sources. The scale of satellite data is discussed in terms of spatial resolution--the fineness of the spatial detail visible in an image--which is represented by pixel size (Campbell 1987 224). SPOT XS has a 20 metre pixel size, suggested to be suitable for mapping at a 1: 50 000 scale (Welsh 1985). The SPOT XS and topographic map had similar scales, making digital comparisons relatively simple. Inconsistencies associated with differing spatial scales can be handled in a GIS by transforming the data to a common scale. The data to be transformed are registered and then rectified to the data with the desired scale. In the remote sensing literature, this process is called resampling.

It was necessary to transform the group maps to a common scale in order to compare and overlay them with the satellite land cover change data. To do this, all ten of the group maps were transferred onto a common 1: 50 000 scale basemap. The details of this procedure were discussed earlier in the group mapping sections (section 3.5.3.3).

Of interest is the combination of the local perspective derived from the RRA techniques and regional perspective of the satellite data. To provide more indepth spatial analysis of the land cover changes identified by the satellite analysis, a trade off was necessary in terms of indepth local analysis in one area (e.g., detailed household analysis) and land use data complementary to the regional perspective. This presented challenges for a "one-person" research team in terms of collecting sufficient data at each scale. As such, the RRA techniques, while employing individual interviews, was mainly used to obtain information about the patterns and processes of land use change at the village level. While this scale

issue in not considered a disadvantage in this research, it is an issue that requires additional attention.

3.8.3.3 Temporal Scale

Temporal scale refers to the dates of the data sources. It is not always possible to obtain data from the same time period, and resolving this inconsistency, if at all possible, would require additional information from field work or existing sources. The temporal scale of satellite data and existing maps are rigid, based on a schedule that is external to the user (i.e., the preprogrammed sensor and agency mapping schedule). RRA, on the other hand, has more temporal flexibility, based largely on scheduling of the team members and community activities.

The main implication of different temporal scales is the inability to field check the 1968 and 1987 land cover and land cover change data. Another issue which arose was the year difference between the field work and the acquisition of the 1995 SPOT image. This inconsistency cannot be rectified, but has been taken into careful consideration in data interpretation and analysis.

3.8.7.4 Geometric Referencing

Geometric referencing involves projecting spatial data to a known world coordinate system, such as UTM. This permits locations on the spatial data to be registered to the corresponding ground location. Most map data are presented in a geometric reference system, although difficulties can arise when this information is not presented with the map. In order to integrate the data into one database, the maps and images are required to have the same geometric referencing system. Geometric correction[14] is a common task available in most GIS and remote sensing packages. The process involves "tying" the unreferenced data to referenced data, usually a map, by selecting ground control points (Jensen 1981; Campbell 1987). As indicated earlier, geometric referencing was completed in both PCI Easi Pace (GCP program) and ARC/INFO (registration and rectification tasks).

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[14] GIS and remote sensing literature have often employed different terminology for what is essentially the same process. For example, related to geometric referencing, remote sensors call it geometric correction, while in GIS, the process is referred to as transformation or projecting.

Overall, data integration in ARC/INFO was completed with both relative ease and difficulty depending on the data set. Integration of the topographic map with the satellite land cover image presented minimal difficulties. Advancements in remote sensing/GIS integration proved a viable avenue, particularly with the support for raster data structure within ARC/INFO. The classified images were exported from Easi Pace in ERDAS format and directly imported into ARC/INFO.

There is substantial literature on the application of each of the data collection techniques for land cover/use change studies. Only very recently has there been literature which deals with the integration of remote sensing, rapid rural appraisal and existing data in a GIS environment (Brehens 1994; Brondizio et al. 1994; Tabor and Hutchnison 1994; Poole 1995:). The combination of advances in geomatic technology, decreasing costs of computer hardware and software, and the improving social, political and cultural climate for preserving traditional knowledge, are providing exciting opportunities for participatory and pluralistic planning approaches, by providing new ways to bring people and information together in a meaningful way. For example, the winter 1995 issue of *Cultural Survival Quarterly* is devoted to the issue of community development, indigenous rights and geomatic technology. Moreover, Poole (1995) provides a valuable inventory of community development and mapping projects employing various RRA and geomatic techniques. These particular studies employ land use/cover change analysis, and are aimed at providing a more comprehensive approach to land use change analysis. That is, examining the interactions among land use/cover change, society, environment and development. It should be noted that these literature sources were published after I had completed my field work. As such, there were no guidelines available from other research, and the integration was largely an experimental process.

The greatest difficulty was the integration of the group mapping data into the GIS database. The challenge was based largely on the inconsistencies of the data in comparison to the stricter requirements of both remote sensing and GIS analysis. The inconsistencies in the data, notably scale and proportion, were largely overcome by combining the data into a common basemap. While data integration was possible, uncertain accuracy of the boundary locations on the group mapped data decreases its utility for quantitative analysis (e.g.,

measurement of areas). **As such, the group mapped data should be viewed as providing a qualitative assessment of trends and patterns in land use change.**

3.8.7.5 Accuracy

Accuracy refers to the "closeness of an observation to a true value (or one accepted as true)" (Chrisman 1991, 166). Accuracy of spatial data is associated with both positional and attribute aspects, defined as a distance or percentage value respectively, indicating how well the map data corresponded with the "true" data of the same location. Accuracy of satellite data is assessed through statistical analysis conducted by matching the image data, such as a land cover class, with the ground truthing data (i.e., field checks). It is recommended that satellite derived land cover classification have a minimum accuracy of eighty per cent (Jensen 1986). The accuracy of the satellite land cover change data (1987-1995) was eighty per cent using the Kappa Coefficient. The accuracy of the 1995 land cover classification was lower at 30 per cent using a Kappa Coefficient.

Accuracy assessment of RRA data, or its trustworthiness, has mainly been subjective using techniques of triangulation, discussions with peers at the University of Gadjah Mada and a discussion with another field team investigating broader development issues in the area. A quantitative accuracy of the group maps (i.e., statistical value) is difficult to ascertain because ground checking was not involved. Instead, triangulation of several sources was used to assess the maps.

3.9 SUMMARY

Data collection techniques of remote sensing, rapid rural appraisal, and existing data collection were employed to collect data for land use change analysis. Analysis of multitemporal satellite data identified and quantified the location, distribution, extent and nature of land cover change at the regional level. Rapid rural appraisal data collection techniques of semi-structured interviews, group mapping, short survey, and participant observation were used to provide qualitative data on rice-related land use aspects, and the main actors and their adaptive strategies associated with rice development. Existing data were collected from various district level government offices and consulting firms to support and supplement data collected in the field. A geographical information system

(GIS) was employed to integrate spatial data from various sources, notably remotely sensed land cover and land cover change analysis and the group maps. Data integration required consistent data, which required transforming the data structure, scale, projection and geometric referencing, and was the greatest challenge for the group maps.

Chapter 4
THE ENVIRONMENT OF SEGARA ANAKAN, JAVA

4.1 INTRODUCTION

The purpose of this chapter is to provide a general overview of the environment of Segara Anakan, including a national, regional and local context. The first section provides a general overview of the government administrative structure and development process in Indonesia. A discussion of the Javanese village is presented to provide a historical account of the role and position of the village in the government administration as well as the national development process. A regional context is provided by outlining land use change on Java, focusing on rice agriculture and semi-intensive fishponds. The general characteristics of the study area are then provided.

4.2 GOVERNMENT AND DEVELOPMENT IN INDONESIA: AN OVERVIEW

Indonesia is an archipelago country of approximately 13,667 islands spread over 5,000 km from east to west (see Figure 1.1 for regional and study area map). The islands are populated by approximately 187 million people, comprised of over 400 ethnic groups (Marshall 1993; World Bank 1992). Geertz (1963) characterized the islands of Indonesia as inner and outer. The inner islands, consisting of Java, Madura and Bali, are distinguished by a high population density and wet rice agriculture (*sawah*). The outer islands, which include the remainder, are portrayed by less dense populations and a swidden, or slash and burn agriculture. As part of the region of Southeast Asia, the strategic location (i.e., between India and China) and tropical monsoon environment of Indonesia have given rise to a diverse human ecological history, involving contact with Hindu, Buddhist and Islamic religions, over 350 years of colonialization by the Dutch, British and Japanese, and the gaining of independence and the formation of a Republic in 1945 (Shlossstein 1991).

In 1967 the New Order Government of Indonesia came to power under the leadership of President Suharto. This government was faced with the monumental task of governing this diverse and fragmented country, particularly in times of increasing regional tensions and a

failing economy (Marshall 1993). National development was based on the trilogy (*pembangunan trilogi*) of security, economic growth and social equity, legitimized by the national ideology of Pancasila, as outlined in Table 4.1 (Marshall 1993). The approach taken by the New Order Government has been described as "soft authoritarianism" in that in this military backed government, a small core of bureaucratic and technocratic elite control the decision-making process, including the use and allocation of resources.

4.2.1 The Administrative Structure of the Government of Indonesia

To pursue the government goals set out in the development trilogy, a hierarchical, five-tier structure was established consisting of the *nasional* (national or central), *propinsi* (provincial), *kabupaten* (district), *kecematan* (subdistrict), and *desa* (village) levels (Figure 4.1). The roles and responsibilities of each level is established by the Basic Law No. 5, 1974 (*Udang-udang No. 5, 1974*), and is based on principles of decentralization and deconcentration. Decentralization involves the transfer of authority for certain government activities from the central to the local levels[15] (Morfit 1986; Zainun 1987). Deconcentration, occurs alongside decentralization, and involves the establishment of central level agencies at the lower levels to administer their policies and programs (Zainun 1987). The structure and allocation of government authority was largely based on the Javanese concept of power, which views authority as emanating outwards from one centre. Those in closest proximity to the centre have a share in the power (Anderson 1974; Marshall 1993). The relationship between the centre and periphery has been described as client-patron or *Bapak-anak* (father-child), whereby the patron,

Table 4.1: Five Principles of Pancasila

1) belief in one supreme being
2) a just and civilized humanitarianism;
3) a commitment to the unity of Indonesia;
4) people led and governed by wise policies arrived at through a process of consultation and consensus
5) social justice for all the Indonesian people

Source: Morfit (1986a, 43-44).

[15] In the literature concerning the government administration in Indonesia, provincial, district, subdistrict and village levels are generally referred to as the local level (MacAndrews 1986; Morfit 1986; Devas 1989; Warren 1993). The term local level has been used throughout this research mainly in reference to the village level. For the sake of clarity the term local level used in the context of the government administration is used for the provincial and levels below. In discussions of the study area, local level refers to village level.

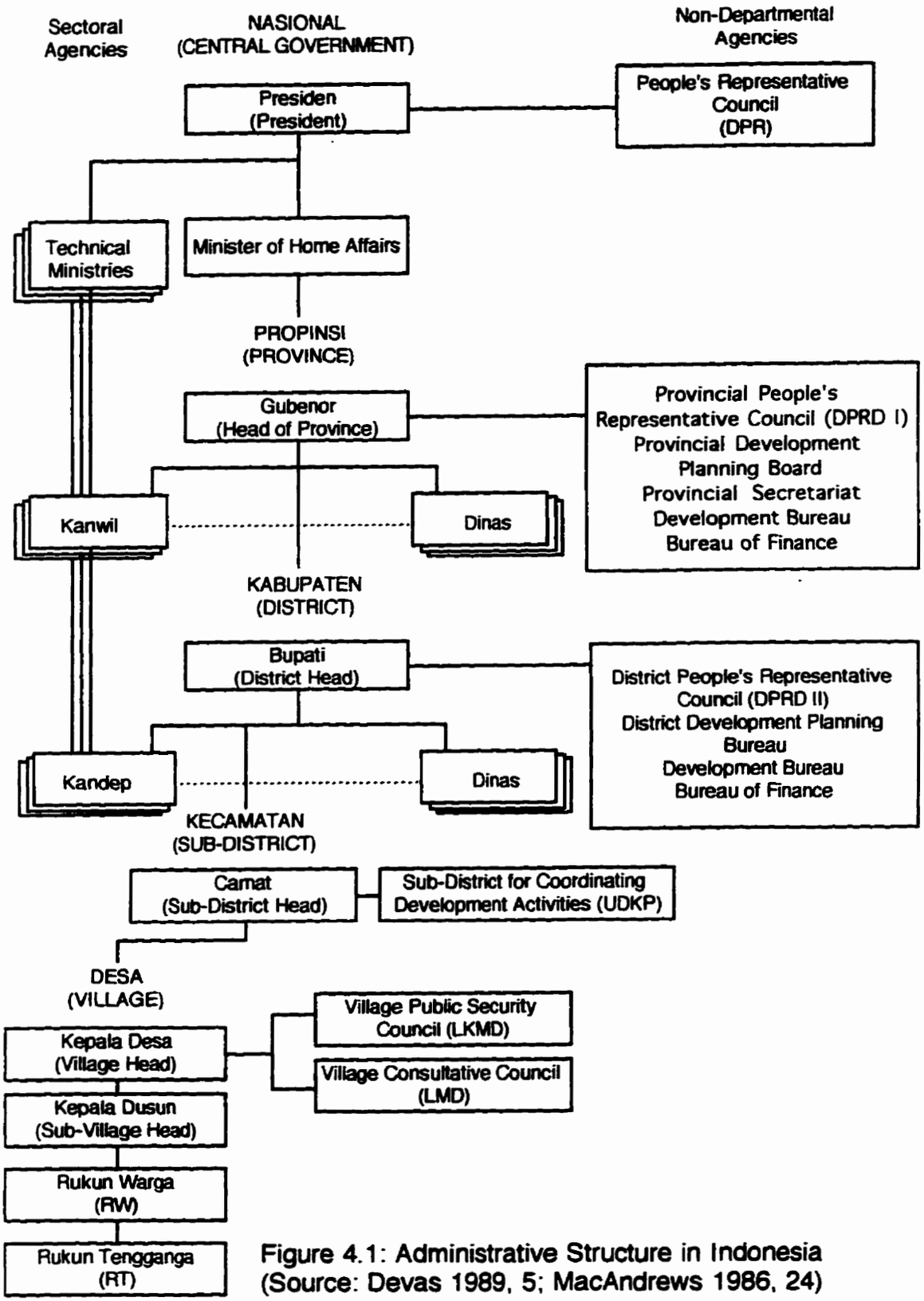

Figure 4.1: Administrative Structure in Indonesia (Source: Devas 1989, 5; MacAndrews 1986, 24)

in return for obedience and loyalty, provides the necessary conditions and services to the client (Marshall 1993).

In the hierarchical administrative structure, each level has a similar structure with a main leader, who acts as a singular authority over government, development and community activities, and supporting sectoral agencies (Zainun 1987). The central level is led by the President and the People's Consultative Assembly (*Majelis Permusyawaraton Rakyat* or MPR). The provincial, district and subdistrict government levels are administered under the Ministry of Home Affairs. The provincial head, or governor, is appointed by the President, with recommendations from the provincial-level People's Representative Council (DPRD Tk. I). Appointment of the District Head (*Bupati*), is by the Minister of Home Affairs, with recommendations on a short list of potential candidates by the People's Representative Council at the district level (DPRD Tk II) (Marshall 1993). The *Bupati* appoints the sub-district head (*Camat*), and in conjunction with the *Camat*, oversees the election of the Village Head (*Kepala Desa*) (McAndrews 1986).

At the provincial, district and sub-district levels, advisory, coordinating, and supporting agencies assist the leader, but they have no overriding authority (Figure 4.1). The Development Planning Boards (*Bappeda*) present at the provincial and district levels were established to act as a coordinating agency for all sectoral activities. The sectoral agencies (*i.e., Dinas)* (e.g., agriculture, fisheries, tourism, public works) also operate at the provincial and district levels, and are funded by and report directly to the Governor and the District Head (*Bupati*), respectively (Morfit 1986). Central level sectoral agencies, *Kanwil* and *Kandep*, through the principle of deconcentration, also operate at the provincial and district levels, but they differ from *Dinas* agencies in that they directly represent, are funded by, and implement programs designated from their corresponding central level offices (Zainun 1987). Only *Dinas* offices and a unit for coordinating development activities (*Unit Daerah Kerja Pembangunan* or *UDKP*) are active at the subdistrict level (McAndrews 1986).

The village forms the lowest level of the administrative structure, acting as the liaison between the communities and supravillage government. The village structure is based on the 1979

Village Government Law (*Udang-udang Republik Indonesia No. 5 Tahun 1979 tentang Pemerintahan Desa*-UU5/1979) which formalized a uniform administrative structure for all villages throughout Indonesia (MacAndrews 1986). The village administrative structure resembles that of the national level of government, and works as a line of command with each level reporting to its superior. The top position is held by the village headman (*Kepala Desa*), who is not a formal government official (i.e., not paid a salary). The *Kepala Desa*, under direct supervision of the *Camat*, acts as the main liaison between the supravillage government structure and the people. As an elected position[16], the main duties performed are to: keep law and order, settle disputes, collect taxes, head the village development councils, and ensure that government policies and programs are implemented (Zainun 1987; Soetrisno 1993). Second in line to the *Kepala Desa* is the village secretary (*carik*), who may assume leadership in the absence of the *Kepala Desa* (Soemardjan and Breazeale 1993). The main role of the village secretary is to maintain all of the statistical village data required for village reports (e.g., *desa monografie*). Under the village secretary is a series of administrative positions, including: religious officer, water manager, village agricultural extension officer, village heralds, *dusun* head, and village police. The main role of these staff members is to assist the *Kepala Desa* to implement and monitor village development programs. While the term of the *Kepala Desa* is limited to five years (maximum of two terms), the time limit of the other administrative positions is based mainly on the ability of the person to perform their job in a satisfactory manner (Tjondronegoro 1984). Village elders also play a prominent role in village level activities, often in an advisory position to the *Kepala Desa*.

The village structure is divided into increasingly smaller units of *dusun*, *rukun warga* (RW) and *rukun tetangga* (RT) (Figure 4.1). The *dusun* is comprised of several RW's, which is comprised of at least two RT's, and the average size of an RT is twenty to thirty families (Sullivan 1992). While all of these levels have a leader who reports to the level above, they are

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[16] The election process for the *Kepala Desa* is done in three stages: 1) Selection stage where all interested village members sit for a written exam at the Kabupaten, and prepare a short written paper on his/her plan if he/she is elected; 2) Campaign period where all participants who passed the written exam campaign for votes in the village (about one month in duration); and 3) Election, where village members cast votes for the candidates (Soetrisno 1993, 45). This process to become a *Kepala Desa* has hidden election costs which can range from thousands to one million rupiah. Consult Soetrisno (1993) for a good description of this election process in a Java.

not officially recognized as part of the administrative structure. The term *rukun* is derived from Javanese and is suggested to imply a sense of community interaction, harmony and collective action, generally among family and close neighbours (Marshall 1993).

Two village councils, *Lembaga Ketahanan Masyarakat Desa* (LKMD) (the Village Public Security Council) and *Lembaga Musyawarah Desa* (LMD) (the Village Consultative Council) were established at the village level to facilitate development. The main roles involve planning development activities, mobilizing community initiative to integrate government development efforts within the community and to encourage community dynamism, and to improve village resilience (Zainun 1987, 111). The role of the village council (LMD) is to convey the wishes of the village public to the village staff (Soemardjan and Breazeale 1993). As established by the Village Law No. 5 1979, both of these councils are directed by the *Kepala Desa*, who with the guidance of the *Camat*, selects its council members (Warren 1993). It has been suggested that this arrangement often impedes the utility of these councils as the *Kepala Desa* will only select members who would support him (Soemardjan and Breazeale 1993; Soetrisno 1993; Warren 1993).

Village autonomy is established in the Law No. 5 of 1979, stipulating that the village councils have autonomy as long as their actions are not "contrary to political, social, cultural, economic and security policies of the state and to the interests of the country as a whole" (Zainun 1987, 108). Matters within the limits of village autonomy deal with general village interests and village financial matters, but these activities must be approved by the *Bupati* (Zainun 1987). At the village level, internal revenue is obtained from land taxes, community contributions, self help activities and income from village endeavors. External sources of village revenue include central and provincial subsidies (e.g., Presidential Instructions), and a portion of the regional government tax (Zainun 1987, 109). It is suggested that the limited ability to raise development funds has resulted in a high dependency on funding from the central level (Devas 1989).

In the administrative structure of the local government, including the village, the heads of each of the levels face both upwards and downwards. That is, they are subordinate and report directly to the head of the level above, as well as having the authority to manage the affairs at

their own level, as long as their activities are in accordance with national interests (Morfit 1986; Devas 1989). Marshall (1993, 226) suggests that the structure of the local level government is best viewed in terms of the "overriding goals of national political integration and political stability. At the governmental level, integration means control by the central government...political stability was equated with centralization and instability with decentralization". Through this central control, the national level has obtained complete authority over local resources, from which it extracts surplus to move to less endowed areas. Thus, in reality the lower levels of government have little authority over resources and development, either through direct authority or financial means (Morfit 1986; Zainum 1987; Marshall 1993). Although the local levels, including the villages, have benefited from central level activities, it is suggested that the central level's main priority is towards national unity and stability, and the protection of current institutional structures, which entails keeping the main role of local government as a facilitator and endorser of central level policies and programs (Morfit 1986; Devas 1989; Sullivan 1992; Soetrisno 1993; Warren 1993).

4.2.2 The Development Process

The development process in Indonesia is structured as a bottom up-top down approach. The bottom-up component was established by a Ministerial Instruction from the Ministry of Home Affairs in 1981, and is based on the role of the village security council (LKMD) in village level development (Morfit 1986). The development proposal process starts at the bottom level in March with village development council meetings, overseen by the *Camat* (Figure 4.2). Village development proposals are then submitted to the sub-district level, where meetings by the sub-district level development council, overseen by the *Bupati*, are held to establish subdistrict development priorities. Subdistrict level development proposals are then submitted to the district level, where the same planning process occurs, overseen by the Governor. By November, this bottom-up process has filtered up to the central level, where the final selection process occurs. The selected development plans are handed back to the provincial level agencies to coordinate and oversee, with the assistance of the *Dinas* and *Kanwil* agencies at the provincial, district and subdistrict levels (Wickham 1993).

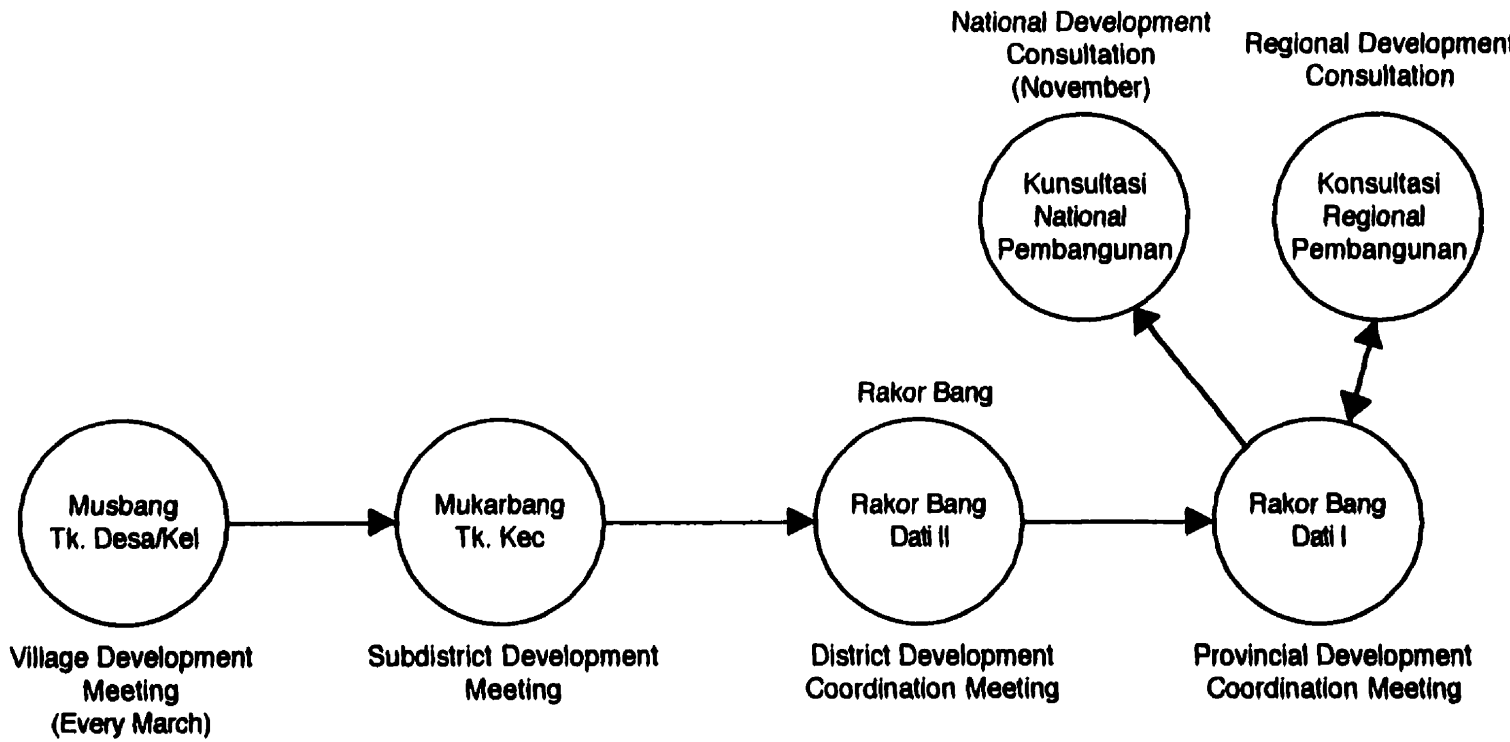

Figure 4.2: The Planning Process in Indonesia

In reality, the development process has been dominated from the top down, with the central government maintaining a strong control at all levels through budgetary allotments and regulation of activities (McAndrews 1986). As such, it is suggested that development programs do not always reflect development priorities at the local level, but instead, reflect the uniform "target system" operating at the national level in an effort to "book quick results" (Soetrisno 1993, 28).

4.2.3 The Desa in Java

Indonesia has approximately 67,000 villages (*desa*) (Soemardjan and Breazeale 1993). In Java, the current structure of the *desa* is the product of historical and current forces. Prior to colonialism, the Javanese *desa* has been described as being loosely bound with social relationships based mainly around family and extended family (Geertz 1959; Tjondronegoro 1984; Sullivan 1992). Social rights and obligations were extended to neighbours, such as aiding financially or manually when asked, but for the most part these relationships were viewed as formal and shallow (Geertz 1959; Tjondronegoro 1984). Under Dutch colonialism, the *desa* on Java was made the focus of administrative activities, in order to exert greater control for continued extraction of agricultural products under the Cultivation System (Donner 1987; Sullivan 1992). A romanticized version of a harmonious and socially homogeneous village life provided the basis for using the village unit, or as also has been suggested, the Dutch provided this misconception to support their decision (Sullivan 1992). Regardless of the intent, this imposed administrative structure integrated the *desa* further into the national system, which has had a lasting impact on social organization in the village (Geertz 1959; Sullivan 1992).

> Pulled this way and that, hammered by forces over which it had no control, and denied the means of reconstructing itself, village social structure lost its traditional resiliency and grew flaccid, pliant and generally indeterminate. The so-called "advance toward vagueness" which has sometimes been remarked of Javanese rural social organization is in fact a result of this peculiarly passive kind of social change experience which it has been obliged to endure; such vagueness is functional to a society which is allowed to evade, adjust, absorb and adapt but is not really allowed to change...by 1945 probably most Javanese villages had reached the crowded, aimless passive formlessness...(Geertz 1959, 36)

The changing role of the *Kepala Desa* in Java is attributed to the process of increasing control over the Javanese people, beginning in the Majaphit Kingdom (10th to the 15th Century),

heightened during Dutch colonialism, and maintained in the current GOI government structure (Soetrisno 1993). As suggested by Soetrisno (1993), in precolonial Java the *Kepala Desa* was selected by village elders, and the position was concerned mainly with community activities. As the village became incorporated in the national system, interactions with the higher levels placed constraints on the *Kepala Desa's* activities, but also opened up new opportunities. The *Kepala Desa* became part of the Dutch system of indirect rule, used to enforce the cultivation of cash crops under the Cultivation System (Donner 1987). Greater control was exerted over the village by requiring approval of the selection, and subsequently the election, of the *Kepala Desa* by the district head.

The place of the *desa* in the current GOI administrative structure has largely remained one of control and manipulation by the central level government (Marshall 1993; Sullivan 1992). Soetrisno (1993) suggests that through the historical process of the incorporation of the Javanese into the national system, the primary function of *Kepala Desa* has been re-oriented towards implementing government policies and programs, rather than addressing community concerns and needs. Moreover, as the lowest member of the administrative ladder, the role of the *Kepala Desa* has been transformed into "a government errand boy", for the subdistrict level. The *Kepala Desa's* activities have been kept in check through performance evaluations conducted by the *Camat* and *Bupati*, who can, if necessary reprimand or replace the *Kepala Desa* if he/she is not doing a satisfactory job (Soetrisno 1993, 25). On the other hand, incorporation into the national system has given the *Kepala Desa* a more powerful and influential position in the community, which can be used for more personal gains (Soetrisno 1993). The advantages of the position arise from direct contacts with government officials, access to village lands (*tanah bengkok*) on which additional income is generated, and a monopoly over information regarding development projects (Soetrisno 1993). Regardless of the community banter towards the *Kepala Desa*, the economic privileges and high social elite status attached to the role have made it a more desirable position. Contrary to an earlier interpretation that suggested the actions of the *Kepala Desa* reflect a squeeze between the government and community, and the need to compensate for both, Soetrisno (1993) argues that the actions of the *Kepala Desa* reflect his/her own personal interests in maintaining the position. On the other hand, the *Kepala Desa* is also responsible for ensuring that national

development projects are implemented, and as such much of his/her time can be taken up by these activities.

The organization of the Javanese village has been described as having two layers (Tjondronegoro 1984). The first layer consists of the government administrators, including the *Kepala Desa*, higher level village staff, the two village councils, and the social elite of the village (e.g., businesspeople, religious leaders). It is suggested that this layer is mainly concerned with implementing, overseeing and satisfying government programs and policies, and hosts several government organizations to facilitate the various social, economic and cultural aspects, such as boy scouts, family planning and farming groups. The main intent of this layer is to ensure social harmony in the village, and to assist the national level in achieving its development programs (Sullivan 1992).

The second layer consists of the RW and more specifically the RT levels, and involves informal leaders and the less prestigious village staff members. It is at these levels "elements of primitive democracy" are suggested to be still functioning, in the form of mutual self-help practices (i.e., *gotong-royong*) (Tjondronegoro 1984). These informal activities, often referred to as the cornerstone of the Javanese village and society, generally occur among family and/or neighbours (Tjondronegoro 1984; Sullivan 1992; Warren 1993).

4.3. DEVELOPMENT AND LAND USE CHANGE ON JAVA: A BRIEF OVERVIEW

The island of Java has historically been dominant in the archipelago of Indonesia, both as its administrative and commercial centre. Java comprises approximately seven per cent of the land mass of Indonesia, contains almost sixty per cent of the total population, hosts the nations capital city of Jakarta, and is the homeland of the largest ethnic group in Indonesia-the Javanese (45% of the total population), one that dominates the higher echelons of the political and military system (Donner 1987; Marshall 1990; World Bank 1992, 10). One of the prominent characteristics of Java is that it is one of the most densely populated places in the world (World Bank 1992). Since 1930, its population has more than doubled, placing it over 100 million in 1990, with an average population density of 815 people/km^2 (World Bank 1992, 10) (Figure 4.3). Of this population, approximately eighty per cent reside in rural areas.

Java has been the main focus of national development initiatives, receiving seventy per cent of the irrigation and drainage infrastructure (e.g., irrigation and drainage) and seventy-five per cent of industrial development. (e.g., textiles, sugar production, automotive assembly) (World Bank 1993). The economic contribution of Java to national development is, in turn, approximately fifty per cent of the GDP, involving sixty per cent of agricultural products (Marshall 1993). Land use change on Java reflects these present economic development forces and densepopulation, cast within historical activities and its tropical monsoon climate and volcanically derived soils. The land uses of rice agriculture (*sawah*) and semi-intensive fishponds (*tambak*) will be discussed in greater detail below.

4.3.1 Sawah on Java

Wet rice agriculture (wetlands), or *sawah*, is the largest land use activity on Java. The spread of *sawah* on Java is associated with Hindu influences and the formation of principalities. In 1833 there were approximately 1.3 million hectares of *sawah*, which increased to 3.5 million hectares in 1957, 4 million in 1970 and then decreased to 3.5 million in 1990 (Donner 1987;

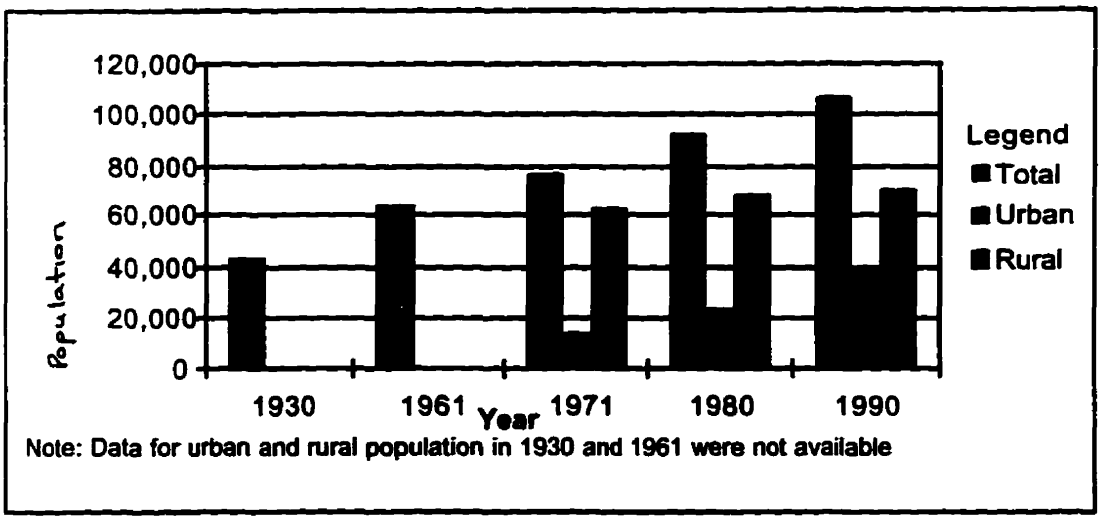

Figure 4.3: Population on Java: 1930-1990

Source: Repetto (1986, 15) and World Bank (1992, 238)

Statistik Pertanian 1990). At the peak, there was an estimated 4.5 million hectares of rice fields on Java (Donner 1987). Similar to the rice landscape throughout Southeast Asia, the Javanese *sawah* landscape, while maintaining an unchanged surface, has undergone dramatic alterations in its social, economic and biophysical characteristics (Rigg 1991). This is largely attributed to increasing commercialization since the 1960's.

Increased rice production became a national development priority of the New Order Government of the Republic of Indonesia when it came to power in 1966 (Hansen 1974; Fox 1991). By the 1950's, population growth had outstripped rice development and Indonesia had become the World's largest rice importer. A major component of rice self-sufficiency was the adoption of "green revolution" technology, administered through the *Bimbingan Massal* or *BIMAS* (Mass Guidance) program[17]. The BIMAS program was supported by both substantial physical (e.g., irrigation and drainage) and social (e.g., local credit, extension officers, seed distribution, and marketing system) infrastructure. The main thrust of this program was rice intensification, as extensification was no longer a viable option on Java. The BIMAS program increased rice yields by 84 per cent since 1970, of which Java accounted for 63 per cent (Fox 1991). Rice yields increased to 4.5 tonnes/hectare, as compared to 2-3 tonnes/hectare for other Southeast Asian countries (Fox 1993). The results of the BIMAS project are considered successful, in that in 1985 Indonesia achieved rice self sufficiency. The program has also received much criticism, mainly associated with the negative impacts on the small farmer (i.e., exclusion from credit programs and increased landlessness) and the ecological implications of the increased use of chemical inputs required by green revolution technology (Hansen 1974; Foley 1987; Fox 1991).

These changes in the Javanese agricultural landscape have been characterized by increasing poverty and smaller rice land holdings as families divided lots for their children (Hansen 1974; Fox 1991). Geertz (1971) referred to this process as "shared poverty" as more and more people are forced to work smaller and smaller plots of land. It has been linked to the growing number of landless farmers who have sold their land in the face of debt, as indicated in Table

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[17] Consult Hansen (1975); Donner (1987), Foyer (1987); Fox (1991); and Rigg (1993) for more in-depth

4.2 (Hansen 1974). With approximately eighty per cent of the population on Java residing in rural areas and an average field size of 0.66 hectares in 1983, it has been suggested that rural poverty is increasing in Java (Booth 1991). These agricultural trends have been offset by increasing incomes generated from off farm activities, highlighting the significance of supplementary income opportunities on Java (Booth 1991).

Table 4.2: Comparison of Rice land Holdings in Java: 1983-1993

	Average size of rice field (ha) on Java	Number of households owning land under 0.5 ha		Number of landless households in Central Java (000)
		Java	Outside Java	
1983	0.66	7,304	2,230	7304 (76.% of Indonesia)
1993	na	8,067	2,839	8067 (74% of Indonesia

Source: Booth (1991), Biro Statistik (1993a)

4.3.2 Semi-Intensive Fishponds (Tambak)

In Indonesia, brackish water fishponds are designated in four categories: traditional extensive, improved extensive, semi-intensive and intensive (Rice 1991). According to Rice (1991), traditional extensive methods rely on the high tides to bring in water and nutrients for both fish and shrimp. Improved extensive ponds still use tides to bring in water and nutrients, but they are stocked with fish and additional food is added. Semi-intensive fishponds (*tambak*) differ from traditional and improved extensive ponds as they generally have higher shrimp densities, feed is added to the ponds, and pumps are often used to ensure adequate water exchange. Intensive fishponds cultivate the highest density of fish and shrimp, use pumps to control water levels, and use fertilizers.

The central level government has encouraged *tambak* development in Indonesia through various intensification programs, the most recent being *Intam* (intensification *tambak*) (Hannig 1988). The overall goal, as established in *Repelita* three and four, is to increase fisheries production, in particular shrimp, to increase foreign revenues and to create productive employment opportunities for fisherfolk (Hannig 1988; Rice 1991). This goal is mainly achieved through intensification of the fisheries sector, involving credit schemes and capital

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descriptions and discussions of the BIMAS and related rice intensification programs in Indonesia.

intensive inputs into *tambak* production, such as pumps, fertilizers, and facilities to cultivate fish and shrimp fry for *tambaks* (Rice 1991). Hannig (1998) has referred to this process as the "blue revolution" to parallel the "green revolution" in agriculture. Interest in *tambak* is associated with the high production levels of shrimp, which has become one of the more important commodities for export. *Tambak* shrimp production has increased in Indonesia from 60,481 tons in 1973 to 337,306 tons in 1993 (World Bank 1994). In 1992 shrimp exports accounted for over 67 per cent of all exports, generating US$ 757.4 million (World Bank 1994).

Figure 4.4 shows the location of current *tambak* in Indonesia, indicating the high concentration along the north shore of Java, as well as potential development areas on the south coast, which includes the Segara Anakan area. In 1992 there were approximately 115,138 hectares of *tambak* on Java, accounting for 37.8 per cent of *tambak* ponds in Indonesia (Biro Statistik Pertanian 1994). While producing economic benefits, *tambak* development has also been associated with environmental degradation on Java, including the conversion of mangroves and pollution of the surrounding waters (Rice 1991).

4.3.3 Development, Land Use Pressures and Soil Erosion on Java

Increasing population and land use change have created many pressures on the land (Hardjono 1991). One consequence on Java has been accelerated soil loss, mainly in the upland areas (Reppetto 1986). Soil erosion on Java has attracted attention since the mid 1800's, when a Dutch technician warned of the looming threat of accelerated erosion (Donner 1987). Today, with one of the highest erosion rates in the world, soil erosion has become a central management concern (Reppetto 1986; Donner 1987; Pearce et al. 1990). General sedimentation rates have been estimated at 10-40 tonnes/ha/year (Donner 1987; Pearce et al. 1990, 67). Causes attributed to accelerated soil erosion include: high population densities, poor agricultural practices (e.g., cultivation of steep slopes), rural unemployment, marginalization, poverty, absentee landlords, loss of traditional management practices, and deforestation in the upland areas (Repetto 1986; Donner 1987; Pearce et al. 1990).

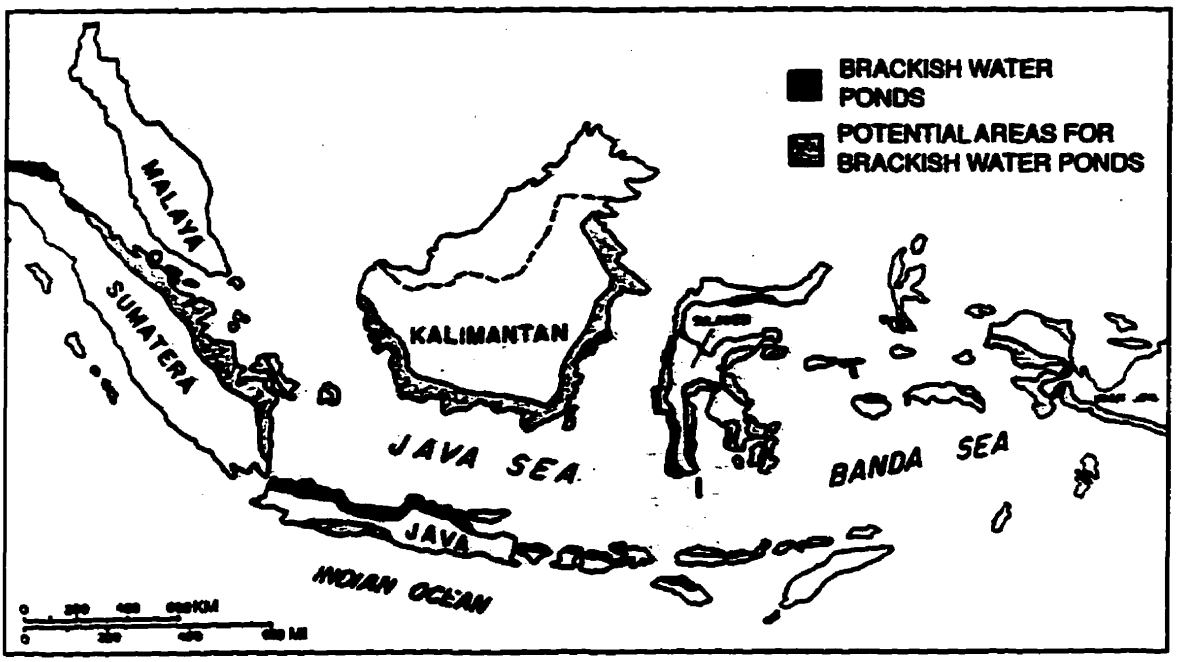


Figure 4.4: Location of Existing and Potential Brackish Water Ponds in Indonesia
Source: Hannig (1988, 55).

Originating from the upland areas, sediments are transported to the coast, where they interact with the coastal systems. The seaward expansion of the land base provides an opportunity for agriculture. Negative impacts are multiple and include: degradation of *tambaks*; increased cost of harbour maintenance (i.e., dredging) and/or a decrease in their utility; increased flooding from rivers; reduced effectiveness of irrigation and drainage canals and dams; degradation of coral reefs and sea grasses; declining productivity of coastal waters; and, discoloration of waters, discouraging opportunities for tourism (Hardjono 1986; Rice 1991). On Java, on and off site costs associated with sedimentation have been estimated at approximately US$ 349-415 million per year (Pearce et al. 1990, 77).

4.4 THE CITANDUY RIVER BASIN AND SEGARA ANAKAN

The Citanduy river basin is located primarily in Central Java, although its boundary does cross into West Java (Figure 4.5). The river basin is approximately 446,000 ha in area, and in 1983 had a population of about 2.4 million, with an average population density of 679 people/km^2

(World Bank 1990) [18]. The elevation of lands in the river basin are categorized as approximately thirty per cent low-lying, fifty per cent between 35 to 500 metres, and twenty per cent are above 500 metres, including five percent higher than 1,000 metres (Engineering Consultants Inc. 1974). It was estimated in 1972, that 74,000 hectares of lands in the basin were critical, meaning they were exposed to erosion. The dominant land uses in the river basin in 1972 included: lowland rice (24%); upland crops (27%); home gardens (10%); forest (19%); plantation (17%) and other (3%) (Engineering Consultants Inc. 1974).

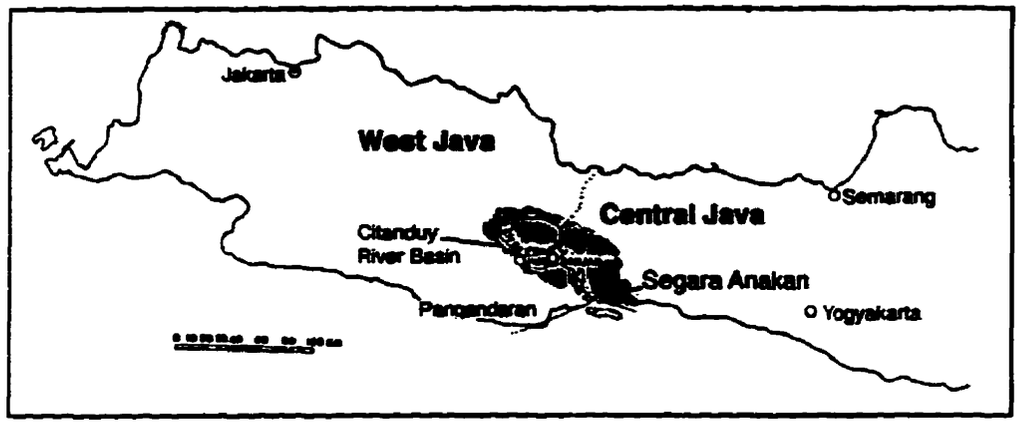


Figure 4.5: Location of the Citanduy River Basin in Java

An historical overview of land use change in the Citanduy River Basin is not presented in this thesis, although one could surmise that land use change, in general, reflects the historical trends on Java, as discussed earlier in this Chapter. These trends involve the expansion of wetland rice in the low-lying areas and the migration of people and farming activities into the upland areas in response to the growing population pressures and institutional changes arising from colonial and the government of Indonesia's interests and activities. General interest in the Citanduy river basin began in the 1930's, largely due to concerns of flooding. In 1969 the government of Indonesia prioritized the Citanduy river basin as one of six in Indonesia considered for development initiatives (Engineering Consultants Inc. 1974). Following several studies, the priorities for development were identified as: flood control through the construction

[18] More recent population figures for the Citanduy River Basin were not readily available.

of dams and reservoirs; irrigation and drainage systems; hydro-electrical power development; and, reclamation of swamp lands for agriculture, including Segara Anakan (Engineering Consultants Inc. 1974). According to PRC (1974), development efforts in the upland areas of the River Basin have been focused on small irrigation projects and soil conservation measures including reforestation, a greening program and contour farming (i.e., terracing).

Sedimentation has been one of the main management concerns in the river basin, particularly regarding the impacts on the low land activities, including the Segara Anakan. The Segara Anakan, "child of the sea", is a brackish mangrove estuary protected from the Indian Ocean by the island of Nusa Kambangan and forms the bottom portion of the Citanduy river basin. The estuary has attracted much attention because of the economic and ecological significance it presents to the surrounding area. In 1987 the mangrove forest was the largest remaining forest of its kind on Java. The estuary and mangroves host a productive fish, shrimp and crab nursery ground, which supports both the commercial offshore fisheries at Cilacap and the local economy of the three traditional fishing villages, collectively known as Kampung Laut, which are located in the estuary.

Interest in Segara Anakan began with a reclamation plan in 1948, as part of the Citanduy watershed project (PRC Engineering Consultants 1987) (Table 4.3). Reclamation of the estuary was in response to its increasing sedimentation. This plan proposed to convert the surrounding tidal forest into agricultural lands through a process of diking and then flushing out the salt water. Similar proposals to reclaim the estuary for agricultural lands emerged again in 1969, 1971 and 1975 (PRC Engineering Consultants 1987). In 1975 and 1976, the ecological and economic significance of the estuary for the commercial fisheries off the coast of Cilacap was acknowledged, which switched the emphasis of management plans towards conservation of the estuary (PRC Engineering Consultants 1987). In 1983, the Provincial government issued a decree to preserve the estuary (Sujastani 1986). Construction of the surrounding irrigation and drainage system also promoted conservation of the estuary, although these concerns dealt mainly with drainage and flooding issues. Flooding will increase in these rice fields if the estuary fills in. In 1992, and again in 1995, the area reported severe flooding, forcing people to move out of their homes temporarily. In 1992, the Asian

Table 4.3: General Overview of Development Activities in the Segara Anakan, Java

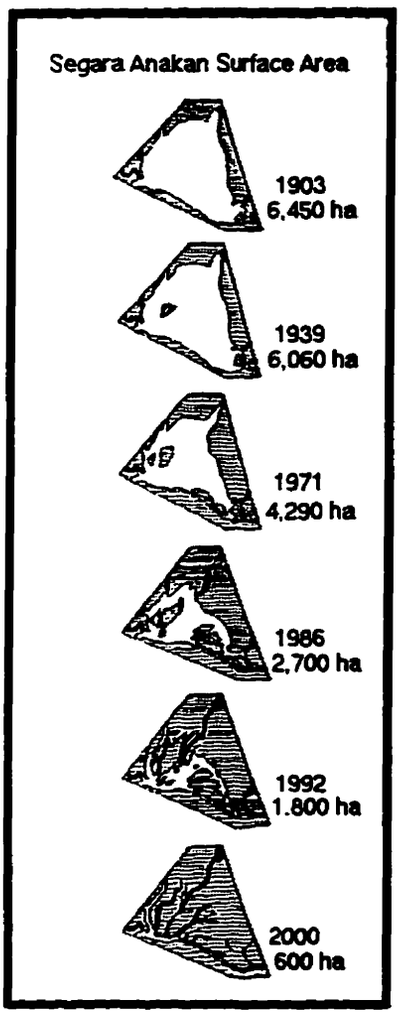
1931	• analysis of the mangrove forest and estuary by a Dutch researcher • the report indicated that with the rate of sedimentation the fisheries would be depleted and the fisherfolk would have to move
1948	• a development plan for the estuary was developed which included reclaiming the estuary for farming. Reclamation was to be achieved by diking the estuary and leaching the salts with rain water.
1972	• another development proposal oriented towards reclaiming the estuary for agricultural purposes, but involved diverting the flood flows of the Citanduy River into the estuary to accelerate sedimentation.
1974	• A feasibility study was conducted which supported the reclamation of 21,000 ha for farming. The Citanduy River was to be diverted directly into the Indian Ocean in order to reduce the inflow of fresh water and sediments.
1975	• the importance of the estuary for the fisheries was identified as a key element in development of the area, raising questions about the desirability of reclamation
1975	• reclamation of the estuary was revived based on the information that sedimentation of the estuary was occurring at a more rapid rate
1975	• the Citanduy River Master Plan was developed which included plans for an irrigation system surrounding the perimeter of the mangrove forest. The estuary was to act as the drainage area.
1982	• construction of the Lower Citanduy Irrigation project began, which encompassed approximately 20,400 ha
1980	• marked greater input of ecological and environmental perspectives on the mangrove forest
1984	• from 1981 to 1985 various organizations were involved in examining the potential of preserving the estuary
1987	• another engineering study of the area highlighted dredging and flushing of the estuary. Aquaculture was included as a potential development activity
1989-1992	• the ASEAN-US Coastal management project, conducted by ICLARM, employed the estuary as its project pilot site
1992	• the Asian Development Bank and the Directorate of Rivers began a new phase of studies in the estuary examining feasible ways to save the estuary.

Source: ATC Engineering Consultants (1994, 1-4)

Development Bank began another project in conjunction with the Directorate of Rivers to find a feasible way to save the lagoon (ATC Engineering Consultants Inc. 1994).

It has been estimated that ten million cubic metres of sediments enter Segara Anakan annually from the five major rivers that empty into the estuary (PRC Engineering Consultants 1975). The Citanduy River supplies most of these sediments, while the other rivers contribute lesser, although still substantial, amounts (ATC Engineering Consultants Inc. et al. 1994). Sedimentation has been attributed to deforestation and poor agricultural management practices in the upland areas of the Citanduy river basin, as well as the 1982 volcanic eruption of Mount Galunggung, which is located in the river basin (PRC Engineering Consultants 1975; ATC Engineering Consultants Inc. et al. 1994). Given the current rate of sedimentation, the estuary

is predicted to fill in by the year 2000 and disappear if there is no intervention (e.g., dredging) (PRC Engineering Consultants 1975; ATC Engineering Consultants Inc. et al., 1994) (Figure 4.6).



4.4.1 The Fishing Villages of Kampung Laut

Kampung Laut consists of three fishing villages--Ujung Alang, Ujung Gagak and Panikel--which in 1994 had a combined population of 11,513 (Figure 4.7) (Desa Monografi 1994).

It is difficult to pinpoint the date of origins of fishing communities of Kampung Laut, but today the fisherfolk maintain a strong attachment to the area. According to local people, they are descendants of guards sent by the Sultan of the *Mataram* Kingdom (who reigned over Java from the 7th to 10th Century) to protect the natural harbour (i.e., Cilacap) from pirates. The guards and their families lived and farmed on the island of Nusa Kambangan. When the Dutch colonialized Java, they turned Nusa Kambangan into an island penal colony. The conflict that emerged between the guards and the convicts forced the guards and their families to flee to Kampung Laut, where they became fishing people. In 1994, four of the original seven prisons were still in operation.

Figure 4.6: Changes in Surface Area of Segara Anakan

Source: PRC Engineering (1994 2-5)

The villages are isolated from the rest of Java, relying for travel on either the government ferries, which run four times a day from Cilacap to Kalipucang (twice in each direction), or in dugout canoes. Ujung Alang is the first village reached by the ferry coming from Cilacap

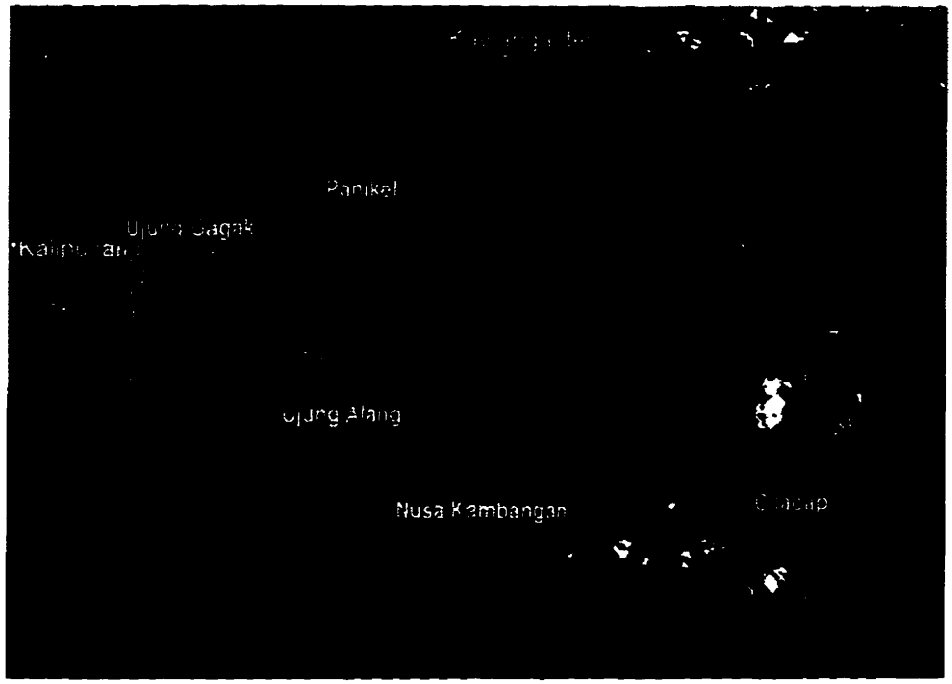


Figure 4.7: Location of Fishing Villages in Kampung Laut, Segara Anakan, Java

(about two hours), followed by Ujung Gagak taking approximately three hours. The third village Panikel, is located in the north/northwestern section of the estuary, and because of sedimentation it can no longer be reached by ferry, although smaller boats (*jempreng*) can be taken from the subdistrict centre of Kawunganten. A boat is required to travel between the villages and/or their own *dusuns*, and can take up to one half hour or more depending upon the destination and the tides. Recently limited road access has linked some areas to the surrounding village and subdistrict capital, Kawunganten.

Located in Central Java, the ethnic composition of Kampung Laut is dominantly Javanese. The dominant religion in Kampung Laut is Muslim (95% in 1990), followed by Catholics

(4% in 1990) and a small number of Protestants and Buddhists (0.7% 1990)[19] (Monografie Desa, 1990).

Historically, the three villages have been highly dependent on the estuary fisheries for their main source of livelihood. In 1980, approximately eighty-five per cent of the local people were fisherfolk (Hardoyo 1980). According to a district level government report, all three villages of Kampung Laut have been designated as *Desa Swasembada*[20], meaning that they have progressed in terms of national level standards of village development (Bappeda Cilacap 1992/3). The income per capita for Ujung Alang, Ujung Gagak, and Panikel in 1990 was stated as 421-480 kg, 541-600 kg, and 421-480 kg of *beras*[21] per year, respectively (Bappeda Cilacap 1992/3). Compared to the suggested poverty line for rural Java, an income equivalent to 240 kg of *beras* per person per year, the villages of Kampung Laut were economically above the poverty line[22] (Hardjono 1987, 247).

Contrary to this government report, other sources considered the socio-economic condition of Kampung Laut to be low in comparison to the national average (Sujastani 1987; ICLARM 1992). In Kampung Laut, it was estimated that in 1986 sixty-seven per cent of the families earned less than Rp. 31,000/month (CND$20), and thirty-five per cent earned less than Rp. 17,000/month (CND$11) (Sujastani 1987). With an estimated average family size of 5-6

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[19] Based on the 1990 village statistics (Monografie Desa, 1990) the breakdown of religious affiliation for each village is:

Religion	Ujung Alang	Ujung Gagak	Panikel
Muslim	3,534 (90%)	2,563 (99.4%)	2,338 (98%)
Catholic	312 (8%)	15 (0.6%)	28 (1.2%)
Protestant & Buddhist	46 (1.2%)	0 (0%)	18 (0.8%)

[20] The Government of Indonesia evaluates village development based on seven indicators. From this evaluation a village is designated from lowest to highest status as: 1) *Desa Swadaya* (traditionally self-sustaining village); 2) *Desa Swakarya* (more developed auto-active village); and 3) *Desa Swasembada* (village that has achieved self-propelled growth and is managed with modern economic and administrative methods) (Tjondronegoro 1984, 283)

[21] Indonesians use different terms for the different stages of rice: *padi* is planted rice; *gabah* is unmilled rice; *beras* is milled rice, and *nasi* is cooked rice for eating.

[22] It is suggested that of the 240 kg of *beras*, half is for consumption and the other half for the purchase of other needs (e.g., fuel, foodstuffs). The 240 kg of beras represents the ability to provide minimum nutritional needs (Sajogyo 1974 in Hardjono 1987, 247).

people, both of these levels of income are below the national poverty line of Rp 10,296/person/month (Marshall 1993). Moreover, all three villages were designated in 1994 for the central government development program *Inpres Desa Tertingal* (IDT) (Villages left behind). The goal of IDT was to increase the socio-economic conditions of the least-developed villages, with an emphasis on the poorest people. The low socio-economic conditions have been attributed mainly to the low income and education levels, and the lack of infrastructure in the villages (Tables 4.4 and 4.5) (Sujastani 1987; PRC Engineering Consultants Inc. 1987).

Table 4.4: Education Levels in Kampung Laut: 1980 and 1990

Village	No Formal Education %		Not Finish Primary School (SD) %		Currently in Primary School (SD) %		Completed Junior & High School %	
	1980	1990	1980	1990	1980	1990	1980	1990
Ujung Alang	64	50	34	26	2	8	2.5	8
Ujung Gagak	53	31	44	26	2	5	0.9	2
Panikel	63	31	34	20	29	10	5.5	3

* All figures are based on the population over five years of age. Source: Haradoyo (1980) and Dalam Angka, Kecamatan Kawunganten (1990)

Table 4.5: Selected Infrastructure in Kampung Laut: 1990

Village	Village Office	Balai Desa	Primary School	High School	Health Help	Television	Radio
Ujung Alang	1	1	3	0	1	25	171
Ujung Gagak	1	1	3	1	1	72	16
Panikel	1	1	2	0	1	28	62

Source: Monografie Desa, 1990

4.5 SUMMARY

This chapter has provided both a national and regional context for village level analysis in Indonesia, with special reference to Java and the Segara Anakan. The village in Indonesia represents the lowest administrative level in the five-tier government structure, and as such acts as the liaison between the government and community. Based on government regulations, the village has certain autonomy over development issues, but in reality the financial constraints and top down approach of the central level government have limited this authority. As such, much of the village level development activities have been strongly associated with the national level development policies and programs, overseen and administered in the village by the

Kepala Desa. It is at the subvillage level that traditional self-help activities have been most prominent in Javanese villages.

The study area of Segara Anakan, a brackish mangrove estuary, is located on the island of Java, and forms the lower portion of the Citanduy River basin. The rapid economic development and high population densities on Java have exerted much pressure on land use activities, particularly the upland areas. Upland activities in the river basin have accelerated soil erosion, and the cumulative effects of sedimentation are rapidly altering the physical environment of the estuary, causing it to enclose. The impact of sedimentation is threatening the livelihood of the three traditional fishing villages located in the estuary. The fisherfolk, who have historically been economically dependent upon the estuary fisheries, are being forced to adapt to the declining productivity of the estuary fisheries. Chapters five and six identify and document the key processes of the land use changes associated with the adaptation process, and Chapter 7 assesses the sustainability of these changes for regional conservation of the estuary and village level development.

Chapter 5:
LAND USE CHANGE IN SEGARA ANAKAN: 1968-1995

5.1 INTRODUCTION

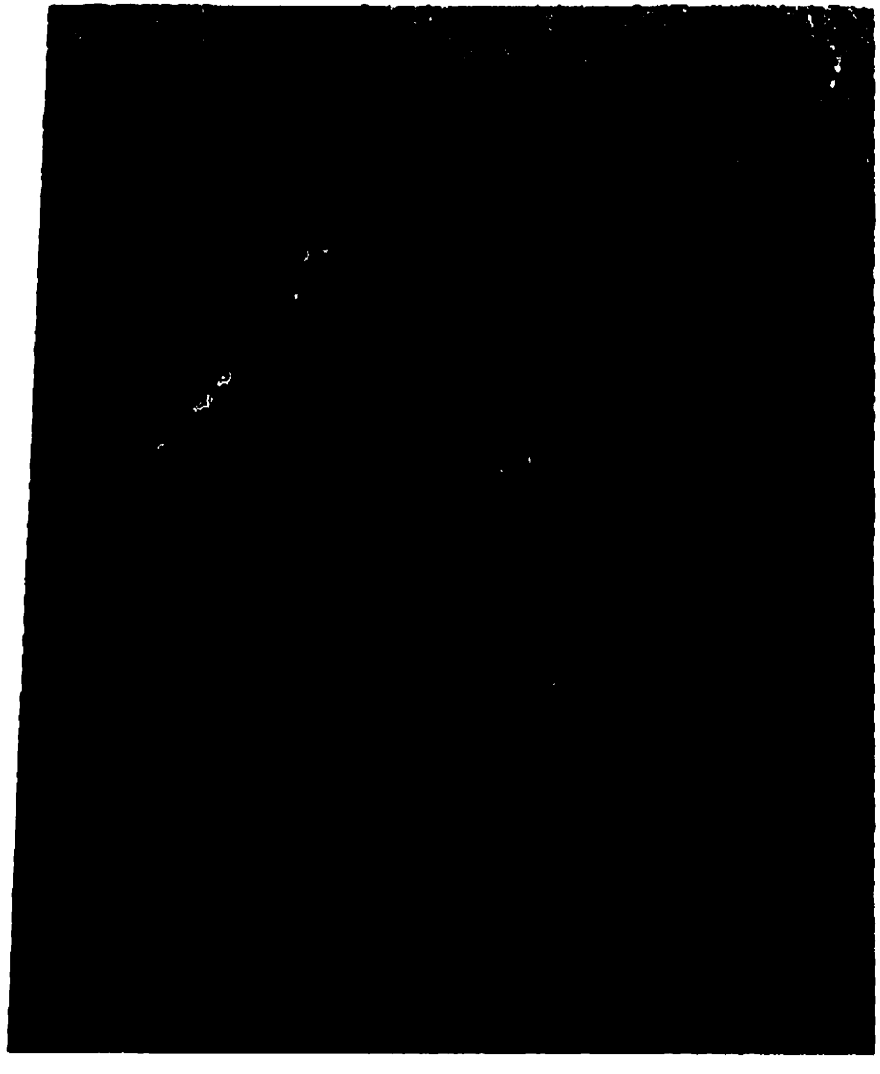
In the previous chapter the study area of Segara Anakan was introduced and the increasing pressures arising from the cumulative effects of sedimentation were highlighted. The purpose of this chapter is to identify land use change in the area from 1968 to 1995, and to describe the main characteristics of the dominant land use activities in the area in 1994-95. This description emphasizes the socio-economic and institutional aspects of the land use activities.

5.2 LAND USE CHANGE IN SEGARA ANAKAN: 1968-1995

Based on the analysis of the satellite data, the main land use activities in Segara Anakan in 1995 were: 1) new lands, 2) mangrove forest; 3) estuary waters, 4) rice fields, 5) settlements, 6) semi-intensive fishponds and rice fields, and 7) rainforest (Figure 5.1).

5.2.1 New Lands

New lands in the estuary are essentially permanently exposed mudflats. These lands have been forming in the estuary as a direct consequence of sedimentation, and emerge as islands and shoreline accretion. Their spatial distribution is largely the result of the transfer and tidal movement of sediments as they enter the estuary from the inflowing rivers. In 1968, the topographic map indicated that there was only a small island in the estuary, situated next to *dusun* Karang Anyar (Figure 5.2). From 1968 to 1987, approximately 74 hectares of new land were formed, and an additional 29 hectares were created from 1987 to 1995 (Figures 5.3. 5.4 and 5.5). In 1995, this land use encompassed approximately 50 hectares (Figure 5.1). It should be noted that the extent of new lands provided here is based on only those exposed. It does not include the new lands that have already been converted into other uses, such as forests and agriculture. The main use of the new lands is that they act as the basis for the forward



Legend

- Mangrove Forest
- Estuary Waters
- Rice Fields
- Rice Fields and Semi-Intensive Fish Ponds
- Settlements
- New Lands/ Permanent Mudflats
- Rain Forest
- Unclassified

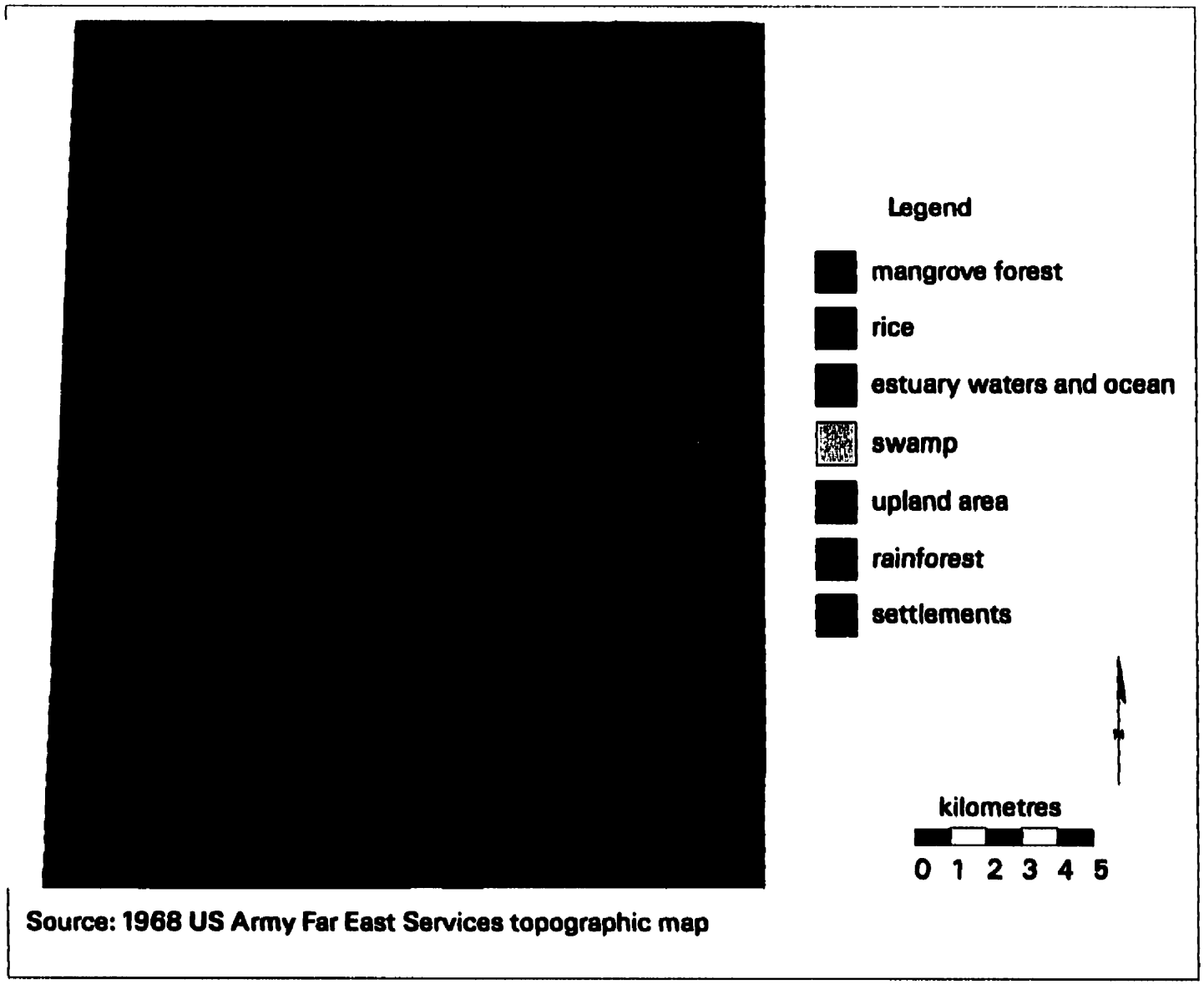
N

kilometres

0 1 2 3 4 5

Source: Classified SPOT XS satellite image, July 7, 1995

Figure 5.1: Land Cover in Segara Anakan, Java, 1995



Source: 1968 US Army Far East Services topographic map

Figure 5.2: Land Cover in Segara Anakan, 1968

Legend

- Mangrove Forest
- Estuary Waters
- New lands
- Settlements
- Rice Fields
- New Rice Fields
- Rain Forest
- Mangrove Encroachment
- No Data

N

kilometres

0 1 2 3 4 5

Source: Classified SPOT XS satellite image, October 11, 1987

Figure 5.3: Land Cover in Segara Anakan, Java: 1987

Legend

- No land cover change (1,2903 ha)
- Estuary to new lands (937 ha)
- Estuary to mangrove forest (3,779 ha)
- Estuary and forest to rice fields and villages (1,426 ha)
- Swamp and forest land to rice fields and villages (8,675 ha)
- No data

kilometres

0 1 2 3 4 5

Source: Digital comparison of 1968 topographic map and classified 1987 SPOT XS satellite image

Figure 5.4: Land Cover Change in Segara Anakan, 1968-1987

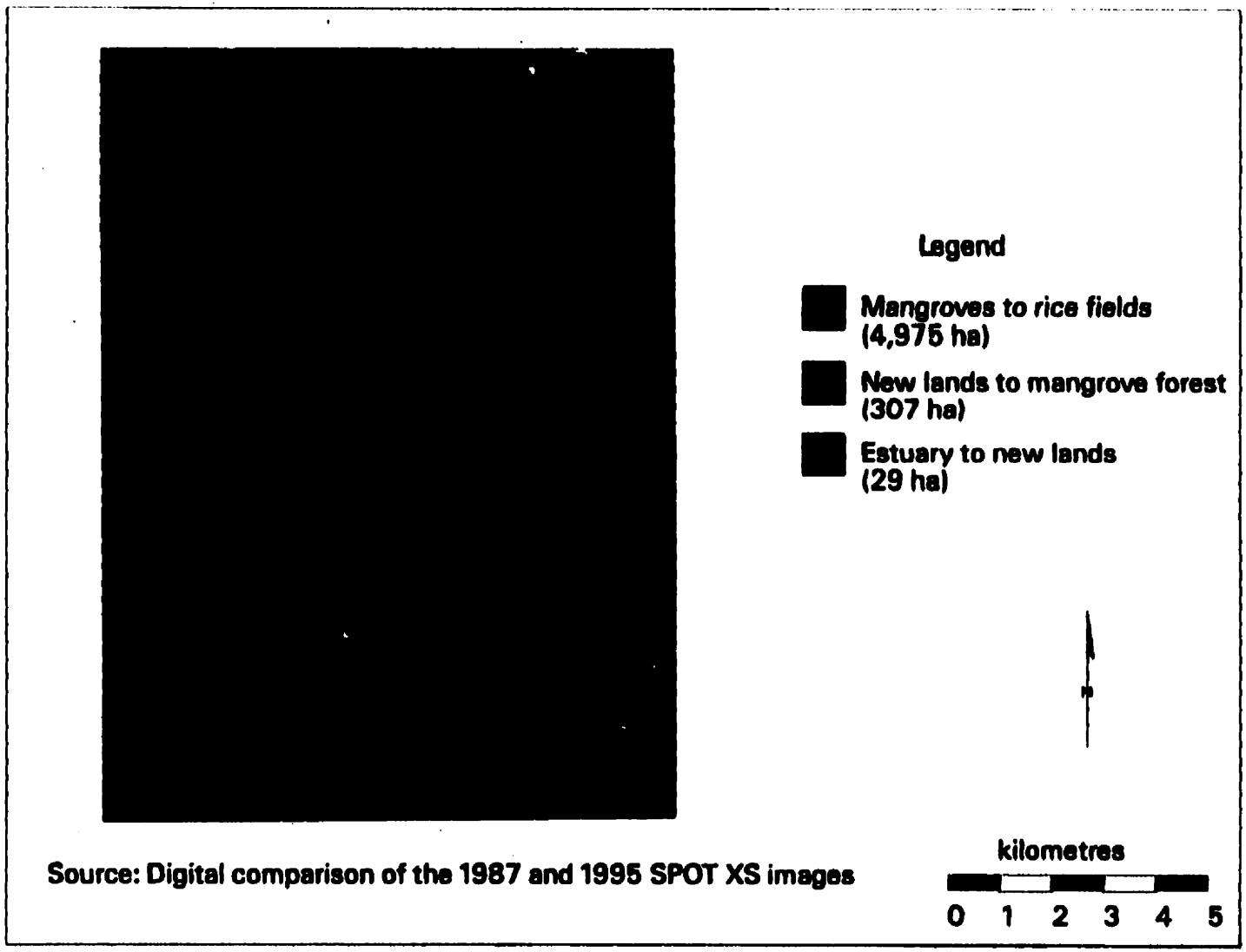


Figure 5.5: Land Cover Change in Segara Anakan: 1987-1995

march of land-based activities into the estuary, such as mangroves, rice agriculture and semi-intensive fishponds.

5.2.2 Mangrove Forest

Since 1968, the size of the mangrove forest has been fluctuating as a result of both deforestation and mangrove encroachment. From 1968 to 1987 approximately 10,100 hectares of forest were cut down, while 3,997 hectares of new mangrove forest were established on the new lands in the estuary (Figure 5.6 and Figure 5.7: Note that all photographs shown in this thesis were taken by the author). The mangroves accelerate the formation of new lands by trapping sediments with their roots, which allows them to advance into the estuary. From 1987 to 1995, an additional 4,975 hectares of mangroves were removed, and 307 hectares of new mangroves encroached into the estuary (Figure 5.5). The total changes in the extent of the mangrove forest from 1968 to 1995 involved a loss of 15,075 ha, and a gain of 4,304 ha. In 1995, the size of the mangrove forest was approximately 3,241 hectares[23] (Figure 5.1).

Figure 5.6: Mudflats at low tide, *dusun* Karang Anyar, Ujung Gagak.

[23] This value can be considered a low estimate because of the high level of spectral confusion and difficulties in classifying the image, notably the mangrove forest. Moreover, there is a relatively high number of unclassified pixels, (i.e., approximately 5,988 hectares) in close proximity to the mangrove class.

Figure 5.7: New Mangrove forests, high tide, Ujung Gagak

Ecologically, the mangrove estuary is considered to be a significant ecosystem on Java, as in 1987 it was the largest remaining mangrove forest on the island (Sujastani 1986). The forest is estimated to have twenty-six species of mangroves, three of which are commercially viable (ICLARM 1992). The distribution of these species is associated with water levels and salinity (Nelson et al. 1992). The mangrove system is considered highly productive in comparison with other mangrove systems in Southeast Asia, which is associated with high sediment and nutrient inputs (ATC Engineering Inc. 1994).

The mangrove forest has been managed by *Perhutani*-the State Forestry Corporation-since 1930 (PRC Engineering Consultants 1987). Currently, no production logging occurs in the forest because of its highly degraded nature, largely associated with illegal cutting for both domestic (e.g., firewood, construction of houses, to sell for everyday needs) and commercial uses (e.g., selling to factories for charcoal) (Figures 5.8 and 5.9) (Soemodihardjo and Suroyo 1988). Income generated from selling firewood for local domestic wood is around Rp 5,000 (CND$3.30) for one canoe full, approximately a days work. The wood is either contracted to a village store or family. Selling to a factory generates an income of approximately Rp 100,000 (CND$67) per *jempreng* (i.e., mid-sized boat) (semi-structured interviews 1994). The selling of wood to supplement the household income was suggested to have begun only in the mid 1980's (key informant Ujung Gagak 1994). Other local uses include the construction of homes and the traditional tidal fishing trap, locally called *wide*. This consumption of wood from the mangrove forest is not restricted to the local fisherfolk, but also includes people from the surrounding areas.

Figure 5.8: Collection of firewood from mangroves, Panikel

Figure 5.9: Collection of wood from mangroves for commercial purposes

The formation of new lands and encroachment of mangrove forests have resulted in two land use conflicts; the first between the fishing communities and the Ministry of Justice, and the second between the fishing communities and *Perhutani* (ICLARM 1992). These conflicts are centred around authority over the use of new lands in the estuary, and have been based on the estuary and forest boundaries delineated on a 1942 Government of Indonesia topographic map. The fishing communities claim that in accordance with *hukum adat* (customary law) the new

lands, including the lands along the north coast and up to the "mountain"[24] of Nusa Kambangan, are within their village administrative boundaries and belong to them. *Hukum adat* states that those who use the land have rights to it. The Ministry of Justice, which is responsible for the prisons on Nusa Kambangan, considers that all of the island is under their authority, but has allowed sixty homes to be built in the coastal area. The tension of this land dispute was highlighted in 1994 when several nonregistered homes were torn down (semi-structured interviews 1994).

Perhutani, in regards to the second dispute, states that because the new lands are covered with mangrove forest, they belong under their authority (ICLARM 1992). In 1972 *Perhutani* staked markers around forest lands in order to stop further agricultural encroachment into the forest. Some local people claim that the staking of land by *Perhutani* was done without their consultation (semi-structured interviews 1994). In 1994, both land use disputes were still unresolved, as a decision had not yet been handed down from the central level government in Jakarta.

5.2.3 Estuary Waters

The brackish water of the estuary is the result of an influx of fresh water from the five major rivers which empty into it, and the tidal salt sea water which enters from the channels on the east and west sides of Nusa Kambangan. The semi-diurnal tides (approximately every 5 hours) range from 0.4 to 1.9 metres throughout the year (Sujastani 1986). The brackish estuary is not a potable source of water for the local people. Regionally, the mudflats of the estuary, along with the mangrove forest, provide what may be the last suitable feeding and resting grounds on the south coast of Java for several migratory bird species, including the endangered Milky Stork (*Mycteria cinera*) (AWB 1988) (Figure 5.10).

The combination of new lands and mangrove encroachment has resulted in a reduction of the estuary water surface area from approximately 9,329 hectares in 1968 to 6,716 hectares in 1987 to 905 hectares in 1995, resulting in a total reduction of 8,424 hectares since 1968[25] (Figures 5.1, 5.4 and 5.3). Concomitant with the cumulative effects of sedimentation has been

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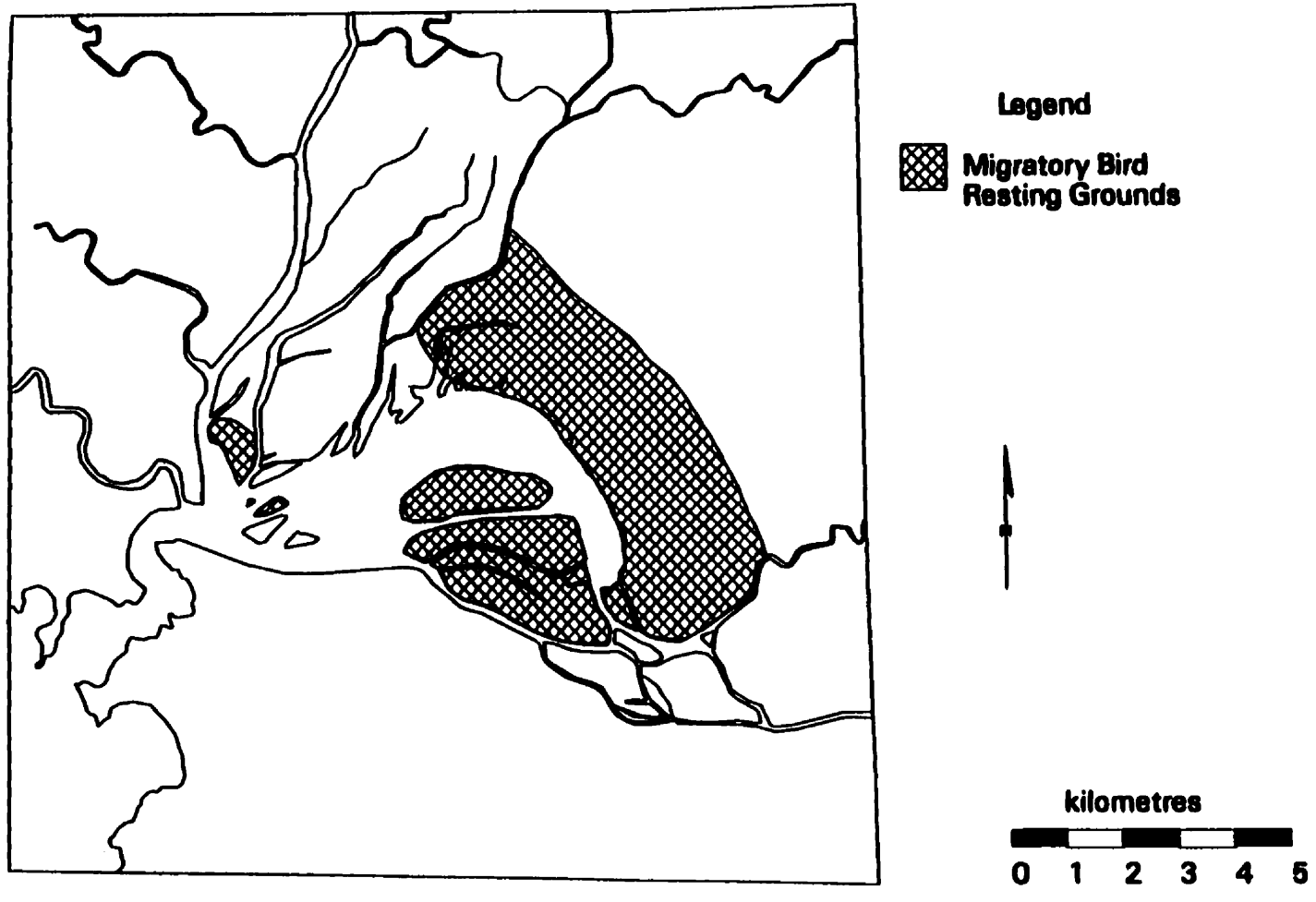
[24] Nusa Kambangan is largely comprised of a limestone outcrop. The new lands which have formed on the north coast of the island join to a steeply sloped outcrop. The local people refer to this outcrop as the "mountain".

[25] The 1968 estimate of surface area was obtained from the Government of Indonesia topographic map, and the 1987 and 1995 estimates were obtained from the 1987 and 1995 SPOT XS classified images, respectively.



Source: Asian Wetland Bureau, 1988

Figure 5.10: Bird Resting Grounds in Segara Anakan

a decrease in the depth of the estuary waters. According to a local fisherman, the estuary was once over eleven metres in depth, whereas in 1994, the average depth was one to two metres (PRC, 1994). During low tide, much of the open areas of the estuary becomes one large mudflat, impeding water transport and making some areas impassable by boat (Figure 5.11). On two different occasions I was stranded on the ferry for several hours, as we had to wait for high tide to get the boat "unstuck" from the mudflats.

Water transport is the dominant mode of transportation to, from and within the estuary. Two return ferries run daily from Cilacap to Kalipucang (a four hour trip one-way) carrying both people and goods. During school vacation, the Cilacap-Kalipucang ferries can become very crowded as both domestic and foreign tourists take this "back-water trip" to the beach resort area of Pangandaran (reached via Kalipucang). Tourist operators now offer package tours from Yogyakarta to Pangandaran (and vice versa) which include this four hour ferry ride. During the 1994 field season, the number of foreign tourists on the ferry reached, on occasion, fifty to sixty persons per trip. The tourists did not spend any time in Kampung Laut as they merely passed through. Smaller boats, either *jempreng* (holding about 10-15 people) or dugout canoes (*prahu*) (3-5 people) provide other sources of transport to markets and other villages.

Clay and sand are excavated from the estuary. Sand, which is excavated by hand from the mouth of the Citanduy River, is sold for construction materials (i.e., concrete) and to build up

Figure 5.11: Decreasing mobility of boats at low tide, Ujung Gagak

the foundation for new houses being built in the area. The extent of sand mining in the estuary is uncertain, as during the field season only one fisherman stated that he engaged in this activity. A reason for its limited potential may be the risk involved. Sand had to be excavated at high tide in order to transport it by boat, and the water is generally more treacherous at the mouth of the Citanduy River as it is fairly close to the channel leading to the Indian Ocean. The selling price of sand was suggested as Rp 5,000 (CND$3.30) per canoe full (semi-structured interviews 1994).

The second activity is associated with clay excavation for brick making. Brick making is located in *dusun* Panikel and is relatively new activity to the area. Clay and sand, transported from the upland areas, are manually taken from the river bed of the Kawanganten River, molded into bricks, dried in the sun, and then baked in a kiln fire. According to one brick maker, approximately 1,000 bricks can be made in two days and sold in the surrounding area for Rp 4,000 (CND$2.60). The fire requires about 1.5 cubic metres of firewood, which is collected from the surrounding mangrove forest. Although all the surrounding land has been claimed for rice paddies, access to the trees on the land is still open. Bricks were also being made a few kilometres upstream, just outside of Kawanganten.

The combination of the estuary and mangrove forests provides a nursery ground for fish, shrimp and crab. Approximately forty-five fish, twenty shrimp (six of which are commercially desirable), and ten crab species are caught in the estuary (Sujastani 1987; ICLARM 1990). It is estimated that the estuary provides eighty per cent of the fish and shrimp caught by the offshore commercial fisheries at Cilacap (Sujastani 1986; ICLARM 1990). In 1991, these commercial fisheries, the seventh largest on Java, caught approximately 9,398,588 kilograms of fish and shrimp, generating approximately Rp 12,671,953,630 for that year (US$ 6,335,977) (Tempat Pekolangan Ikan (TPI) Cilacap 1992).

The local economy of the three fishing communities located in the estuary has been highly dependent on the estuary fisheries. The fisheries of Segara Anakan are subsistence level, employing traditional fishing techniques and equipment, as illustrated in Figures 5.12 and 5.13. Fishermen employ a variety of throw and fixed nets, each fisherman generally owning two or three different types of nets. Table 5.1 shows the main types of nets used in Kampung Laut, and indicates that the nets used vary among the villages. The variation in nets reflects the different fishing conditions (i.e., wet or dry season), type of catch (i.e., fish, shrimp or crabs), and the fish yield (Table 5.2). The *apong* net is a tidal trap made from the end of the trawl nets

which became available when fishing trawlers were banned in 1983. This net catches both fish and shrimp and generally produces the highest yields, in comparison with the other nets used in the estuary (Table 5.2). On the other hand, the *apong* net costs the most, requires a fixed location and has been associated with over fishing in the estuary (semi-structured interviews

Figure 5.12: Fisherman with apong equipment, Ujung Alang

Figure 5.13: Fisherman with wadong (crab) traps, Ujung Gagak (key informant 1994).

Table 5.1 Fishing Nets Used in Kampung Laut

Type of Net	Ujung Gagak		Ujung Alang		Panikel		Total	
	n	%	*n*	%	*n*	%	*n*	%
Apong (tidal trap)	55	28.7	25	12.1	17	11.5	97	17.8
Kecrek (tidal trap)	0	0.0	38	18.4	0	0.0	38	7.0
Wide (tidal trap)	0	0.0	1	0.5	10	6.8	11	2.0
Kantong (tidal trap)	22	11.5	57	27.7	0	0.0	79	14.5
Cikur (throw net)	20	10.5	9	4.3	0	0.0	29	5.3
Jaring (throw net)	8	4.2	6	2.9	33	22.4	47	8.6
Jala (throw net)	9	4.7	44	21.3	6.0	4.0	59	10.8
Surungan (push net)	17	8.9	9	4.3	23	15.6	49	9.0
Sirang (crabs)	20	10.5	5	2.4	0	0.0	25	4.6
Pinting (crabs)	36	18.8	3	1.4	0	0.0	39	7.1
Wadong (crabs)	3	1.6	8	3.9	26	17.7	37	6.8
Pintur (crabs)	1	0.5	1	0.5	21	14.2	23	4.2
Mancing (line fishing)	0	0.0	0	0.0	11	7.5	11	2.0
Total	191	100	206	100	147	100	544	100

χ^2 (24, $n = 544$) = 453.639, $p \leq 0.05$.
Source: Semi-structured interviews (1994)

1994; ICLARM 1992). The fishing nets are either made by the fisherman and his wife, or are bought from a store in Cilacap (semi-structured interviews 1994). Previously, the net *wide* was the only net used by the fishermen. *Wide* is a stationary tidal trap net made from mangrove stakes. In the mid-1980's *wide* was largely replaced by *apong*, which according to the fisherman who first introduced it in *dusun* Karang Anyar, was met with much resistance and conflict from the rest of the community (semi-structured interviews 1994). The resistance diminished when the increased yields were demonstrated by its use. Fishermen using apong nets, with a fixed location, pay a tax of Rp 5,000/year (CND$3.30) to the village staff.

Table 5.2: Types of fishing nets, Capital Output and Associated Incomes in Kampung Laut, 1994

Nets	Cost of Nets (rupiah)	Average Income in Rupiah Generated per Day (minimum to maximum*)		
		Ujung Gagak	Ujung Alang	Panikel
Apong	250,000-300,000	2,000-20,000	3,000-5,000 to 20,000-40,000	2,000-20,000
Kantong	30,000/net	3,000-10,000	2,000-10,000	na
Jala	small 60,000 large 200,00	2,000-10,000	2,000-10,000	2,000-5,000
Cikur	25,000	5,000 (average)	3,000-7,000	na
Surungan	10,000/net	2,000-5,000	2,000-5,000	2,000-5,000
Pintur/wadong/sirung	10,000-15,000-25,000/each	2,000-10,000	3,000-7,000	2,000-5,000

Source: Semi-structured interviews 1994
*Rp 1,500 is approximately equal to CND$1.00

The estuary fishing is a combination of a private and common property resource. Locations for fixed nets are privately owned, but the rest of the estuary is open access. Fixed net locations are required for both *wide* and *apong* nets, and ownership of location is established through hereditary rights. These locations can be rented or sold, with a selling price depending on the location and potential yields. According to local fishermen, some *apong* locations can fetch up to one million rupiah. Each village has authority over sections of the estuary which falls within its administrative boundaries. According to local fishermen, they must pay an annual fee if their fixed location lies within the boundaries of another village. When using free throw nets, fishermen are able to go anywhere in the estuary without paying a fee, regardless of village boundaries. There is no management of the estuary fisheries, controls on the size of the catch, nor restrictions for outsiders fishing in the estuary. Moreover, the fishermen have limited interactions with the *Himpunan Nelayan Seluruh Indonesia* (HNSI: the Indonesian Fishermen Association), which is located in Cilacap (key informant 1994). Organization of the fishermen is also limited, arising generally on a spontaneous basis in response to a need, such as a death in the village (semi-structured interviews 1994).

A fishing team is generally made up one or two males, generally a father and son, father and other male family member, or father and other male community member. In the latter instance the catch would be divided 2 to 1, the equipment owner receiving two portions. Fishermen generally fish twice daily; generally mid-morning and evening (*siang/sore*), for a duration of four to eight hours per day depending upon the weather, season and tides (semi-structured interviews 1994). The average number of fishing days per month varies slightly among the three villages at 19 days/month in Ujung Gagak, 18 days/month in Ujung Alang, and 16

days/month in Panikel (short survey of fisherfolk 1994). Other fishing-related work mainly involves the fixing and making of nets, which is done by both men and women (semi-structured interviews 1994).

There are two main "fishing periods" or seasons in the estuary. These are associated with the Javanese lunar calendar. *Ngember* is associated with low spring tide fluctuations (August to December), and during this time the fishing yields are lowest. Conversely, during *Ngangkat*, which is associated with spring tide and higher tidal fluctuations, the fishing yields are highest (January to July). High and low fishing yields also occur on a monthly basis, governed by the tides.

Very little, if any processing occurs in the villages, and as such, most of the fish is sold fresh (Figure 5.14). Previously in Kampung Laut, *terasi* (a shrimp paste) was produced, but the *rebon* shrimp is no longer caught in large enough quantities (key informant 1994). The marketing of the fish involves a system of *bakuls* or middle traders. Fishermen sell their fresh fish on their return home to a *bakul kecil* (small trader) located in the village. The fisherman is paid cash for the amount, type and quality of the fish, shrimp or crab caught. The selling price is associated with the prices set by *Tempat Pekolangan Ikan* (TPI), a government run fishing cooperative located in Cilacap, according to the daily market prices, although it is suggested that the buying price is sometimes lower (Hardyono 1980). The *bakul kecil* then sells the fish to a *bakul besar* (larger trader) in either Cilacap, Kalipucang, or Kawanganten. This trader may sell again to larger traders, or to other interests (e.g., restaurants and international shippers) (semi-structured interviews 1994).

The main source of credit for the fisherfolk is from the *bakuls* and the trading arrangement involves the *ijon* system (key informants 1994). With the *ijon* system, the fishermen borrow money from the *bakul* on the agreement of selling his fish to him/her at a set price (regardless of the market price fluctuations) (Hardyono 1980). Generally, the buying price is more beneficial for the trader than the fisherman. It was suggested by a key informant that the *ijon* system was not always the case, and that the fishermen could sell the fish to any trader, and then repay in cash.

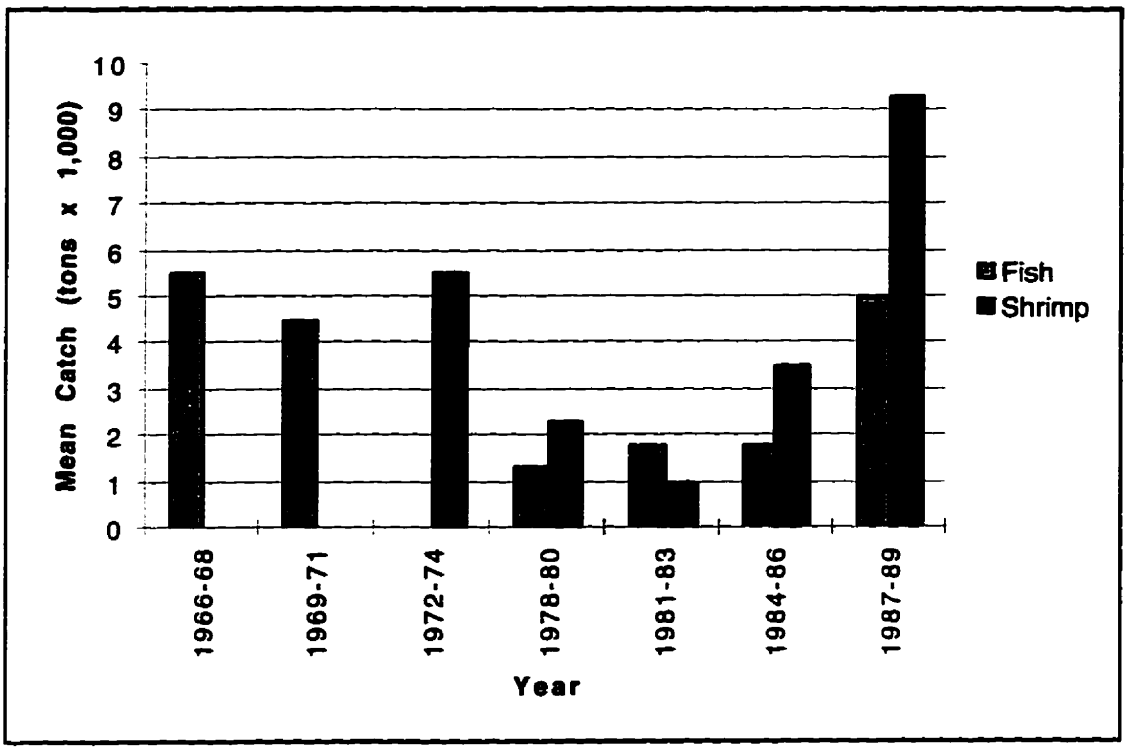
Income derived from fishing fluctuates seasonally and monthly, depending on the type and amount of fish or shrimp caught. The daily income from fishing ranges from a low of Rp 1,000-2,000 (CND$0.66-$1.33) during the dry season (*ngember)* up to Rp 10,000-20,000-

Figure 5.14: Marketing fresh fish to a *bakul*

40,000 (CND$6.60-$13-$26) during the rainy season (*ngangkat*) (semi-structured interviews 1994). An average low monthly income was estimated for the fisheries, based on the lowest income provided in the semi-structured interviews and the average number of fishing days per month. The average low monthly income in Ujung Alang was Rp 81,000 (CND$54), Rp 48,000 (CND$32) in Ujung Gagak, and Rp 40,000 (CND$26) in Panikel (semi-structured interviews 1994).

There is a consensus among the fisherfolk that not only are the fishing yields decreasing in the estuary, but so are the varieties and sizes of the fish and the number of viable fishing locations for both fixed and free throw nets. This change has mainly been attributed to the cumulative effects of sedimentation, although over-fishing resulting from the *apong* nets has also been suggested (ICLARM 1992). Figure 5.15 illustrates yearly changes in the average fish and shrimp yields in the estuary, indicating that the yields have increased since an eight year low in the early 1980's. This increase is most likely associated with the effects of the banning of the trawls. This information contradicts what the fisherfolk are suggesting about the continuous decline in fishing yields. In order to confirm these results with the fisherfolks' general consensus, more recent information is required, as well as documentation on how the data were collected for this graph. In 1987, it was estimated that the annual catch in the estuary was approximately 2,700 tons, generating Rp 1,419 million (ICLARM 1992, 30).

Figure 5.15: Estimated Mean Catch of Fish and Shrimp in Segara Anakan, 1966-1989



Source: ICLARM (1992, 28)

It is difficult to measure the economic impact of sedimentation on the fisherfolk's income, as limited historical data are available on the yields, types of fish caught, and market prices. This lack of data is related to the poor marketing system in the villages prior to the early 1980's. Prior to the early 1980's, no *bakuls* lived in, or regularly visited, Kampung Laut to buy the fish, and the villagers seldom visited Cilacap. As a result, fish would often pile up and rot (key informant Ujung Gagak 1994). Moreover, the market price for selling fish, shrimp and crab was very low, and it was suggested that local people used to eat the shrimp and crabs themselves because there was no market for selling them. In the early to mid 1980's this situation changed with international marketing interest, particularly from Japan. As such, the lower fish yields have been compensated for by both the higher market price and a more stable marketing system (semi-structured interviews 1994).

This change is illustrated by the account of one fisherman, who in 1994 suggested that if the amount of yields were the same today as ten years ago, then with today's selling price it would only take eight days to build a home. With the current yields, however, it was not possible to build a home.

5.2.4 Rice Agriculture

In 1968, rice agriculture did not exist within Segara Anakan, only along the outside perimeter of the mangrove forest (Figure 5.2). From 1968 to 1995, the establishment of rainfed rice (*sawah hujan*) lands accounted for the largest conversion of land use in Segara Anakan. From 1968 to 1987, approximately 10,100 hectares of mangrove forest and new lands were converted into rice fields (Figure 5.4). These new agricultural lands were located mainly to the north, northwest and northeast of the estuary, as well as along the north coast of Nusa Kambangan (Figures 5.16 and 5.17). In areas closer to the mangroves, rice replaced *wrakas*, a shrub-like vegetation which grows on drier land (Figure 5.18). From 1987 to 1995, approximately 4,975 hectares of additional mangrove forest were converted to rice fields (Figure 5.5). During this time period, the majority of land cover change occurred in Ujung Gagak and Panikel. In 1995, there were approximately 9,958 hectares of rice fields and settlements (Figures 5.1, 5.19 and 5.20).

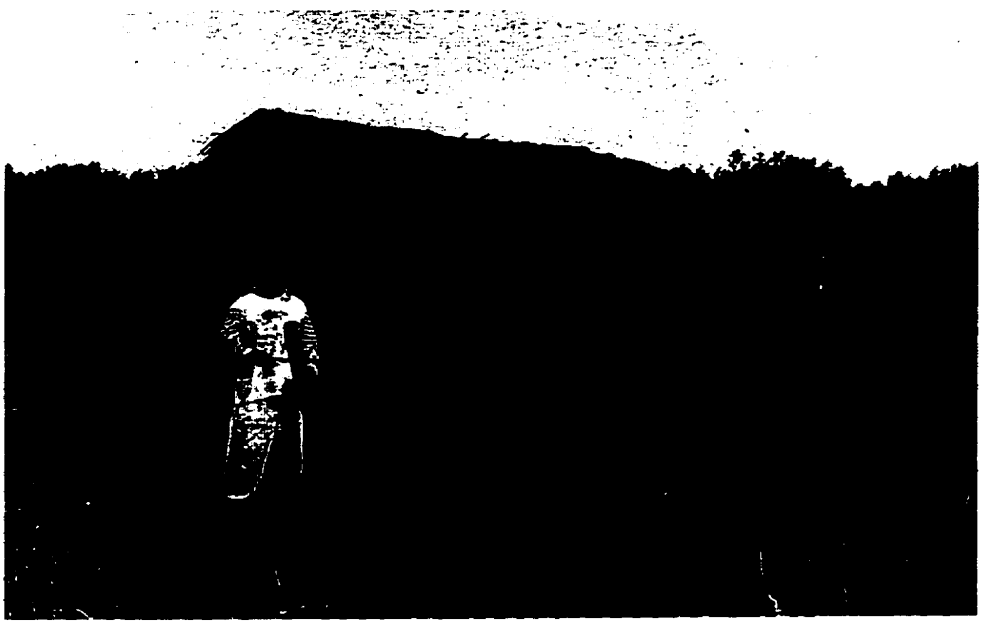


Figure 5.16: Clearing mangroves for rice fields, Ujung Gagak

Figure 5.17: Clearing mangroves for new homes and rice fields, Ujung Alang

Figure 5.18: Wrakas shrubs replacing mangroves in drier areas, north perimeter of forest

Figure 5.19: Established rice fields in Ujung Alang (along the 'mountain')

Figure 5.20: New rice fields and settlements, Ujung Alang

The cultivation of rice began at various times in Kampung Laut. Table 5.2 illustrates the time frame of rice development, indicating that it first began in Ujung Alang in the early 1980's, and in 1987 in Panikel, and even later in 1989 in Ujung Gagak. The pioneering of rice agriculture in Ujung Alang was attributed by local people to either the military men stationed at the guard post in Klaces, or to an older fisherman in Motehan whose outside contacts provided him with sufficient information to cultivate rice in the early 1970's. In the early 1980's, rice cultivation

became more popular with a "willingness" of the fisherfolk to try growing rice because of the declining fishing yields (semi-structured interviews 1994). The development of rice agriculture was supported and promoted by the *Kepala Desa* at that time (i.e., prior to 1988) as he viewed it as a needed development opportunity for his village and an alternative to transmigration (semi-structured interviews 1994)[26].

In Ujung Gagak, rice agriculture first began in 1987 in *dusun* Ujung Gagak Baru and Cibereum (Table 5.2). *Dusun* Ujung Gagak Baru was established in 1987 on village lands (*tanah bengkok*). In *dusun* Karang Anyar, rice agriculture began later in 1989.

In Panikel, the development of rice agriculture began around 1986/1987 (Table 5.3). According to the previous *Kepala Desa*, prior to rice development, approximately twenty-five per cent of the households had transmigrated by the early 1980's (key informant 1994). Another local transmigration was planned to the nearby *Desa* Cikerang in 1983. This transmigration was in response to the worsening economic conditions resulting from the declining estuary fisheries. This plan for transmigration was never implemented because of the perceived small land allocation of two hundred *ubins*[27] per family and two major floods which occurred around that time. The floods brought large amounts of mud creating new lands in a short time period. These floods were viewed as *Berkah Tahun*-a gift from God-by the local people. As a result of the new mud, rice seedlings were transported downstream where fisherfolk saw that they could grow. With the permission from the *Kepala Desa*, fisherfolk planted a small area of rice to determine if it would be successful. The next year a larger area was planted, and subsequently more people began to plant rice.

The main physical constraint to rice cultivation in Segara Anakan is the control of water (semi-structured interviews 1994). Frequent floods during the rainy season, and lack of fresh water and salt water intrusion during the dry season, impede rice cultivation throughout Kampung Laut (Figure 5.21). The severity of flooding ranges from extreme, long lasting levels, where no rice can be harvested (i.e., 4 metres deep), to temporary floods, where harvests are still possible, although at lower yields. The floods result from both salt water intrusion from the estuary waters and from the rains. Flooding of the rice fields often results in planting rice

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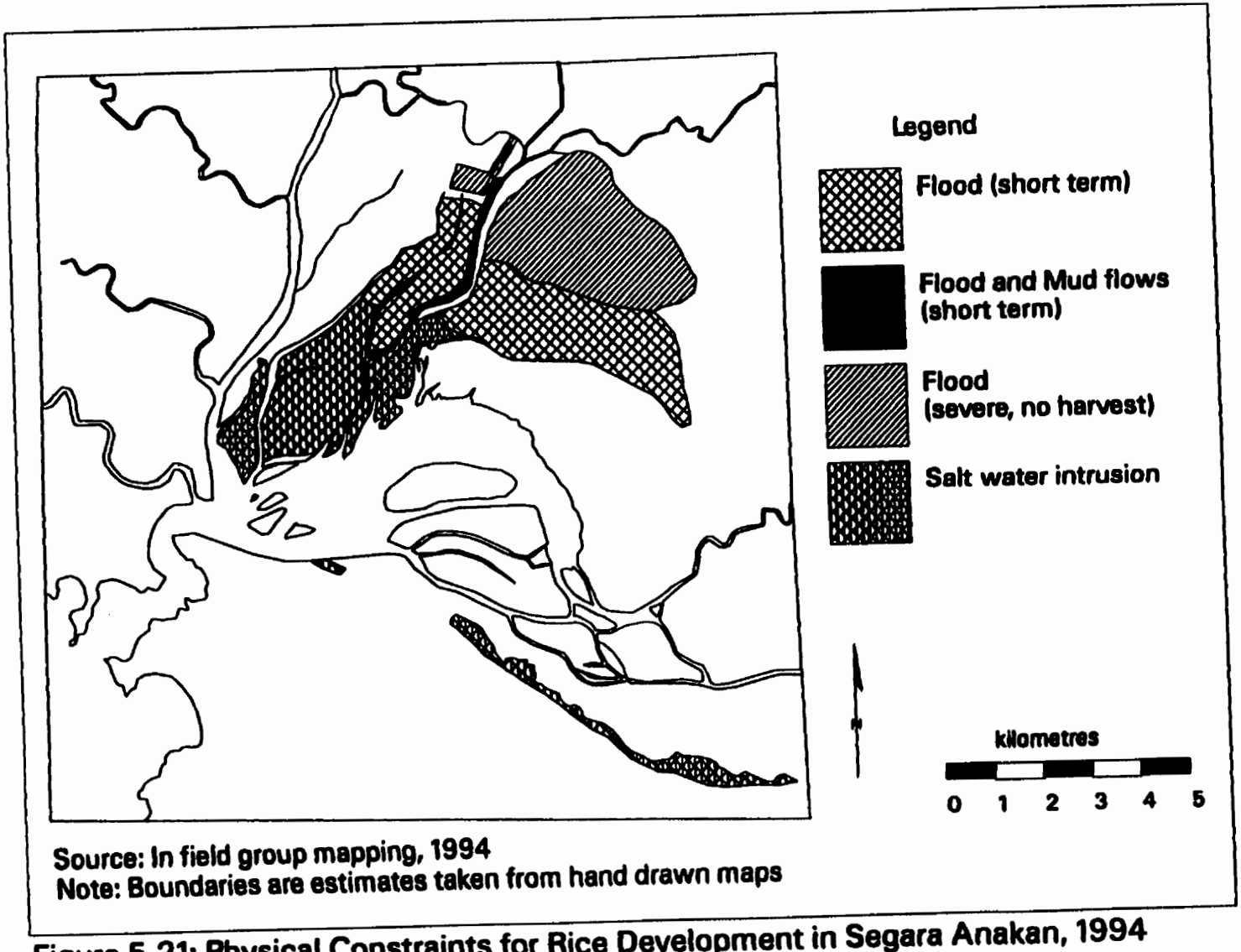
[26] The last election for village head was in 1988 in which a the post was filled by a new person in each of the villages.

[27] One *ubin* is equal to 0.14 hectare, or 700 *ubins* is equal to one hectare.



Source: In field group mapping, 1994
Note: Boundaries are estimates taken from hand drawn maps

Figure 5.21: Physical Constraints for Rice Development in Segara Anakan, 1994

Table 5.3: Time Frame for Rice Development in Kampung Laut

Year Obtained Land	Ujung Gagak		Ujung Alang		Panikel		Total	
	n	%	*n*	%	*n*	%	*n*	%
1970-1979	0	0.0	11	15.0	0	0.0	11	3.4
1980-1984	0	0.0	39	53.4	0	0.0	39	12.1
1985-1989	49	37.9	19	26.0	101	85.5	169	52.8
1990-1994	80	62.0	4	5.4	17	14.4	320	31.5
Total	129	40.3	73	22.8	118	36.8	320	100

χ^2 (6, n = 320) = 273.117, $p \leq 0.05$. (Note: 25% of the cells have expected counts less than the critical value of 5) Source: Short Survey of fisherfolk 1994

seedlings two to three times, adding cost to farmer, as well as lower yields (Figure 5.22). During the dry season, all the rice fields in Segara Anakan suffer from lack of fresh water, with the exception of locations close to the mountain on Nusa Kambangan (semi-structured interviews 1994).

Dikes have been constructed throughout Segara Anakan, starting in the early 1980's, as a means to control salt water intrusion into the rice fields (Figure 5.23). The specific location of the dikes in each village was decided upon by the *Kepala Desa*, village members and the nongovernment organization of Yayasan Sosial Bina Sejahtera (YSBS), the funding

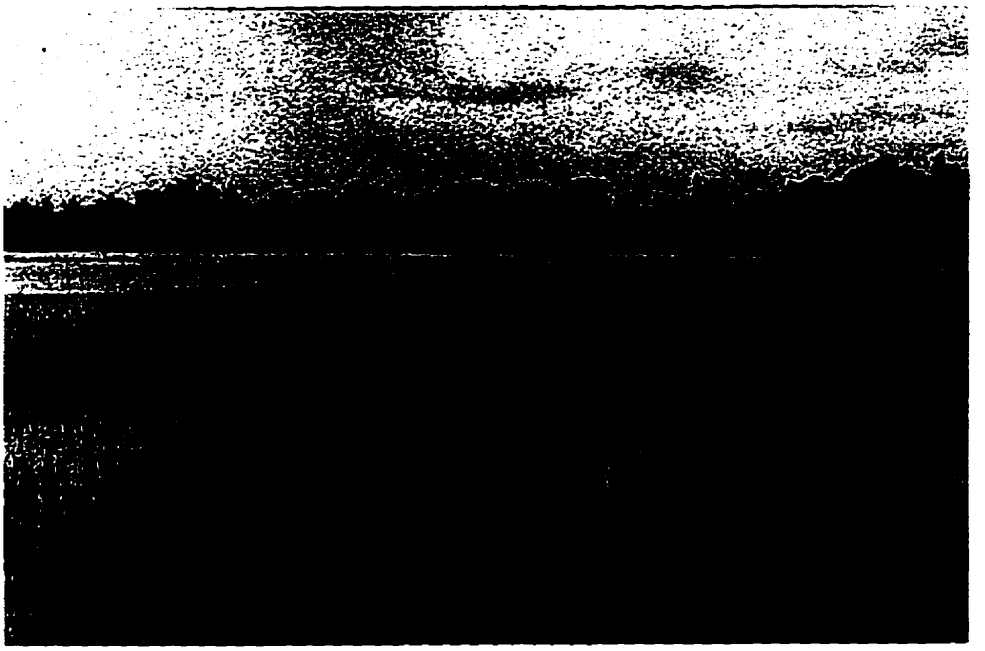
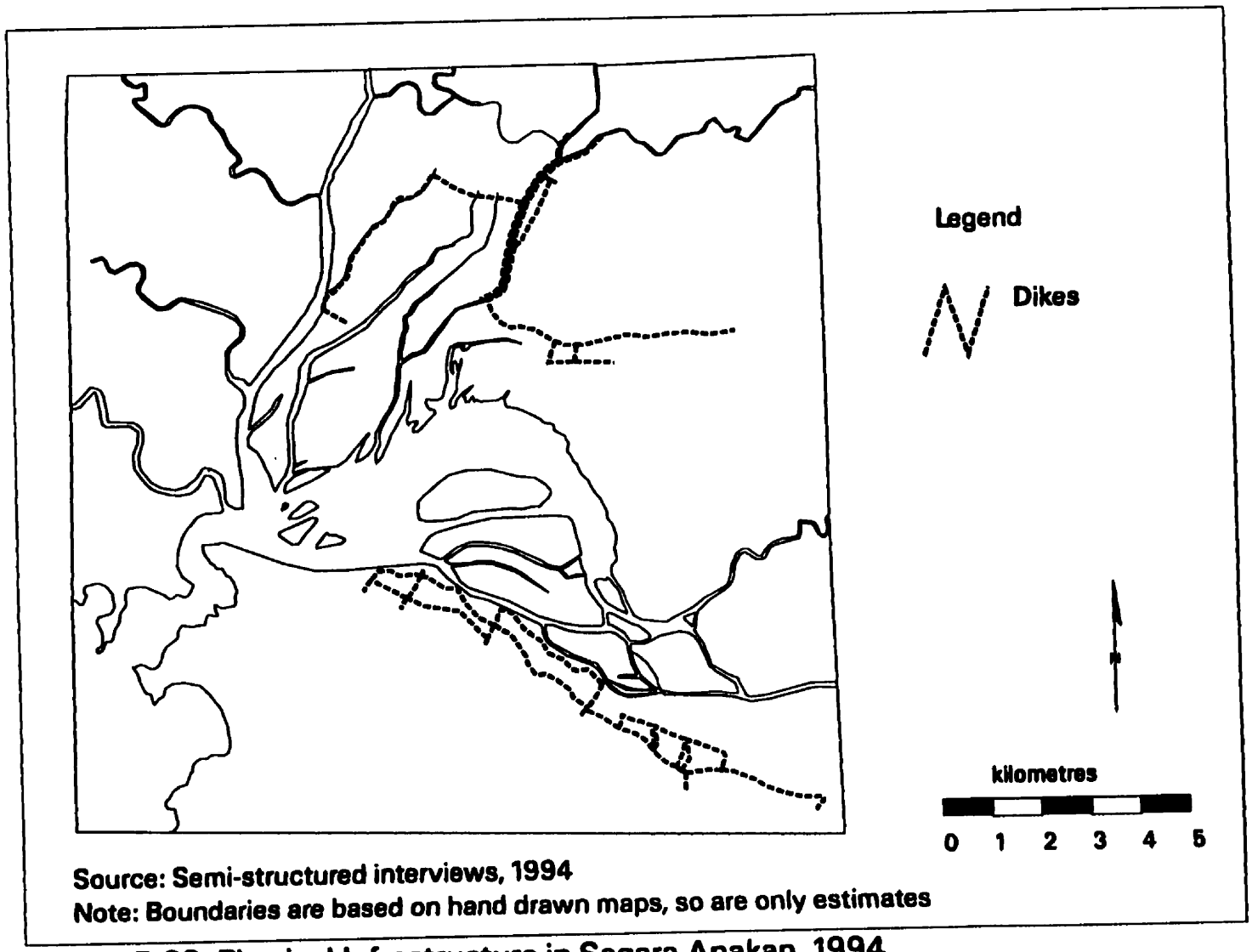


Figure 5.22: Flooded rice fields, Ujung Alang



Source: Semi-structured interviews, 1994
Note: Boundaries are based on hand drawn maps, so are only estimates

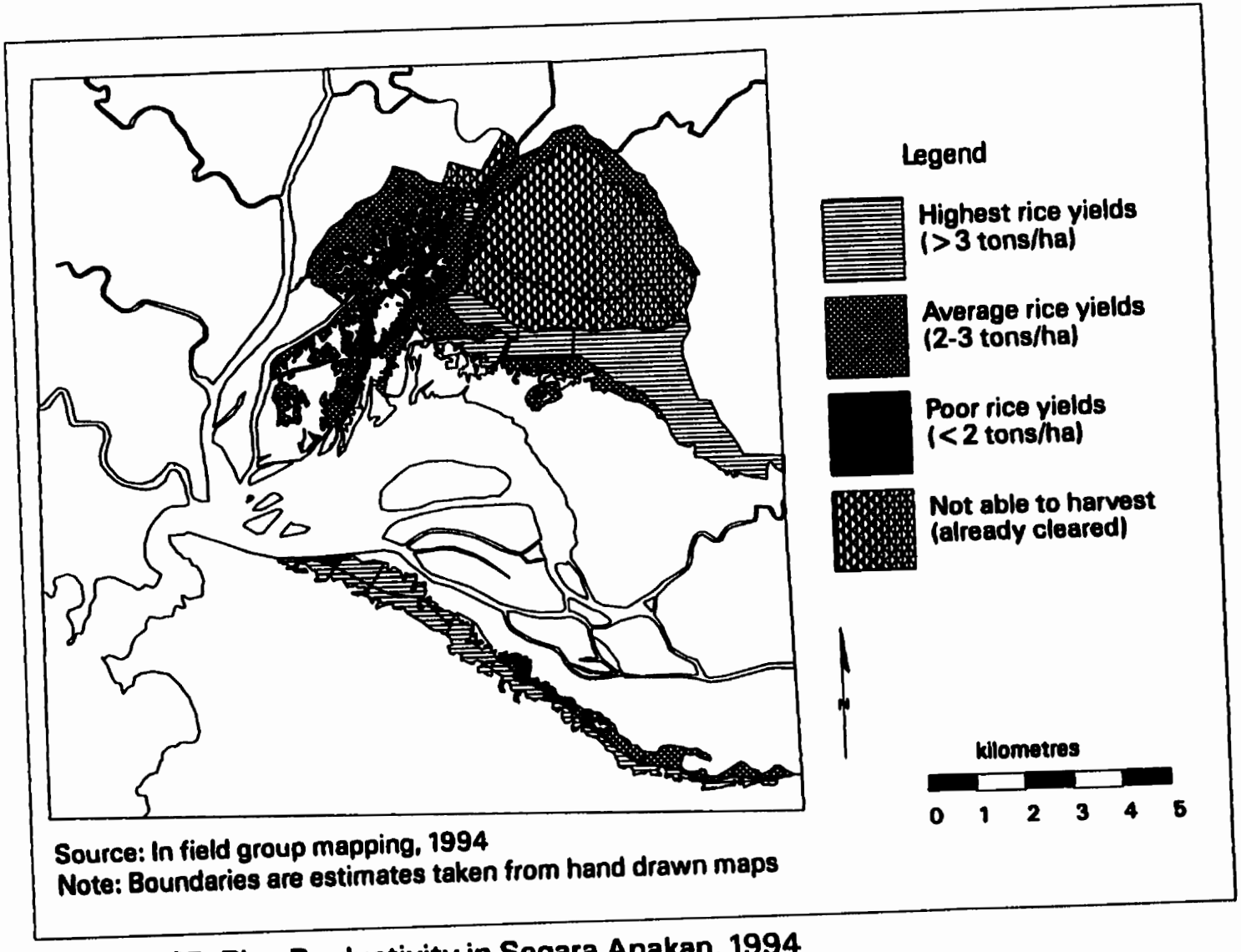
Figure 5.23: Physical Infrastructure in Segara Anakan, 1994

organization and overseer of operations. The effectiveness of the dikes to stop salt water intrusion varies throughout Kampung Laut, depending upon the quality of construction (i.e., materials) and maintenance (Figure 5.24).

The main rice species grown is *Cisedane*. *Cisedane* is a high yielding variety (HYV), cross-bred from the rice species *Pelita* and *Atomita* in Bogor, West Java in the mid 1980's (pers. com, Agricultural Department Official 1994). *Cisedane* has produced the highest yields in Segara Anakan, which is attributed to its higher stalk and tolerance for wetter conditions (semi-structured interviews 1994). According to the agricultural extension officer, *Cisedane* was brought to Kampung Laut by immigrant farmers. Only four of interviewed farmers planted traditional rice species.

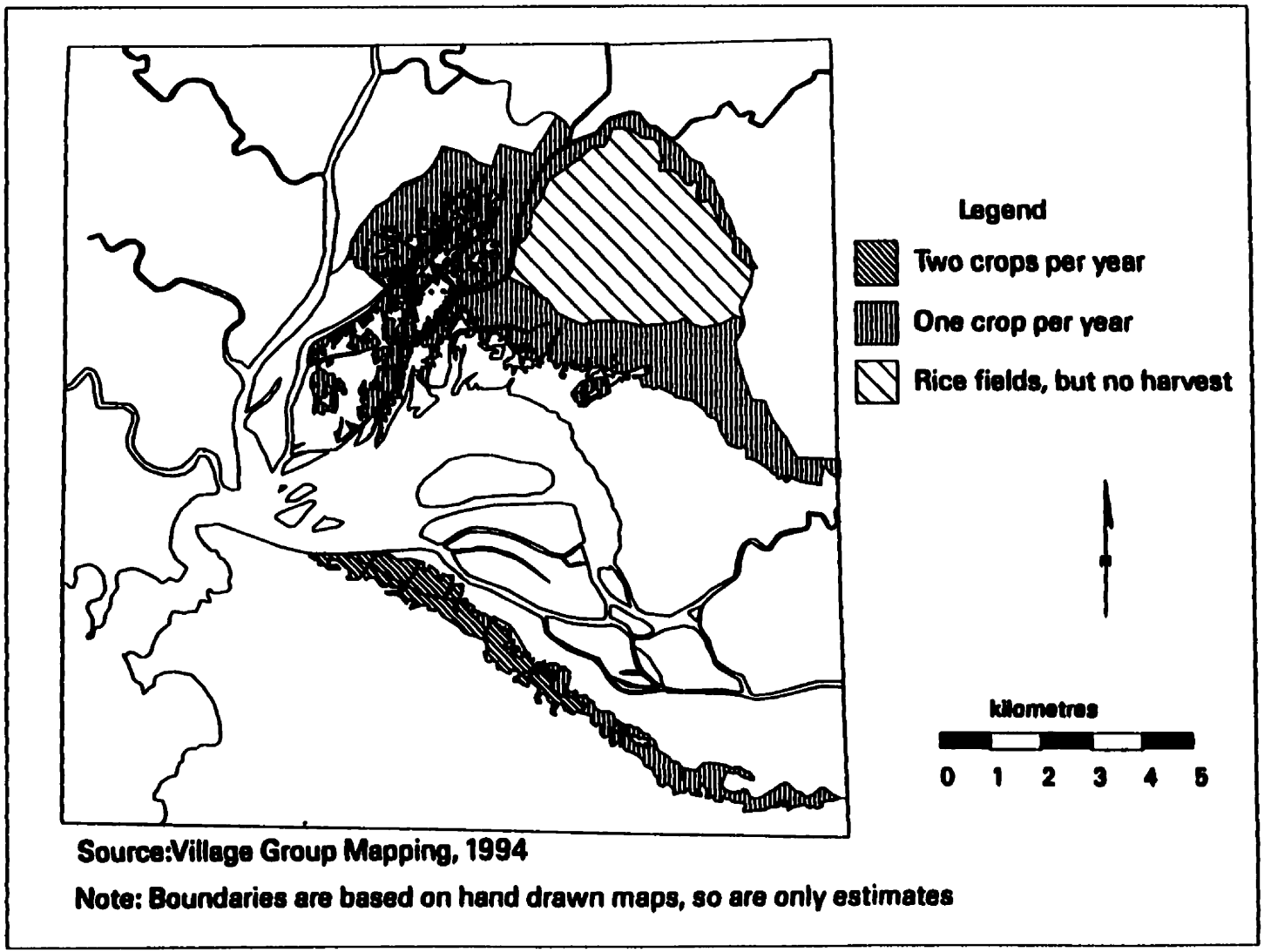
Rice productivity in Kampung Laut ranges from a low of no yields to a high of 4-5 tons/hectares, as indicated in Figure 5.25. The average rice yields are highest in Ujung Alang at 3 tons/ha, while the rice fields in both Ujung Gagak and Panikel average 2 tons/ha (semi-structured interviews 1994). The majority of the rice fields in Kampung Laut can only produce one crop per year, although some fields in *dusuns* Klaces and Motehan Baru can produce two rice crops annually (Figure 5.26). In 1994, the conditions were too dry to cultivate a second

Figure 5.24: Damaged dike in Ujung Alang



Source: In field group mapping, 1994
Note: Boundaries are estimates taken from hand drawn maps

Figure 5.25: Rice Productivity in Segara Anakan, 1994



Source:Village Group Mapping, 1994

Note: Boundaries are based on hand drawn maps, so are only estimates

Figure 5.26: Number of Rice Crops Cultivated Per Year in Segara Anakan, 1994

crop (semi-structured interviews 1994). The stability of the rice yields also varies, with an overall decreasing trend, particularly in Ujung Gagak and Panikel. The village secretary of Ujung Gagak stated that once the rice fields could produce four to five tons/hectares, but after planting two or three times the yields had decreased.

The cultivation of the rice fields is managed through various labour arrangements, notably, farmers working the land themselves, hiring labour, and/or help from family members. A common response was that additional labour is hired if extra money is available. The cost for hired labour ranges from Rp 2,000/day (CND$1.33) plus three meals, to Rp 3,000/day (CND$2) and no meals, although in *dusun* Cibereum labour costs have been driven to Rp 4,000/day (US$2) because of the construction of semi-intensive fish ponds (*tambak*). Extended family members and/or neighbours sometimes share labour needs, each working on the other's land, a process referred to as *liuran*. There was no direct payment involved, only an exchange of labour. *Liuran* groups are established mainly on an informal basis, sometimes organized through the head of the *RT* or *RW* (semi-structured interviews 1994).

The rice fields of Kampung Laut are not yet considered intensive, in that there is limited use of technology, including the application of pesticides and fertilizers and mechanized methods (semi-structured interviews 1994). The main reasons for limited use of fertilizers were because the land was still considered fertile, or the farmers did not have enough money to buy them. In Ujung Gagak and Panikel, the farmers suggest that the soils do not yet need to be fertilized nor must they be weeded. Tractors were not extensively used, although they were available from outside people. The cost of hiring a tractor (plus the labour to operate it) was rupiah 15,000 to 17,000/ubin (CND$10-$11.30), which was suggested to be similar to manual labour costs. The main problems encountered with the use of a tractor are: 1) the ground is too muddy to support the tractor (i.e., it sank), 2) tree stumps were left in the ground when the land was initially cleared, and 3) tractors are not always available when it is time to plow the land (semi structured interviews 1994). Three rice mills are located in Kampung Laut, one in Ujung Alang and two in Panikel.

Harvesting in Kampung Laut is conducted through a *bawon* arrangement, as opposed to the *tebasan*[28] system prevalent in the rest of Java. In *bawon* harvesting, any person is permitted to participate and receives as payment one-fifth of the amount of rice harvested. The amount of rice a harvester can obtain during harvest season depends upon the number of days worked (approximately 20 days in a harvest season) as well as their skill. There is a high availability of both male and female harvesters, including the fisherfolk (semi-structured interviews 1994). Some of the harvesters have obtained larger amounts of rice yields by participating in the rice harvest, than some farmers have from growing rice.

Based on the semi-structured interviews, the range of income generated from rice farming varies substantially throughout Kampung Laut. Estimations obtained from the semi-structured interviews indicated a range in income from rice farming in Ujung Alang from Rp 20,000 (CND$13) to Rp 850,000 (CND$566) per year, with an average income of Rp 197,437 (CND$131) (semi-structured interviews 1994). In Ujung Gagak, the income from rice farming ranged from a loss of Rp 400,000 (CND$333) to a profit of Rp 430,000 (CND$286)/year, and an average income of Rp 157,321 (CND$104)/year. In Panikel, the range of income from rice agriculture was Rp 72,000 (CND$48) to Rp 500,000 (CND$333), with an average income of Rp 188,555 (CND$125)/year (semi-structured interviews 1994).

The stability of income generated from rice farming is associated not only with the yields generated, but also the inputs used, and the selling time and arrangements. Table 5.5 provides five examples of rice inputs and outputs from various parts of Kampung Laut, indicating the general expenses involved. All of the interviewed fisherfolk and farmers stated that they only sold rice when they needed money, and that the income generated depends upon when the rice is sold. For example, if the crop was bought prior to harvesting through the *ijon* credit system, similar to that of the fishermen, then the buying price is around Rp 20,000/kg; (CND$13) at the time of harvest, the buying price is higher at approximately Rp 30,000/kg (CND$20); and if sold during *paceklick*, when rice availability is at its lowest (e.g., August), then the selling price is higher, around Rp 40,000/kg (CND$26) (semi-structured interviews 1994). The marketing system of rice is similar to the fisheries, based on a system of *bakuls* (traders). Local *bakul kecils* (small traders) purchase the harvested rice (*beras*) from local farmers and then sell it to *bakul besars* (larger traders) outside of the village.

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[28] *Tebasan* is "the sale of a rice crop when ready to a buyer who employs a limited number of harvesters of his own choice, often from outside of the village" (Hardjono 1987, 14).

Table 5.5: Examples of Income generated from Rice Farming

Pak A Ujung Alang			
1600 kg/200 ubin (last harvest) (Rp 30,000* /100 kg)			Rp 480,000
inputs:			
Cisedane seedlings	20 kg/200 ubin	@ Rp 4800.00/5 kg	Rp 19,200
fertilizer: Urea	50 kg/200 ubin 2 times @ Rp 275/kg		Rp 27,500
TS	20 kg/200 ubin, 2 times @ Rp 350/kg		Rp 14,000
Pesticide	Diazonine (ws) 1 litre		Rp 10,000
Labour	@ Rp 3000 /day + breakfast		
	hoe	10 people/1 day/200 ubin	Rp 30,000
	plant	9 people/1 day/200 ubin	Rp 27,000
	weed	5 people/2 days/200 ubin (2 times)	Rp 60,000
	harvest: bawon system 1/5 of harvest given to worker		
		Total cost of inputs	Rp 175,100
		Profit	**Rp 304,900**
Pak B Ujung Alang			
2000kg/400 ubin @ Rp 30,000/kg			Rp 600,000
Inputs:			
Cisedane seedlings	60 kg/400 ubin @ Rp 4,500/5 kg		Rp 54,000
Fertilizer	Urea 12kg/400 ubin (2 times) @ Rp 275/kg		Rp 3,300
Pesticides	Simprot 1/2 litre x2		Rp 4,000
Labour	Rp 3,000/day (no food)		
	hoe (tractor) Rp 15,000/ubin		Rp 60,000
	planting 5 people/6 days/400 ubin		Rp 90,000
	weeding 3 people/5 days/400 ubin (2 times)		Rp 90,000
		Total Input Costs	Rp 310,300
		Profit	**Rp 289,700**
Pak C Panikel			
400 kg/100 ubin selling at Rp 30,000/100kg			Rp 120,000
inputs:			
Cisedane seedlings	1 kw at Rp 5,000 /100kg		Rp 5,000
Labour at Rp 3,000/day			
hoe	4 people for 1 day		Rp 12,000
plant	5 people for 1 day		*liruan* (no cost)
clear	4 people for 1 day		Rp 12,000
or weed killer: needs 7 bottles @ Rp 3,5000/bottle			Rp 24,500
total input costs	Rp 24,000 or Rp 36,500 (using weed killer instead of labour)		
Profit	**Rp 101,800 or Rp 89,300 (using weed killer instead of labour)**		
Pak D Panikel			
1400 kg/ha selling at Rp 30,000			Rp 420,000
inputs:			
Cisedane seedlings 200kg at Rp 5,000/100kg			Rp 10,000
Fertilizer: Urea 50kg			Rp 375
Labour: *liuran* (no direct costs)			
		total input costs	Rp 10,375
Profits			**Rp 409,650**
Pak E Ujung Gegak			
Rice Yields for 1994: 1500kg /350 ubin, sold @ Rp 30,000/100 kg			Rp 450,000
inputs: Cisedane seedlings:	40kg @ Rp 5,000/kg		Rp 40,000
Fertilizer: Urea	10kg @ Rp 350/kg + sprayer		Rp 4,000
Labour: @ Rp 3,000/day (no meals)			
	clear land 5 people for 6 days		Rp 90,000
	plant	10 people fo 2.5 days	Rp 75,000
	weeding	not yet required	
	harvest	bawon	
		total cost of inputs	Rp 208,500
		profit	Rp 241,900

While rice has been the dominant agricultural activity in Segara Anakan, the cultivation of other agricultural products, generally cash crops, occurs on a much smaller scale. These crops include soybean, sugar production, sorghum, fruits and vegetables, and are often sold to supplement the household income (semi-structured interviews 1994). Soybeans are being cultivated in different areas throughout Kampung Laut, mainly during the dry season when there is not sufficient fresh water for rice. The cultivation of soybeans is fairly recent, arising from the need to supplement the rice income, and in most areas it is still in experimental stages. Fruits and vegetables are also cultivated throughout Kampung Laut on an annual basis, mainly on land that is more established, such as near the "mountain" in Ujung Alang, and along the bank of the Kawanganten River in Panikel. The fruits (e.g., bananas and jack fruit) and vegetables (e.g., chilies) are for both personal use and to sell to neighbours and small local stores (semi-structured interviews 1994).

Sugar made from coconut sap (*gula jawa or gula merah*) is produced in Ujung Alang (Figure 5.27). The sugar producers are mainly farmers from West Java, who either rent the coconut trees from local owners, or enter into a share-cropping arrangement. The cost of renting a coconut tree ranges from Rp 2,000 to Rp 5,000/tree/year (CND$1.30-$3.30) depending on its productivity. The amount of sap produced per tree per day ranges from 0.15 to 0.75 kg, with an average daily yield of approximately 0.42 kg (semi-structured interviews 1994). The selling price of sugar ranged from Rp 550 to Rp 800/kg (CND$0.35-0.50). Sugar is sold in the same manner as fish and rice, through a system of *bakuls*, three of whom reside in Klaces. Additional inputs required to make the sugar include a chemical to make the sugar more cohesive and a lighter colour (which has a market preference), and firewood, which is collected from the surrounding forest. The head of *dusun* Klaces felt that the area is good for sugar production because a tree can produce sap three years after it has been planted.

During the dry season in 1994, sorghum was planted on approximately fifteen hectares of land in Panikel. The cultivation of sorghum arose through a contract with a company, which uses it to produce brooms for export (semi-structured interviews 1994). As part of the contract, the company pays for the seeds and labour, and the buying price was quoted as Rp 120 (CND$0.08) for one kilogram of sorghum (semi-structured interviews 1994). The productivity of sorghum was still uncertain in 1994.

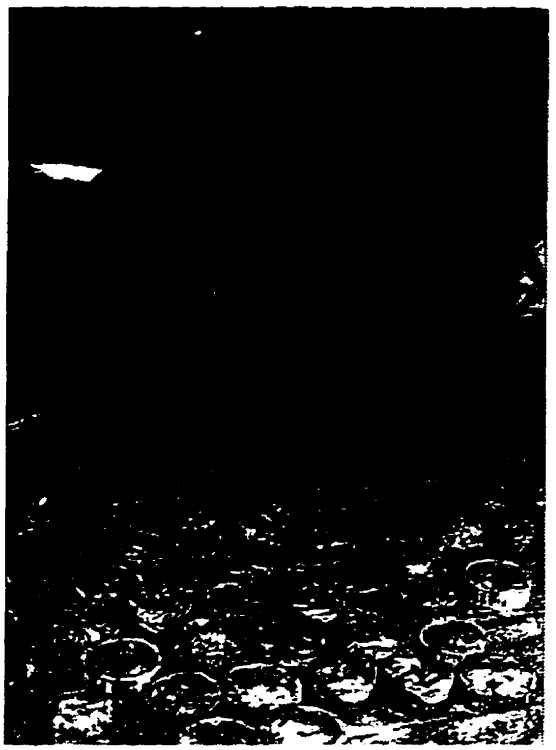


Figure 5.27: Sugar production in Ujung Alang

5.2.5 Semi-Intensive Fishponds (Tambak)

In 1968 and 1987, there were no semi-intensive fishponds in Segara Anakan (Figures 5.2 and 5.3). The 1995 land cover classification indicates that there were approximately 609 hectares of semi-intensive fish ponds and new rice fields in Kampung Laut (Figure 5.1). Because of the wetland nature of the *tambak* and its close proximity to new rice fields and new lands, it was difficult to digitally classify it as an individual land cover. As such, the land cover class consists of a mixture of *tambak* and rice fields. The field work indicated that there were approximately 100 hectares of *tambak* in 1994, showing a large discrepancy with the classified image.

Semi-intensive fishponds (*tambak*) were only located in *dusun* Cibereum, Ujung Gagak (Figure 5.28). *Tambak* development first began in 1991 by a fish pond labourer from Pati, Java. In 1994, of the approximately one hundred hectares of *tambak* ponds, an estimated ninety-four hectares were owned by people from outside of Kampung Laut (key informant 1994). The cost of *tambak* construction is relatively high, ranging from Rp 7.5 million to buy a one hectare pond already operational, to approximately Rp 600,000 (CND$400) to build one (Table 5.4). One *tambak* owner sold one hectare of land in Sumatra for Rp 2.8 million, which

Figure 5.28: Construction of *tambak* in Cibereum, Ujung Gagak

Table 5.4: Costs Associated with Fishpond Construction in Kampung Laut

Construction Activities	Cost in Rupiah
1. Buying the land (still forest)	1 million
2. Clearing and cleaning land	500 thousand
3. Digging (1m x 3m x 1/2 m)	2.5 million
4. Digging canals deeper	300 thousand
5. Making dikes higher	300 thousand

Source: Semi-Structured Interviews 1994

allowed him to purchase two hectares of land in Cibereum. The price of land is considered inexpensive by *tambak* developers, relative to other areas of Java. In 1994, the average buying price of land in Cibereum was one million rupiah per hectare (pers com *tambak* owner 1994). It was suggested by an outside owner, that even though the success of *tambak* is still uncertain, the area is beginning to attract more *tambak* developers from other parts of Java.

5.2.6 Settlements

In 1968, the only settlements in Segara Anakan were the fishing communities. In 1994, although under the same administration, the settlements can be divided into the fishing and rice agricultural communities. In 1995, these two types of settlements comprised approximately 197.6 hectares of land (Figure 5.1).

When originally constructed, the fishing villages were all built on stakes above the estuary waters, where the fisherfolk "used to sleep above the fish" (key informant 1994). Since the early 1970's, the houses have been gradually rebuilt onto the new lands, as they have became more stable. In 1994, the only stilt homes (*rumah panggung*) remaining were found on the fringes of *dusuns* Karang Anyar and Motehan. The fishing settlements are nucleated, with the houses built very close to each other. The grounds around the homes have largely remained barren, with only a few plants along the main pathways and selected homes. The main walkways which traverse the villages are used to repair larger nets, socialize, as well as a playground for children (Figures 5.29 to 5.31).

The agricultural settlements, which emerged in the early 1980's through to the present, are mainly extensions of the fishing communities, although they are a linear form, strung along the rivers and dikes. As a consequence of these extensions, all three villages have had, or in 1994, were in the process of establishing new *dusuns*. In Ujung Alang, *dusun* Motehan Baru was established in the mid 1980's, *dusun* Ujung Gagak Baru was created in 1987 in Ujung Gagak, and in 1994 Desa Panikel planned to divide *dusun* Mara Dua into four *dusuns*, and split *dusuns* Panikel and Bugel each into two *dusuns*. These village extensions are settled mainly by immigrant farmers and returning transmigrants, making some *dusuns* almost entirely

Figure 5.29: Traditional fishing homes on stilts, Ujung Gagak

Figure 5.30: Fishing village built to ground, Ujung Gagak

Figure 5.31: Net repairing and socializing in village path, Ujung Gagak

comprised of newcomers, as highlighted in Figure 5.32. Since 1975, there has been a forty-five per cent increase in the population, as indicated in Figure 5.33. It is difficult to ascertain how much of this population growth is associated with either natural increase in the villages or the immigration of farmers. Figure 5.32 does indicate that immigrant farmers account for a

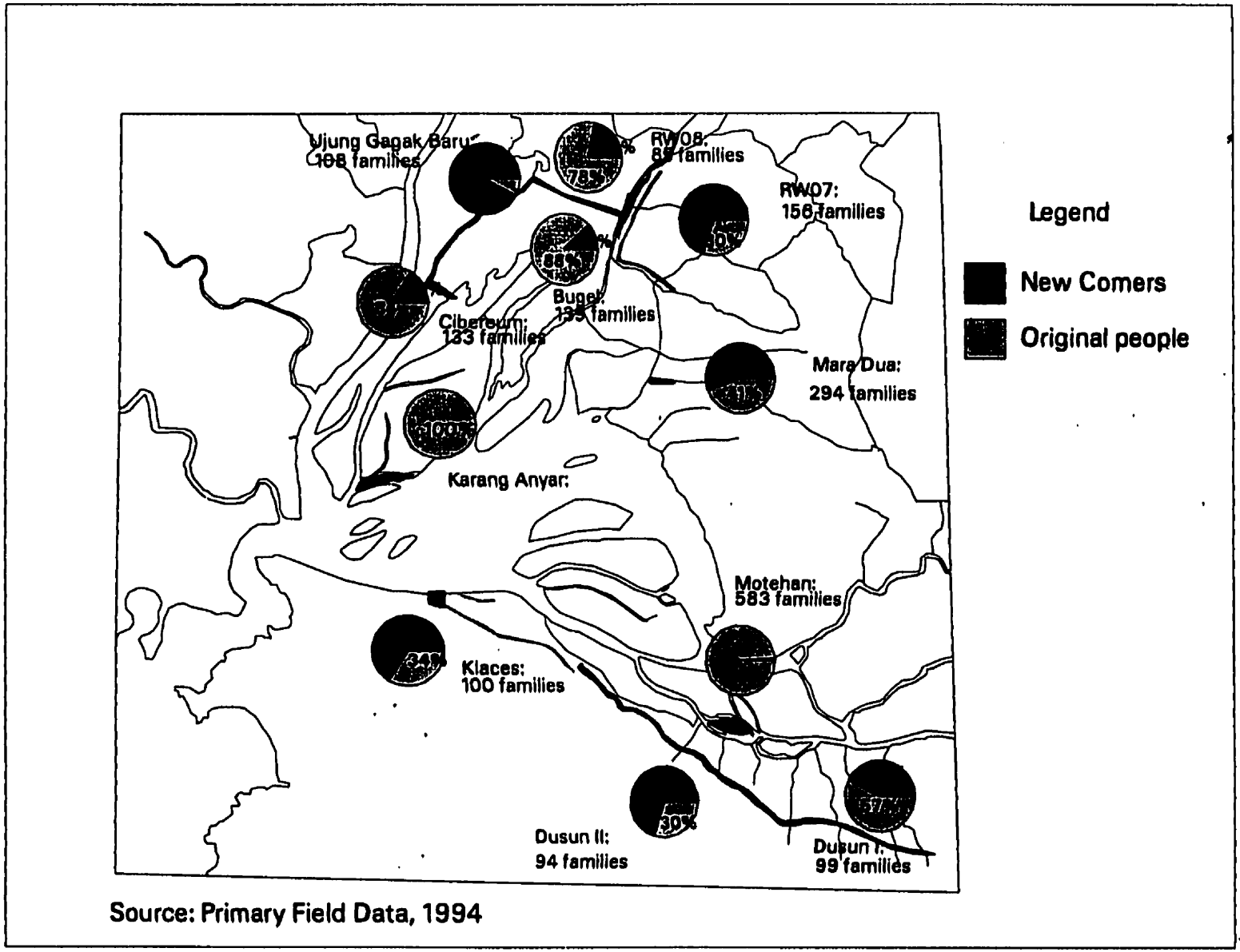


Figure 5.32: Immigration in Kampung Laut, 1994

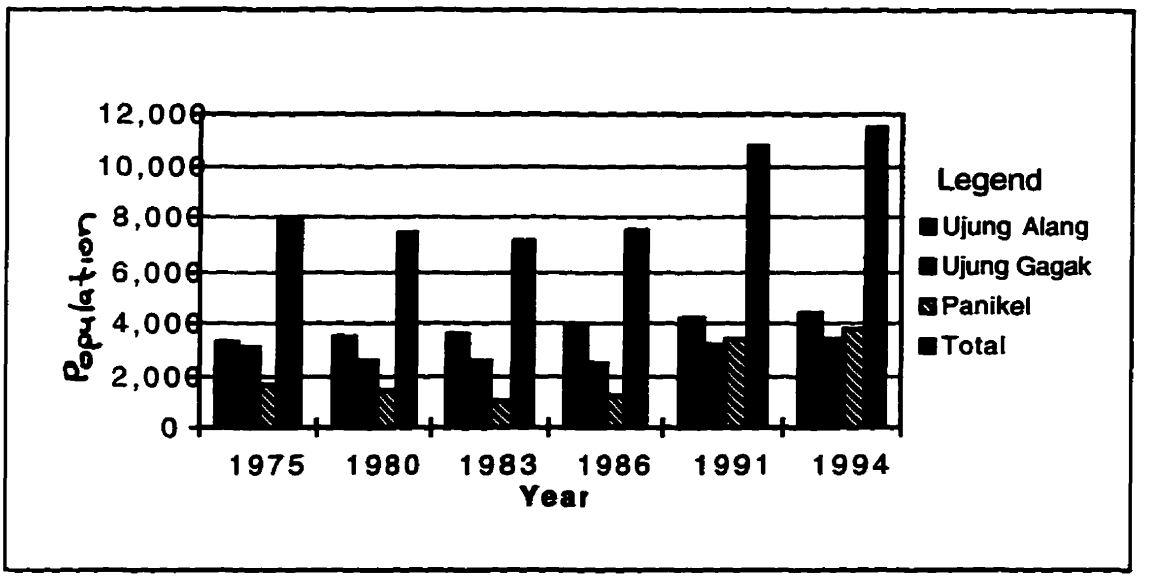


Figure 5.33: Population by Village in Kampung Laut: 1975-1994

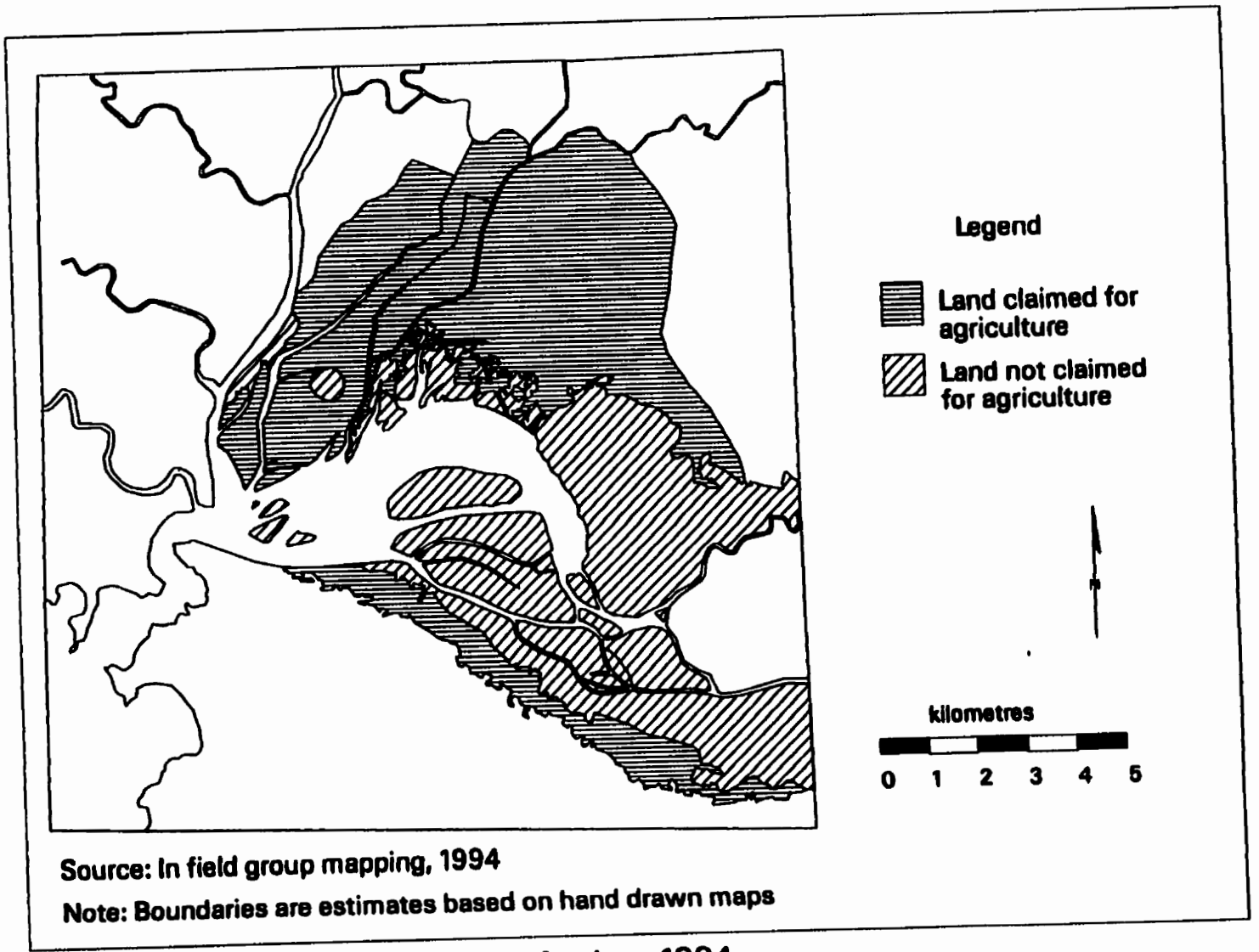
Source: PRC Engineering Consultants (1987), Desa Monografie (1991,1994)

significant proportion of the population of Kampung Laut. With this increase in population, most of the available land for rice has been claimed (Figure 5.34).

An aspect of this population growth has been the increase in the number of Sundanese families from West Java. There was never any suggestion that tension existed between the Javanese and Sundanese and/or the fisherfolk and immigrant families. In fact, it was suggested that in *dusun* Motehan Baru, there is a sharing of some customs between the Javanese fisherfolk and the Sundanese farmers.

Land use activities around the farmers' homes are generally more diverse than in the fishing communities, including home gardens and fishponds (Figures 5.35 and 5.36). Home garden crops, or *palawija*, are mainly located on built up areas, in particular along the bank of Kawanganten River in Panikel. According to local farmers, the land along the river is the most fertile, as the river has transported soil down from the uplands. The areas further inland are lower lying and more subject to salt water intrusion and flooding. Crops grown along the rivers edge include soybean, chilies, and green beans.

Small non-intensive fish ponds (*kolam*) have been constructed around some of the houses. The digging of ponds has a dual function; it minimizes flooding by providing a built up area for the



Source: In field group mapping, 1994

Note: Boundaries are estimates based on hand drawn maps

Figure 5.34: Land Status in Segara Anakan, 1994

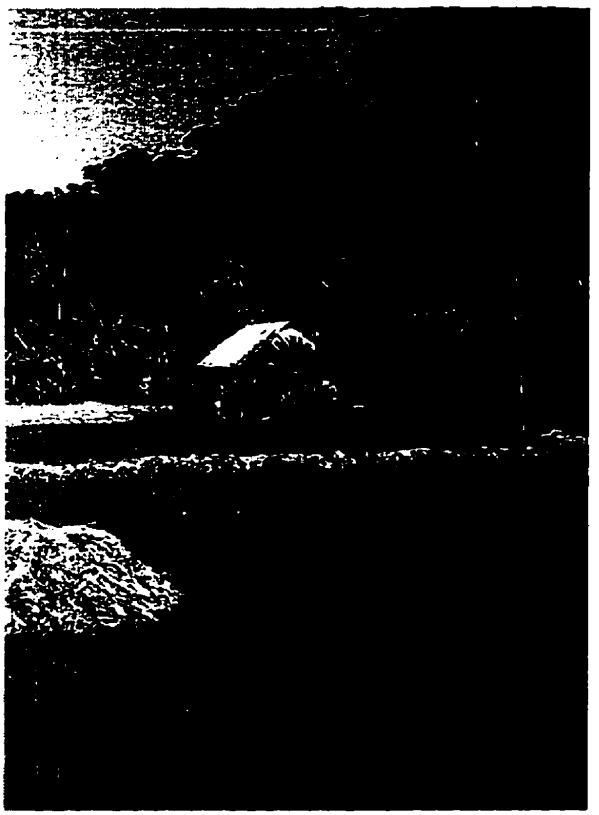


Figure 5.35: Rice area in Ujung Alang

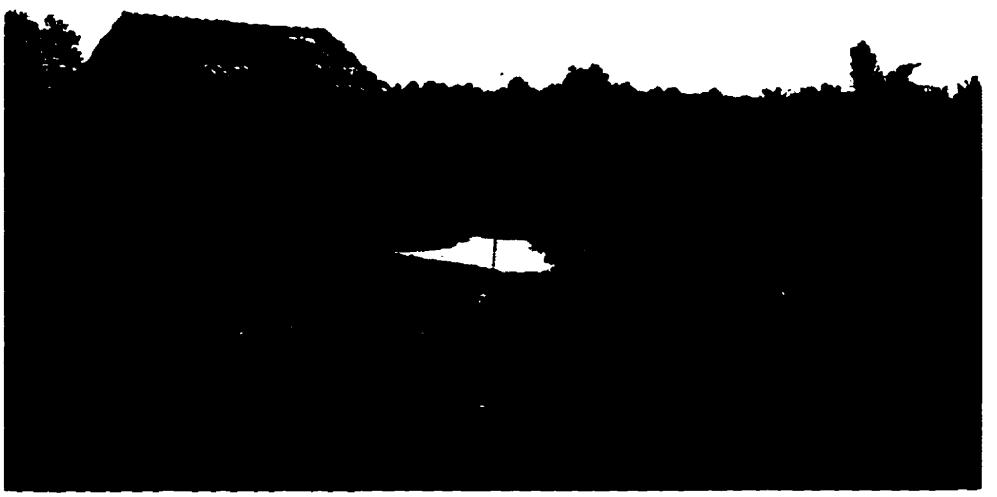


Figure 5.36: Recent home in newer rice area, Ujung Alang

house, and a pond to cultivate fish. Training for the construction of fishponds was provided by the district Department of Fisheries (*Dinas Perikanan*) in conjunction the ICLARM coastal zone management project, locally referred to as CRM. Fish frys are either bought, taken from the estuary or rice fields, or provided from the Fisheries Department (one time only). Based on the yields provided by seven fishpond owners in Ujung Alang, it is estimated that the yield from one fishpond ranges from 50-80 kg in six months. The results are often sold for Rp 2,000-3,000/kg (CND$1.30-$2) (semi-structured interviews 1994). The main management problems experienced with the fish ponds, which have limited their success, are: 1) leaking ponds, which are attributed to holes created by the burrowing of the *yuyu* crab, 2) otters stealing the fish, with the ability to clear out a pond in one evening, 3) loss of fish when the ponds are flooded out, and 4) lack of water during the dry season (semi-structured interviews 1994).

5.2.7 Rainforest

Rainforest is only located on Nusa Kambangan and in 1995 it comprised approximately 3,592 hectares (Figure 5.1). There is limited up-to-date information concerning the current condition and uses of the rainforest, as well as any changes. This dearth of information is largely the result of limited access to the island, enforced because of the four prisons operating there. The controlled access has reduced local activities in the rainforest, but according to local people, larger trees are sometimes obtained to make canoes. There have been suggestions to open the island to tourism, if and when the prisons are closed (PRC Engineering Consultants 1987). Moreover, it has been suggested that the fisherfolk of Kampung Laut believe that when the land joins the island to the mainland, it will become accessible to them and will provide a better life (Martopo 1994).

5.3 SUMMARY

From 1968 to 1995, Segara Anakan has experienced rapid and extensive land use changes, largely resulting from the conversion of new lands and suitable mangrove forest into the rice farming and associated activities. The key findings of the land cover and land use changes are summarized in Table 5.5. Overall, the land use changes represent the expansion of the Javanese rice landscape into the area. The result of these changes has been an increase in the diversity and complexity of the social, economic, technological, institutional and cultural environment. The transformation of land use activities has been accelerated by the immigration of farmers, which has significantly increased the population of the area. The next chapter

examines in more detail the elements of society and development in Segara Anakan which have given rise to these land use changes.

Table 5.5: Summary of Land Cover and Land Use Changes in Segara Anakan: 1968-1995

Land Cover Type	Land Cover Changes and Associated Land Use Activities
New lands	**Land Cover Change** • increase by 4,407 ha from 1968 to 1995 (including the lands under the mangrove forest) • in 1995 there was approximately 29 ha of new lands in the estuary **Land Use Activities** • use of the new lands has caused institutional conflicts in the area • decreased mobility of transportation and decline in the number of feasible fishing areas
Estuary	**Land Cover Change** • decrease in size by approximately 8,424 ha from 1968 to 1995 • decrease in depth of waters **Land Use Activities** • decline in the productivity of the estuary fisheries • excavation of sand for making bricks and construction materials • provides for the main mode of transportation (*i.e.*, boat) • wildlife habitat, such as otters
Mangrove forest	**Land Cover Change** • cutting of mangroves of approximately 15,075 ha from 1968 to 1995 • growth of about 4,304 ha of mangroves onto new lands from 1968 to 1995 **Land Use Activities** • wood supply for domestic and commercial uses • supply of nutrients to the estuary waters • supports the nursery ground for fish, shrimp and crabs • wildlife habitat for birds and monkeys
Rice agriculture (and associated uses)	**Land Cover Change** • increased by 15,075 ha from 1968 to 1995 **Land Use Change** • increased population by 45% from 1975 to 1994 with immigrant farmers • increased economic opportunities (labourer, harvest) • varied range of productivity and stability of rice yields, associated with physical constraints (lack of fresh water, salt water intrusion and flooding) • cultivation of cash crops in suitable areas, such as sugar, chilies, soybean and fruit • requires greater modification of the physical environment
Settlements	**Land Cover Change** • in 1995 there was approximately 197.6 ha of settlements in Segara Anakan • changes in extent from 1968 to 1995 is not possible to ascertain, as the land cover type of settlements was included with the rice fields **Land Use Change** • increased number of people living in the area by 45% from 1975 to 1994 • some areas are inhabited mainly by immigrant farmers • home gardens in farming settlements
Semi-intensive fishponds	**Land Cover Change** • an increase in semi-intensive fishponds from 0 ha in 1968 to approximately 100 ha in 1994 (located only in *dusun* Cibereum, Panikel) **Land Use Change** • ponds are about 1-2 ha in size, and requires much capital and special skills • in 1994, 96 % of the ponds were owned by outsiders • inputs largely purchased from outside • productivity of ponds still uncertain in 1994
Rainforest	**Land Cover Change** • in 1995, rainforest was approximately 3,592 ha in size (located on Nusa Kambangan) • satellite analysis indicated minimal change in extent of the forest **Land Use Change** • limited information on qualitative changes in the forest • land use activities involve collection of wood and birds

Chapter 6:
SOCIETY AND DEVELOPMENT:
RICE AGRICULTURE IN SEGARA ANAKAN

6.1 INTRODUCTION

The previous chapter identified and described ongoing land use changes in Segara Anakan from 1968 to 1995. Since 1968, the development of rice agriculture has been the main driver of land use change in response to the cumulative effects of sedimentation. The purpose of this chapter is to identify the key actors involved in these land use changes, and their responses to the land use changes. Given the growing significance of rice land use systems in the area, key elements of society and the development process which have influenced how the fisherfolk have participated in rice farming are identified.

6.2 ACTORS AND ADAPTIVE RESPONSES TO LAND USE CHANGE

The development of rice agriculture in Segara Anakan has resulted from the actions of several key actors, notably the fisherfolk, the *Kepala Desas*, subdistrict and district levels of government, two nongovernment organizations (NGO's) working in the area, and immigrant farmers. The purpose of this section is to identify the main adaptive responses of each of these groups to the ongoing land use changes.

6.2.1. The Fisherfolk of Kampung Laut

A general consensus exists among the fisherfolk that sedimentation has been reducing the productivity of the estuary fisheries. The adaptive responses of the fisherfolk to rice farming can be divided into four broad types (Table 6.1):

1) farm rice and stop fishing
2) do not adopt rice and continue to fish
3) adopt rice farming and continue to fish
4) do not rice farm or fish

Table 6.1: Adaptive Strategies of Fishermen for Rice Farming

Adaptive Strategy	Respondents							
	Ujung Gagak		Ujung Alang		Panikel		Total	
	n	%	*n*	%	*n*	%	*n*	%
1) Farm only	15	8.5	7	3.6	33	21.9	55	10.6
2) Fish only	24	13.6	100	51.5	0	0.0	124	23.8
3) Farmer-fisherman	135	76.7	87	44.8	118	78.1	340	65.3
4) Neither	2	1.1	0	0.0	0	0.0	2	0.4
Total	176	99.9	194	100.0	151	100.0	521	100.1

χ^2 (4, n = 519) =153.441, $p \leq 0.05$. (the Chi Square analysis does not include the class of neither)
Source: Short survey of fisherfolk and semi-structured interviews 1994

6.2.2.1 Adopt rice farming and continue to fish

Overall, the most popular response by the fisherfolk of Kampung Laut was to both fish and farm (*petani-nelayan*) (Table 6.1). In both Panikel and Ujung Gagak, just over seventy per cent of the interviewed fisherfolk selected this response, while in Ujung Alang it was second to the fishing only response.

The activity of fishing and farming manifested itself in three different ways: 1) fishermen farmed the land themselves; 2) sharecropped out the land; and 3) rented out the land (Table 6.2). As indicated by Table 6.2, a large proportion of the fisherfolk surveyed had not yet cultivated their land. Beyond this, the most popular response was to farm their own land, suggesting that they had enough time and energy to do both.

A variety of management strategies was adopted by the fishermen who both fished and farmed. The main strategy was to work the rice fields in the morning, for approximately four hours and then fish in the afternoon. One fisherman stated that he worked more in the field during the rice growing season, while another hired labour when the fishing was good (semi-structured interviews 1994). Agricultural labour for the rice fields was conducted mainly by the fisherfolk and family members (i.e., wives and children), and to a lesser degree by hired labour, which was generally used when there was sufficient money (Table 6.3). The semi-structured interviews indicated that *liruan* was employed more by the immigrant families, although two fishermen interviewed stated that they also employed it within their family.

Table 6.2: Working Arrangement of Rice Lands by Fisher-Farmers

Working Arrangement	Respondents							
	Ujung Gegak		Ujung Alang		Panikel		Total	
	n	%	*n*	%	*n*	%	*n*	%
self and family	86	75.4	34	46.6	82	50.3	202	57.7
sharecropped	13	11.4	15	20.5	81	49.6	60	31.1
still forest / not yet cultivated	15	13.2	18	24.7	0	0.0	33	9.4
land mortgaged out	0	0.0	6	8.2	0	0.0	6	1.7
Total	114	100.0	73	100.0	163	100.0	350	100.0

Note: May be more than one response per respondent
Source: Short survey of fisherfolk 1994

Table 6.3: Structure of Agricultural Help by Fisherfolk

Agricultural Help	Respondents							
	Ujung Gegak		Ujung Alang		Panikel		Total	
	n	%	*n*	%	*n*	%	*n*	%
Self only	41	31.1	2	5.3	46	31.0	89	28.3
With family	55	41.6	29	76.3	6	4.1	97	30.8
With hired labour	4	2.7	2	5.2	4	2.7	38	12.1
With family and labour	4	3.0	5	13.1	88	61.1	97	30.8
Total	132	99.9	38	100.1	144	100.0	314	100.0

χ^2 (6, n = 314) = 183.682, $p \leq 0.05$.
Source: Short survey of fisherfolk, 1994

Sharecropping (*bagi-hasil*) was the second greatest response of those interviewed (Table 6.3). With the sharecropping arrangement, the fisherfolk remain "owners" of the land, but others, mainly outsiders, worked it. The sharecropping arrangement was based on *maro*, whereby the land holder pays for the inputs, notably seeds, fertilizer and pesticides, and the sharecropper pays for labour. Each party then receives half of the yield (semi-structured interviews 1994). The main reasons stated for fisherfolk entering into a sharecropping arrangement were the lack of time and energy to both fish and farm, as well as the lack of farming skills. One fisherman stated that he had tried for several years to farm his land, but later entered into a sharecropping arrangement for these reasons.

The renting out of land (*gadai*) was not a popular response of the fisherfolk interviewed (Table 6.2). The process of renting involved the use of land (including its produce) for a sum of borrowed money. The land would be returned to the owner when the money was

repaid. It was suggested by a key informant that it was not uncommon for the land to eventually be sold to the user because the fisherfolk could not repay the loan.

6.2.2.2 Not Farm and Continue to Fish Only

For all three of the villages, fishing only was the second most widely chosen response (Table 6.1). The variation of response among the villages again reflects the spatial distribution of the impacts of sedimentation. In Ujung Alang, half of the interviewed fisherfolk stated that they did not farm, while in Panikel, fishing only was not a response selected by any of those interviewed. In Ujung Gagak, fishing only was the second most popular strategy.

Reasons provided for not farming included: 1) fishing still provided sufficient income so farming was not as yet necessary; 2) farming is not yet very productive; and, 3) income from farming occurred only once, or in some areas twice per year, while fishing provided a needed daily income. It was stated by ten fishermen, mainly in Ujung Alang, that they would like to try farming, but had not yet acted to receive land (i.e., asked village official), or that there was no land currently available (mainly in Ujung Alang) (semi-structured interviews 1994).

6.2.2.3 Farm Rice and Stop Fishing

The response of rice farming and no longer fishing was the third most popular strategy for all of Kampung Laut, but differences did exist among the three villages (Table 6.1). Of the villages, Panikel had the largest number of adopters of this strategy, while none of the fishermen surveyed in Ujung Alang had stopped fishing. In Ujung Gagak, this strategy was not popular, accounting for only a small number of those interviewed.

The higher adoption of farming only in Panikel can be partially related to the spatial distribution of the impacts of sedimentation. The distribution of the new lands in the estuary has caused Panikel to be at a greater distance from fishable waters, forcing the fishermen to travel further. One fisherman stated that he now travels one and a half hours to reach his fixed net location. Moreover, the number of feasible locations for fixed nets of *apong* and *wide* has also declined (semi-structured interviews 1994). Ujung Gagak is

beginning to experience the same process, as new lands continue to enclose the village. In 1994, at low tide the waters in front of *dusun* Karang Anyar became a large mud flat and the area was referred to as the "future soccer field" by a village official. In Ujung Alang, although experiencing the impact of sedimentation, the deeper rivers have allowed for more fishing grounds closer to the villages, especially for *apong* and *wide* nets.

In Ujung Alang and Ujung Gagak, the fisherfolk selecting this response were generally older, with the rationale that farming required less strength and energy than fishing. Other reasons stated for switching to rice farming were: 1) the poor yields of fishing, 2) preference for staying at home at night with the family, and 3) the income generated from farming provides a larger sum of money so it was easier to save (i.e., a sense of financial security) (semi-structured interviews 1994).

6.2.2.4 Do not farm or fish

The adaptive strategy of not fishing nor farming was the least widely adopted response, accounting for a small number of respondents (Table 6.2). Most of these respondents were people who had not been fishing for sometime, or had never fished nor farmed. Most of the respondents were newcomers to the fishing communities, mainly associated with marriage to a local person and had other skills (e.g., fish trader, shop owner, retired government official).

The above discussion outlines the diversity of the adaptive responses of the fishermen in association with rice farming in Kampung Laut. To provide a more complete picture of the fishermen's occupations, both main and secondary types of work of those surveyed are shown in Table 6.4. The most popular response of those interviewed was that they did not have any secondary occupations. This was followed by secondary occupations of labourer, followed by business, migration, and then selling wood. Work as a labourer mainly involved working in rice fields, digging semi-intensive fish ponds (*tambak*) or in housing construction/wood working. Business mainly involved small shops (*toko*), food stalls (*warung*) or fish or rice trader (*bakul kecil*). Migration involved traveling outside of Kampung Laut to work as fishermen in either Cilacap or on the larger ships in Jakarta (i.e., foreign fishing vessels), as domestic labour in a larger city, such as Jakarta or Bandung, or

Table 6.4: Main and Secondary Occupation of Fisherfolk in Kampung Laut

Occupation	Respondents																			
	Ujung Gagak						Ujung Alang						Panikel							
Main	Farm		Fish		Fish & Farm		Farm		Fish		Fish & Farm		Farm		Fish		Fish & Farm		Total	
Total	8		22		114		0		83		73		30		0		114		444	
Secondary*																				
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
labourer	3	33.3	8	34.8	29	25.9	—	—	52	46.8	19	32.2	9	27.3	—	—	52	44.4	172	37.1
no other	5	55.6	12	52.2	57	50.9	—	—	31	27.9	28	47.4	3	9.1	—	—	28	23.9	164	35.3
business	1	11.1	1	4.3	20	17.9	—	—	3	2.7	7	11.9	13	39.4	—	—	16	13.7	61	13.1
migrate	0	0.0	2	8.7	2	1.8	—	—	19	17.1	4	6.8	5	15.2	—	—	18	15.4	50	10.8
government	0	0.0	0	0.0	3	2.7	—	—	2	1.8	0	0.0	1	3.0	—	—	1	0.9	7	1.5
other	0	0.0	0	0.0	1	0.9	--	--	4	3.6	1	1.6	2	6.1	--	--	2	1.7	10	2.2
Total	9	100.0	23	100.0	112	100.1	—	—	111	99.9	59	100.0	33	100.0	—	—	117	100.1	464	99.9

Source: Short survey of fisherfolk 1994

*Note: More than one response may be given

in factories in larger cities such as Jakarta or Batam. Working as a fisherman in Cilacap provides a minimal income of Rp 16,000 to 25,000 (CND$10-$16) per week, while in Jakarta a fisherman's salary is approximately Rp 250,000 (CND$160) per month (semi-structured interviews). The representative of *Himpunan Nelayan Seluruh Indonesia* (HNSI: the Indonesian Fishermen Association) in Ujung Gagak, stated that in the 1970's the farthest fishermen migrated for work was the commercial fisheries in Cilacap. Since the early 1980's, fisherfolk have been traveling farther, including Jakarta (semi-structured interviews 1994). The fishermen of Kampung Laut lack the necessary equipment and skills to fish in the sea themselves. It was estimated that the average cost of equipment (boat and nets) was approximately Rp 7 million (US$3,500) (key informant 1994).

6.2.2 Kepala Desa and Village Staff

The *Kepala Desa* and village staff in each village strongly believed that the new lands in the estuary belonged to the villages. In Ujung Gagak and Panikel, rice development was assisted by the *Kepala Desas* with the establishment of village regulations and agricultural training (semi-structured interviews 1994). The intent of the activities was to provide an alternative economic activity to support socio-economic development in the village. On a more subtle level, other rationales for promoting rice were to make the new lands "productive", which may ensure their authority to the villages (as opposed to *Perhutani*) and to generate development funds, as discussed in the next section.

In 1988, the *Kepala Desa* and village staff of Ujung Gagak and Panikel established village regulations of *bawon* and *maro*. The regulations of *bawon* and *maro* permitted outsiders to clear land and receive as payment one-half and one-third of the amount of land cleared respectively. The rationale behind these regulations was to assist the fisherfolk to open forest land for rice farming, as their economic ability to do so was limited, and to expedite the opening of forest lands for farming (semi-structured interviews 1994). A similar village regulation was not established in Ujung Alang.

Village-level development activities associated with rice agriculture have been limited, and to date have been overshadowed by other development issues (semi-structured interviews 1994). For example, in 1994 in Panikel the focus was on the construction of

a new PKK building and rebuilding of the road (key informant 1994). In Ujung Gagak, development issues were oriented towards fresh water supply, and in Ujung Alang they consisted of fresh water supply (e.g., pipes and communal water holes), the reconstruction of the dock meeting area, and building of the security post.

Other support for rice development was mainly in the form of training and the maintenance of the dikes through *gotong royong*[29] activities. Agricultural training sessions occurred in 1992 and 1993. These sessions ranged from one day to one week and were often coordinated with the *Kecamatan's* office. These training sessions offered general information on agricultural practices (semi-structured interviews 1994). *Gotong-royong* activities for dike maintenance were only held in Ujung Alang. Every Sunday morning, by the request of the *Kepala Desa*, people were to provide labour for repairing the dike in their neighbourhood (semi-structured interviews 1994).

6.2.3 Subdistrict level government (Kecamatan)

The *Kecamatan*, in line with roles and responsibilities specified in the Indonesian government structure, mainly facilitates district level programs and policies through assisting and monitoring development activities in the villages. In Segara Anakan, development assistance associated with rice was mainly in the form of training, agricultural assistance from the *Kooperasi Unit Desa* (KUD), and the formation of neighbourhood farming groups (*kelompok tani*). In 1988, a team from the subdistrict level did measure the agricultural land holdings (*persil*) in Kampung Laut, indicating the location, size and owner of land use.

Officials at the district level agricultural department (*Dinas Pertanian*) stated that they no longer communicated directly with the communities of Kampung Laut, but instead worked through the agricultural extension officers located in the *Kecematan's* office. In the subdistrict of Kawanganten, there were four agricultural extension officers, two of whom conducted agricultural training and assistance in Kampung Laut. These activities

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[29] *Gotong-royong* is an Indonesian term associated with mutual assistance. The *Kepala Desa* has the authority to ask community members to provide labour for village maintenance activities. For example, in Ujung Alang, every Sunday morning male members of the community were asked to provide labour for dike maintenance.

were generally part of a subdistrict level government team which visited the area when requested by the *Kecamatan*. Visits generally occurred twice a year, once before planting and again prior to harvesting (semi-structured interview 1994). The agricultural extension officer suggested that more training sessions were not held in Kampung Laut because of the difficulty encountered when traveling to the isolated villages, as well as the difficulties in organizing the fishermen during day visits (i.e., they were out fishing). The rice agricultural training sessions were arranged through the *Kepala Desa* and generally twenty to twenty-five farmers and fisherfolk participated (pers com. agricultural extension officer 1994). These agricultural activities in Kampung Laut were considered as a trial-and-error process, particularly for the selection of plants most suitable for its physical environment (pers com. agricultural extension officer 1994).

The *Kooperasi Unit Desa Lestari* (KUD) is located in Kawangantan. In 1994, all KUD agricultural activities had stopped in Kampung Laut (pers com. KUD officer Kawangantan 1994). In 1991, an agricultural package containing seeds and fertilizers was distributed in Ujung Gagak and Panikel. According to a KUD officer in Kawanganten, this service was stopped because: 1) payments for the previous KUD supported solar energy program were too far behind schedule and collecting moneys was difficult; 2) much of the fertilizer in the agricultural packages was returned unused, and 3) payments for the agriculture packages were not remitted on time (pers com. KUD officer 1994). Some of the farmers from Kampung Laut had purchased materials on an individual basis from the KUD, but there were no group activities or involvement with the KUD.

In 1992 the Kecamatan's office made an official request to each *Kepala Desa* to establish farming groups (*kelompok tani)* in their village. In 1994, these farming groups did exist, although the extent of their activities varied throughout Kampung Laut. Their activities were mainly nonagricultural, such as local savings and credit

services (e.g., *arisan*[30]), security and construction of mosques (semi structured interview 1994).

6.2.4 District level government (Kabupaten)

The rice development strategies at the district government level have been largely oriented towards socio-economic activities associated with training and aid (Bappeda 1992). Located in Cilacap, the government offices of the *Bappeda*, Fisheries Department (*Dinas Perikanan*), Agriculture Department (*Dinas Pertanian*), and Public Works (*Pekerjaan Umum-PU*) have all had development activities in the area. Moreover, the district level has worked with national and international projects, notably the Citanduy Project (1993) and the coastal resources management project conducted with ICLARM (International Coastal and Living Aquatic Resources Management), (1992). While these projects did not specifically deal with rice agriculture, they were concerned with development and management of the area.

The key to rice development in Segara Anakan has been the *Bupati* regulation *Surat Bupati No. 593/01039/02 April 1989*. This regulation, first proposed in 1988, gave official consent for the people of Kampung Laut to use the new lands in the estuary to cultivate rice. The initiative for this regulation largely came from the fishing communities, conveyed through requests made by the *Kepala Desa* asking permission to cultivate rice (key informant 1994). This regulation was made possible through the consensus among the district government agencies that the *Bupati* had ultimate authority over land use issues, although the conflict between *Perhutani* and the fisherfolk had not yet been resolved[31] (ICLARM 1992). The result of the *Bupati's* regulation was the issuance of land use certificates, or *Surat Keputusan Ijin Mengarap* (SKIM), although those who did not have one were still able to use the land[32]. The

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[30] *Arisan* is a rotating lottery where people contribute a sum of money per week or month, usually Rp 1,000. Each week or month a name is drawn and that person receives the purse. This continues until each person who has contributed has received the purse.

[31] *Perhutani* officials in Cilacap were not willing to participate in the 1994 field work component of this research because of this unresolved land use conflict

[32] During semi-structured interviews, it was often commented that although the land users had applied and paid for SKIM, they had not yet received one from the Kecamatan (via the Desa). People were not sure of the reason behind the delay.

conditions attached to a SKIM were: 1) the people were to open and work the land to the best of their ability; 2) they were not allowed to sell the land; and 3) the land had to be returned to the government, if and when the government requested. SKIM officially established the right to use of the land and could facilitate a future transfer of land ownership from the State to the land user.

Agricultural training provided by the *Kabupaten* consisted of a two month session in 1992 conducted by *Balai Latihan Kerja* (BLK), a government training organization located in Cilacap. Approximately thirty local people from each village were selected by their *Kepala Desa* to participate in this training, which was conducted in each village. Training included various aspects of agriculture, including animal husbandry, basics of mixed farming, plant protection, cultivation of food crops and group cooperatives (semi-structured interview 1994). As part of this training, a farming group (*kelompok tani)* was formed in each village consisting of the BLK training participants. Other unrelated types of training provided by the district level government included repairing boat motors and fish pond cultivation (Bappeda 1992; ICLARM 1992).

Aid was provided in 1992 in the form of dryland crops (e.g., fruit trees, cocoa seedlings) from the Department of Agriculture and fish frys for fish ponds (*kolam*) from the Department of Fisheries (in conjunction with fish pond training). The *Bupati* also gave a rice mill to Ujung Alang, when the rice yields were shown to be productive (pers com., NGO fieldworker 1994). Additional potential aid was being investigated by the Department of Agriculture, in the form of a banana plantation development. If feasible, the banana plantation could provide an economic activity, since the flour produced from the bananas commands a high export price, with a ready market existing in Japan (pers. com, Agricultural Official Cilacap 1994).

6.2.5 The National and Provincial Level Government

From 1986 to 1992, Segara Anakan was the site for an international coastal resource management pilot project conducted by ICLARM, which was funded by the United States Foreign Aid agency (USAID). This project comprised a management plan and training. The goal of the management plan was environmental protection and social upliftment, and involved the establishment of a special task force in 1989. In 1992, a

spatial zoning plan was devised as part of a management plan, and included twelve general land uses zones: protection, reserve, forest, development, agricultural, human settlement, urban-industrial (Cilacap), aquatic, Ministry of Justice (Nusa Kambangan), marine, and an agricultural area that is not included in the plan (ICLARM 1992, 53). The boundaries were based on ecological conditions as well as land use authority, which could be adjusted in the future. According to ICLARM (1992), the plan still needed central government approval, and as such was not yet official. Training was conducted for government officials and involved general coastal resource management, as well as training in fisheries (e.g., fish ponds-*kolam*).

Transmigration[33] has been promoted in Kampung Laut, with a message that the fisherfolk would be better off living in another location. Transmigration has been promoted via the district and subdistrict government levels, generally when various subdistrict teams visit the area. Transmigration has only been partially successful, and some transmigrants returned when they heard that new lands were being opened in Kampung Laut (semi-structured interviews 1994). A 1994 newspaper article in a national newspaper indicated that this transmigration policy was still active when it suggested that the residents of all three villages may be moved because the land was required for a new irrigation and drainage system (Jakarta Post, July 7, 1994).

6.2.6 Nongovernment Organizations (NGOs)

In 1994, two NGO's were working in Kampung Laut: Yayasan Sosial Bina Sejahtera (YSBS) and Yayasan Pertanian Kerjaan Sosial (YPKS), whose activities have been oriented towards socio-economic development of the area. YSBS, a Catholic organization, has worked in Kampung Laut since 1977. Their activities associated with rice agriculture have been the construction of physical infrastructure, notably dikes[34]. Permission to build the dikes passed district level government approval and their

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[33] Transmigration is a national government project in Indonesia which relocates families from densely populated areas, mainly Java, Bali and Lombok, to less populated regions in Indonesia. The national government sponsors families through planned re-settlement and financing (Babcock 1986).

[34] Development projects of YSBS in the villages are not restricted to only physical infrastructure, but also included: work for rice and money projects, mainly associated with the construction of the dikes in Kampung Laut, sending children to high school outside of Kampung Laut, and training at their Maritime Institute located in Cilacap.

locations were selected by the *Kepala Desa*, village staff and community members. All construction specifications and supervision were done by the NGO staff, some of whom were local people.

YPKS, the other NGO, has its main office and training centre located near Solo, Central Java, but has a field officer responsible for activities in Kampung Laut residing in Cilacap. The main focus of YPKS activities was promoting self-sufficiency and self-help, mainly through training and the forming of neighbourhood farm groups (*kelompok tani)*[35]. Training sessions had been concentrated in Ujung Alang, but were gradually extended to Ujung Gagak, with intentions to conduct training in Panikel. A more intensive three month agricultural training session in facilities near Solo was also offered to individuals from Ujung Alang and Ujung Gagak. The purpose of this intensive training was to provide local agricultural trainers in the village (pers com., NGO field worker, 1994).

In 1994 one farming group (*kelompok tani*) was operating in Ujung Alang, which was organized by YPKS (pers com. NGO field worker 1994). The farming group's activities included income generation to support its small credit and savings operation (e.g., one group was cultivating and selling fruit tree seedlings) as well as a forum to discuss farming issues and exchange information.

6.2.7 Immigrant Farmers (Orang Pendatang)

The opening of the forest lands for rice agriculture has attracted outsiders (known locally as *orang darat*-land people) to the area. Four main groups have immigrated to Kampung Laut: permanent farmers, seasonal farmers, returning transmigrants, and semi-intensive fishpond (*tambak*) developers. The majority of the permanent immigrant farmers were from neighbouring villages in both Central and West Java, who had heard about the new land from relatives, business-people, or "the wind" (semi-structured interviews 1994). It was stated by one farmer that Segara Anakan was "an area of immigration not transmigration", and the move to Kampung Laut was seen

by most as a good opportunity for a better life. Prior to immigrating, about half of these farmers did not own land in their previous village, and the others had only a small plot which was given to their children (semi-structured interviews 1994).

The seasonal farmers (*orang aman*) worked the land, usually through a sharecropping arrangement, but did not permanently live in Kampung Laut. Generally, these farmers lived in small shacks near their rice fields and also participated in community activities, such as *gotong-royong* (semi-structured interviews 1994). When the farming season finished, they returned to their own village. After a length of time, some seasonal farmers asked permission from the *Kepala Desa* to officially move to the village. Similar to the immigrant farmers, the seasonal farmers viewed the opening of rice lands in Kampung Laut as an opportunity for a better life (semi-structured interviews 1994).

The returning transmigrants were fisherfolk originally from Kampung Laut, who participated in the government transmigration program. When they heard that new lands were being opened in Kampung Laut for agriculture, they returned to their villages either selling their land or leaving it for another family member to work. The reasons for wanting to return included the poor conditions in their new village, and because they wanted to be close to family and friends (semi-structured interviews 1994). One story told about returning transmigrates in *dusun* Klaces, *desa* Ujung Alang commented on the difficult life in the transmigrant site, resulting from the poor conditions, such as lack of fresh water and facilities.

Table 6.6 provides a chronological summary of the adaptive responses associated with land use change in Kampung Laut. Rice cultivation in the area has occurred mainly on an ad hoc basis, based largely on village level adaptive responses influenced by the district and subdistrict levels of government and the two NGO's working in the area. How the development process has influenced the emergence of rice has inplications for local development and is examined in the next section.

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[35] Other development projects of YPKS included: aid in construction of fresh water sources near the settlements (e.g. pipes and cement wash centres); and training in legal and civil rights. YPKS required the villages to contribute half of the money and labour necessary for the project.

Table 6.6: A chronological summary of development activities associated with rice agriculture Kampung Laut

Late 1970's/early 1980's	• The first rice fields in Ujung Alang
1983	• Provincial Decree to preserve the estuary
1986	• "Mud flood" resulting from the eruption of Mt. Gannung • Request to resolve land use conflict in Segara Anakan sent to Jakarta (no response as of 1994) • More outsiders moving into Kampung Laut
1987/88	• Rice agriculture begins in Ujung Gagak and Panikel • Establishment of *dusun* Ujung Gagak Baru • Beginning of dike construction in Kampung Laut by NGO YSBS
1988	• Bupati regulation which established the right of the fisherfolk to use the new lands for agriculture • Village regulations of *bawon* and *maro* were established in Ujung Gagak and Panikel respectively
1991	• KUD agricultural activities in Kampung Laut • *Tambak* development begins in *dusun* Cibereum
1992	• District level supported agricultural training by BLK • Various subdistrict and district level agricultural training • Commencement of Asian Development Bank Funded Project
1994	• Demonstration in *dusun* Karang Anyar to protest the perceived selling of land by the *Kepala Desa*, resulting in the closure of all unopened lands in Kampung Laut

6.3 RICE AGRICULTURE: THE INTERACTIONS OF ACTORS AND ACTIONS

The preceding section described the main actors and their actions associated with adaptation to change and rice development. This section examines how the adaptive actions of these main actors have interacted to give shape not only to the emerging rice land use system, but also interactions with other land use systems in the estuary. Special attention is given to the fisherfolk and how they, as part of the development process, have accessed the resources necessary to participate in rice agriculture, particularly land distribution, training and skills in rice agriculture, credit and leadership.

6.3.1 Land

The new lands in the estuary provide the basis for rice agriculture, and the distribution process varied among the villages. In Ujung Alang, the main methods for the fisherfolk to obtain land was to claim it individually and then report to the village office, whereas the farmers obtained land mainly by buying it from the fisherfolk (Table 6.7). When rice farming began in Ujung Alang in the early 1980's, prior to the *Bupati's* regulations, there was no formal distribution process or village regulation equivalent to

Table 6.7: Process of Obtaining Land in Kampung Laut

Process of Obtaining Land	Respondents													
	Ujung Alang				Ujung Gagak				Panikel				Total	
	Fisherfolk		Immigrant		Fisherfolk		Immigrant		Fisherfolk		Immigrant			
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Claim by self	22	59.5	6	14.6	29	85.3	0	0.0	0	0.0	0	0.0	57	38.8
Bought	1	2.7	24	58.5	0	0.0	4	50.0	0	0.0	0	0.0	29	19.7
Village staff	2	5.4	4	9.8	2	5.9	0	0.0	6	46.2	7	50.0	21	14.3
Bawon/Maro regulation	0	0.0	0	0.0	0	0.0	3	37.5	7	53.8	7	50.0	17	11.6
Other (sharecrop and rent)	1	2.7	7	17.7	0	0.0	0	0.0	0	0.0	0	0.0	8	5.4
No Land	11	29.7	0	0.0	3	8.8	1	12.5	0	0.0	0	0.0	15	10.2
Total	37	100.0	41	100.0	34	100.0	8	100.0	13	100.0	14	100.0	147	100.0

χ^2 (25, n = 147) = 213.385, $p \leq 0.05$. (Note: 72% of the cells have expected counts less than the critical value of 5)
Source: Semi-structured interviews 1994

the *bawon* and *maro* regulations in Panikel and Ujung Gagak, respectively. During this time, fisherfolk claimed the land and then reported to the village staff. Also during this time, farmers began to move into the area and buy land from the fisherfolk. The *Kepala Desa* at that time welcomed the farmers, as they were viewed as a valuable source of "free" agricultural information necessary for the success of farming in the area. The farmers were not allowed to buy land. Those that did, became permanent residents of Ujung Alang, In 1994, the distribution process was said to be more controlled by the *Kepala Desa* and village staff. To be eligible for land, the person had to be: 1) head of the family; 2) a permanent resident; or 3) married to a local person (pers com. *Kepala Desa* Ujung Alang 1994). Other avenues for obtaining land in Ujung Alang include sharecropping, renting, and from the village staff (Table 6.7).

In Ujung Gagak the rice development began around the same time of the *Bupati's* regulation. The *Kepala Desa,* in regards to this regulation, stated in a village speech that each family would receive two hectares of land, but no formal action was taken to distribute the land (key informant 1994). The village secretary stated that since the village office was not able to assist financially with farming, no formal regulation and land distribution process was established. The immigrant farmers obtained rice lands either through buying it from local people and/or the village regulation of *maro*.

In Panikel, the fisherfolk and farmers obtained land in similar ways, either distributed from the village staff or through the village regulation of *bawon* (Table 6.7). The

distribution of land in Panikel was initially regulated by the previous *Kepala Desa* and village staff. Each local family was provided with one half hectare of land to begin farming, which could be increased if the family indicated that it could use the land productively (key informant 1994).

Overall, the main avenues for obtaining land were identified as: 1) claiming the land individually, 3) provision by the village office, 3) provision through the village regulation of *bawon/maro*, 4) buying, 5) renting, and 6) sharecropping (Table 6.7). The main response of the fisherfolk interviewed was that they claimed the land themselves and then reported to the village staff. This was most prevalent in Ujung Alang and Ujung Gagak and to a lesser extent in Panikel. In fact, of those interviewed in Panikel, none had claimed the land themselves, rather they had obtained it either from the village staff or by entering into a *bawon* arrangement with another land owner (Table 6.7). The second most popular avenue of land distribution among the fisherfolk was from the village staff, followed by either sharecropping and buying. The main avenue of land distribution for immigrant farmers was to buy the land, followed by the village regulation of *bawon/maro* and then sharecropping (Table 6.7). Approximately ten per cent of the fisherfolk surveyed did not have land. This is most prevalent in Ujung Alang, where it accounts for almost thirty of those surveyed, followed by eight per cent in Ujung Gagak, and none in Panikel.

The average size of rice land holdings of the fisherfolk varies among the three villages, as indicated in Table 6.8. Overall, the largest rice fields are located in Panikel, with an average size of 866 *ubin* (350 *ubins* is the equivalent to 1 hectare), followed by rice fields in Ujung Gagak at an average size of 700 *ubins*, and 277 *ubins* in Ujung Alang.

Table 6.8: Agricultural Land Holding of the Fisherfolk in Segara Anakan, 1994

Number of Ubins (700 ubins =1 hectares)	Respondents					
	Ujung Gagak		Ujung Alang		Panikel	
	n	%	*n*	%	*n*	%
1 -99	0	0.0	4	5.2	0	0.0
100-199	1	0.9	33	42.9	0	0.0
200-299	1	0.9	16	20.8	6	4.2
300-399	33	28.2	8	10.4	2	1.4
400-499	0	0.0	4	5.2	0	0.0
500 -599	2	1.7	7	9.1	18	12.6
600-699	2	1.7	2	2.6	3	2.1
700 -799	47	40.2	1	1.3	39	27.3
800-899	0	0.0	0	0.0	7	4.9
900-999	1	0.9	0	0.0	4	2.8
1000-1400	28	23.9	0	0.0	62	43.4
> 1400	2	1.7	2	2.6	2	1.4
Total	117	100.1	77	100.1	143	100.1
Average Size	704 ubins		277 ubins		866 ubins	

Source: Short survey of fisherfolk and Semi-structured interviews 1994

Once the land was claimed, it was necessary to clear the mangrove forest. Table 6.9 indicates the arrangements employed by the fisherfolk to open the land. In both Ujung Alang and Ujung Gagak, the main approach was for the fisherfolk to clear the land themselves. In Panikel, the village regulation of *maro* provided the main means, followed by clearing the land themselves. The cost of clearing the land depended upon its size and amount of labour used, as indicated in Table 6.10. The third most popular method employed in the three villages was buying the land already opened (Table 6.9). Approximately seven per cent of the fisherfolk surveyed had not yet opened their land. This was most prominent in Ujung Alang, followed by Ujung Gagak. In Panikel all of the respondents had opened their land.

The selling of new lands in Kampung Laut was a prominent feature of the rice development process. The selling of land was referred to by both the fisherfolk and farmers, as either the exchange of energy (*ganti tenaga*) or compensation for energy (*ganti rugi*). This is an important terminology as the selling of land was not permitted by the SKIM regulation. Table 6.11 illustrates that 31 per cent of the surveyed fisherfolk had sold land. Given the sensitive nature of this subject, and information

Table 6.9: Process of Fisherfolk Opening Rice Lands in Kampung Laut

Process of land opening*	Number of Respondents							
	Ujung Gagak		Ujung Alang		Panikel		Total	
	n	%	*n*	%	*n*	%	*n*	%
open by self	109	78.4	76	76.0	67	34.3	252	58.1
bawon/maro regulations	8	5.7	5	5.0	97	49.7	110	25.3
obtain already opened	7	5.0	1	1.0	31	15.8	39	8.9
Not yet opened	15	10.7	18	18.0	0	0.0	33	7.6
Total	139	99.8	100	100	195	99.8	434	99.9.

Source: Short survey of fisherfolk 1994
*Note: May be more than one response per respondent

Table 6.10: Examples of the Cost of Opening Forest Lands in Ujung Gagak

Cost of opening land (labour)	Amount of land
300.000 rph	1/2 ha
350.000 rph	1/2 ha
300.000 -400.000 rph	1 ha
300.000 rph	1/2 ha

Source: Semi-structured interviews in Ujung Gagak 1994

Table 6.11: Exchanging of Land by Fisherfolk

Strategy	Number of Respondents							
	Ujung Gagak		Ujung Alang		Panikel		Total	
	n	%	*n*	%	*n*	%	*n*	%
Sold land	23	17.4	22	20.9	73	51.1	118	31.1
Not sold land	109	82.5	83	79.1	70	48.9	262	68.9
Total	132	99.9	105	100	143	100	380	100

χ^2 (42, n = 380) = 43.161, $p \leq 0.05$.
Source: Short survey of fisherfolk, 1994

conveyed in discussions with key informants, this percentage should be taken cautiously.

The exchange of land has not created tension in Ujung Alang, as it has in Ujung Gagak and to a lesser degree in Panikel. In Ujung Alang, immigrant farmers often stated that in the early 1980's it was easy to exchange land with the fisherfolk, and in many cases they were the ones approached. According to the previous *Kepala Desa*, a village regulation was established which stated that only local people could "own" the land, and that people from outside were only allowed to work the land (i.e., not 'own' it). He viewed the knowledge of immigrant farmers as an important and free source of agricultural information and key for the success of local fisherfolk at farming. The result was an influx of outsiders buying land from local people. The exchange of land

was not permitted, and the *Kepala Desa* stated that he did not realize that it was occurring. The land was never taken back by the *Desa*, but instead these immigrant farmers became permanent residents of Ujung Alang. As such, the majority of land exchange occurring in Ujung Alang was between the fisherfolk and immigrant farmers.

In Ujung Gagak, the village secretary suggested that the exchanging of land by fisherfolk was suggested to occur mainly as *lintiran* (pers. com. village staff Ujung Gagak). That is, the local people sell the land and then visit the village office with the buyer to report it. A larger issue surrounding the exchange of land in Ujung Gagak, one that has caused much tension in the community, is associated with the activities of the *Kepala Desa*. The *Kepala Desa* has used the village regulation of *maro* to open village lands (*tanah bengkok*). The tension arose from the perception that he was selling land because of the increasing administration fee charged to those wanting to participate in the agreement, mainly the immigrant farmers. The cost of this administration fee has risen substantially over the past few years, starting at approximately Rp 42,000 (US$21) in 1988, increasing to Rp 250,000 to 300,000 (US$125-150) by the early 1990's, and rising to Rp 400,000 (US$200) by 1994 (semi-structured interviews 1994 and key informants 1994). Moreover, the amount of lands being entered into this *maro* arrangement has also increased, beginning with the settlement of Ujung Gagak Baru and followed by the development of semi-intensive fishponds (*tambak*) in Cibereum, and land for rice farming.

The development of *tambaks* has attracted outside attention to the area. In 1991 and 1993, approximately twenty hectares and another seventy-five hectares were obtained for *tambak*, respectively (pers. com. key informant 1994). A *tambak* owner suggested that although it was more expensive to exchange land through the village office, it was safer than dealing directly with the local people. This was associated with a few cases of fisherfolk exchanging other people's land, which were sometimes resolved at the expense of the outside person. In response to perceived selling of land by the *Kepala Desa*, on July 2, 1994 a demonstration of approximately two hundred fisherfolk protested with a march to the village office and to the lands being newly opened (pers.

com. key informant 1994). After this protest, the *Kecamatan's* office closed all lands not yet opened in Segara Anakan (pers com. government official *Kecamatan's* office 1994).

In Panikel, half of the surveyed fisherfolk indicated that they had exchanged land, although the main complaints of land exchange arose in conjunction with the activities of the *Kepala Desa* (Table 6.11). According to one key informant, although difficult to substantiate, the *Kepala Desa* had been reclaiming land from some farmers who obtained it prior to the 1988 *bawon* regulation. He viewed these farmers as '*bawon* people' and as such reclaimed five hundred *ubins* of land (i.e., approximately one third of the land), which were then suggested by a key informant to be resold to outsiders. Another issue was the difficulty which some returning transmigrants were having obtaining land from the *Kepala Desa*, because it was suggested that rice lands were no longer available. One transmigrant stated that he had paid Rp 200,000 (CND$260) and still had to wait for one year to obtain land.

The reasons for fisherfolk exchanging land were varied among the villages, as indicated in Table 6.12. Overall, the most common reason was the need for money to rebuild or renovate their house. A fairly recent trend in the fishing communities has been the replacement of wooden and thatched homes with brick and concrete ones (Figures 6.1 to 6.3). Houses constructed from these materials are thought to be more comfortable and prestigious (key informant 1994). In Ujung Alang, the main reason for exchanging land was to purchase fishing equipment, which reflects the strong orientation towards fishing. Other key reasons for selling land included: capital to buy fishing equipment, to pay for their children's schooling, hospital and medical needs, and to clear land for farming (Table 6.12). A key informant also conveyed that the fisherfolk were consuming more goods, such as radios, with the money from exchanging land. As indicated by Table 6.13, large sums of money were obtained from exchanging, which were not possible from fishing.

Table 6.12: Reasons for Fisherfolk Selling Land

Reason for Selling Land	Number of Respondents							
	Ujung Gegas		Ujung Alang		Pantai		Total	
	n	%	*n*	%	*n*	%	*n*	%
renovate or build house	4	16.6	2	9.1	29	36.7	35	28.0
to buy fishing equipment	3	12.5	7	31.8	6	7.5	16	12.8
pay for school	0	0.0	0	0.0	13	16.4	13	10.4
pay for hospital/medicine	3	12.5	3	13.6	7	8.8	13	10.4
family needs	4	16.6	1	4.5	5	6.3	10	8.0
other	7	8.6	6	27.2	1	4.1	14	11.2
no answer	9	37.5	3	13.6	12	15.1	24	19.2
Total	24	100.0	22	100.0	79	100.0	125	100.0

χ^2 (12, n = 125) = 36.594, $p \leq 0.05$.
(Note: 57% of the cells have expected counts less than the critical value of 5)
Source: Semi-structured interviews and short survey 1994

Table 6.13: Selling Price of Rice Lands in Ujung Alang

Year Purchased	Amount and State of Land	Price in Rupiah*
1981	100 ubin, opened	400.000
1983	100 ubin, opened	200.000
1984	1400 ubin (2 ha), forest	500.000
1986	700 ubin (1 ha), forest	500.000
1988	200 ubin, opened	250.000
1989	250 ubin, opened	500.000
1991	150 ubin, opened	350.000
1993	200 ubin, opened	500.000

Source: Semi-structured interviews in Ujung Alang 1994
*700 ubins = 1 hectare

6.3.2 Agricultural Training and Skills

Access to the necessary knowledge and skills is an essential element for the fisherfolk to participate in rice farming. Table 6.14 indicates the main sources of agricultural training in Kampung Laut as government, NGO's, informal exchange with immigrant farmers, and the transmigration program. The main source of agricultural information in all three villages was the informal exchange among fisherfolk and immigrant farmers. This was followed by no training. While some fisherfolk suggested that they had no training, it is conceivable that in order to begin they must have watched or discussed various aspects with other fisherfolk and/or immigrant farmers. Thus, the no category can probably be viewed as informal sources of training. Formal sources of training from the village, subdistrict and district levels of government as well as the

Figure 6.1: Older style home following the stilt houses, Ujung Gagak

Figure 6.2: Recent reconstruction of house, Ujung Gagak

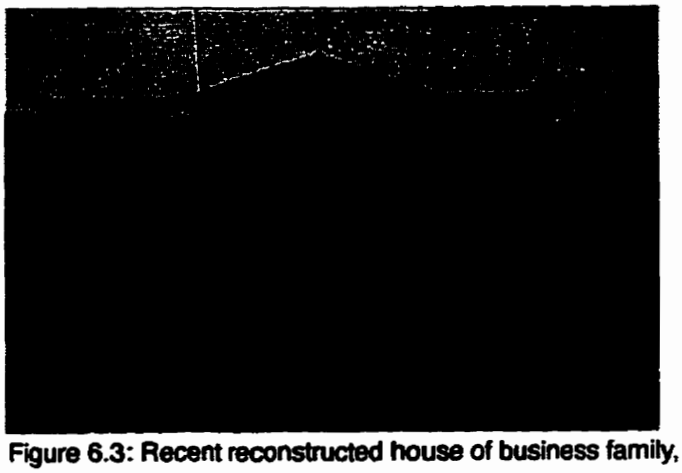


Figure 6.3: Recent reconstructed house of business family, Ujung Gagak

NGO all provided similar levels of contributions to agricultural training in Kampung Laut, as far as numbers of participants are concerned. The returning transmigrants had obtained training as part of the national transmigration program. Of the immigrant farmers interviewed, the majority had not participated in any agricultural training since moving to the area (Table 6.14).

The quality of each of the training sources was not ascertained. The BLK and the NGO training in Solo were the most intensive sources, spanning two to three months. The farming group that was established as part of this training involved only the participants, and it was suggested in Ujung Gagak that there was minimal sharing of information from the participants to the nonparticipants (key informants 1994). The village and Kecamatan training were much shorter in duration, lasting one day to one week..

The need for additional training was a common comment by informal leaders, village staff, the YPKS NGO fieldworker, as well as the agricultural extension officer. The general response of the fisherfolk was that they did not have any real difficulties "changing the paddle for a hoe" and that through watching and practicing they learned how to cultivate rice. Farmers suggested that the fisherfolk who worked hard could become successful, but overall they still lacked the needed skills, and consequently their rice yields were lower. The agricultural extension officer suggested the need for

Table 6.14: Sources of Agricultural Training in Kampung Laut

Source	Number of Respondents *													
	Ujung Alang				Ujung Gagak				Panikel				Total	
	Fisherfolk		Immigrants		Fisherfolk		Immigrants		Fisherfolk		Immigrants			
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
NGO	2	7.6	2	7.1	0	0.0	0	0.0	1	12.5	0	0.0	5	4.3
Government	3	11.5	7	25.0	4	13.7	2	22.2	1	12.5	0	0.0	18	15.6
BLK (District)	2	7.6	6	21.4	2	6.9	0	0.0	1	12.5	0	0.0	11	9.5
Transmigration	0	0.0	0	0.0	3	10.3	0	0.0	2	25.0	0	0.0	5	4.3
Informal	9	34.6	0	0.0	6	20.6	0	0.0	1	12.5	0	0.0	16	13.9
None	10	38.4	13	46.4	14	48.2	7	77.7	2	25.0	14	93.3	60	52.2
Total	26	100	28	100	29	100	9	100	7	100	15	100	114	100

* Note: Maybe more than one response per respondent
Source: Semi-structured interviews 1994

demonstration plots, particularly for the application of fertilizers (e.g., the new urea fertilizer tablet). As suggested by a village staff member in Ujung Gagak, the low levels of formal education prevalent in the fishing communities was an impediment for the fisherfolk to fully understand and put into practice information provided from training.

6.3.3 Credit

In 1994, no government credit institutions were available for rice farming in Kampung Laut. As such, the fisherfolk relied on informal sources of credit, mainly loan arrangements with a *bakul* or village money lenders (key informants 1994). Neither source of credit was provided at advantageous rates for the local people. Loan arrangements with a *bakul* was mainly based on the *ijon* system, and as discussed in the previous chapter, the arrangements are not generally favourable to the fisherfolk. The "village bank" or money lenders, on the other hand, charged twelve per cent interest per day, with maximum daily loans of approximately Rp 20,000 (CND$13). Larger loans, such as Rp 100,000 (CND$66) required collateral, such as a boat, until payment was made (key informant 1994).

6.3.4 Leadership

Leadership in Kampung Laut has been a major influence in the direction of the development of rice agriculture. At the village level, the main leaders have been the *Kepala Desas*, and leadership roles have mainly been concerned with the formation of farming groups, *gotong-royong*, and the exchange of land.

Gotong royong activities in the village, associated with rice agriculture, have been limited or not effective because of lack of enforcement. The only *gotong-royong* rice related activity, organized by the *Kepala Desa,* was in Ujung Alang, associated with the maintenance of the dikes. According to local people, this activity was limited in some areas because the *Kepala Desa* did not spend enough time there, resulting in the lack of enforcement (semi-structured interviews Ujung Alang 1994).

Associated with the selling of land, leadership of the *Kepala Desas* in Ujung Gagak and Panikel was illustrated by the following statement: "in the family if the father [*Kepala*

Desa] cannot give a good example, then the children [community] cannot follow" (key informant 1994). The concern over the selling of land in both Ujung Gagak and Panikel came with a common message that better management and control of land distribution were badly needed and should come from higher levels of government (semi-structured interviews 1994). As suggested by one key informant, the issue of land availability in Panikel was not that there was not enough, but that it was not fairly distributed among the local people. There were also mixed views on the utility of the village regulations of *bawon* and *maro*. While some viewed these as necessary because the fisherfolk did not have the time, energy, or money to clear the land, others viewed them as unnecessary and that with time and support the fisherfolk would gradually clear the land (semi-structured interviews and key informants 1994).

Informal leadership and organizational activities also occurred at the subvillage level, mainly in Panikel and Ujung Alang. In Panikel, farmers had asked for assistance from the *Kepala Desa* for the construction of small canals. When there was no response from the *Kepala Desa*, the people organized themselves, whereby each family was to dig seven metres allotted in a specific area (semi-structured interviews 1994). The small canals were needed to bring sediments carried down the river farther inland to build up the land as well as drain excessive water. The farmers were concerned that these lower lands would become swampy if they were not built up. The head of the LKMD in Panikel suggested that canal construction could be part of the 1995/96 village development proposal.

In Ujung Alang, several farming groups (*kelompok tani*) had been established, and are functioning in a way that is supporting the farmers. These activities include the exchange of information and savings (i.e., *arisan*). One of the groups had been formed with the assistance of the NGO YPKS, and had established income generating activities, such as raising ducks and growing fruit tree seedlings to sell.

6.4 SUMMARY

This chapter has identified the main actors and responses related to the cumulative effects of sedimentation. As indicated in Chapter 5, since 1968 rice agriculture has

become a dominant land use activity in the area. In this chapter, rice farming was identified as the main development response to the declining productivity of the estuary fisheries and the formation of new land. Development of rice was identified as largely a village level initiative, carried out within the opportunities and constraints arising from the responses of the other key actors, notably the central and district level governments. The evolving context of change is largely associated with institutional arrangements, both formally and informally. Formally, the responses from the government and NGO's included the *Bupati's* regulation which gave the fisherfolk the right to use the land and the establishment of the village regulations of *bawon* and *maro*, the construction of the dikes, the various forms of aid, and the provision of agricultural training. The informal arrangements occurred more at the village level, and mainly involved the distribution of land and the informal exchange of agricultural information The implications of these responses by the various actors for sustainable development are discussed in Chapter 7.

Chapter 7
LAND USE CHANGE AND SUSTAINABILITY IN SEGARA ANAKAN

7.1 INTRODUCTION

The previous two chapters identified land use changes from 1968 to 1995 in Segara Anakan, and the key interactions among society, environment and development which gave rise to these changes. The purpose of this chapter is to assess the land use changes in terms of sustainable development, and in doing so identify the main opportunities and constraints in Segara Anakan. Sustainable development is addressed in terms of economic viability, social equity and ecological integrity.

7.2 LAND USE CHANGE AND SUSTAINABLE DEVELOPMENT IN SEGARA ANAKAN

Changes in land use in Segara Anakan have occurred in a two stage process; sedimentation of the estuary followed by the expansion of the Javanese rice landscape onto the new lands. The result of these changes has been an increase in the number of actors involved in land use activities, as well as an increase in the diversity of the economic, institutional, technological, cultural environment, as indicated in Table 7.1.

A central element of sustainable development in Segara Anakan is the continual modification of the physical and human environment. This makes it difficult to provide a "firm" assessment of what sustainable development may look like in the estuary. With this in mind, the following analysis examines issues of economic viability, social equity and ecological integrity as they mainly relate to the land use activities in 1994. This of course does not rule out other possible development avenues, such as tourism, nor the possibility that current land use systems may eventually disappear. The development of semi-intensive fishponds, for example, could eventually replace rice agriculture, if they show to be productive. As such, assessment and

Table 7.1: Comparison of Dominant Land Use Systems in Segara Anakan, 1994

	Estuary Fisheries	Rice Fields	Semi-Intensive Fishponds
Social	• individualistic	• group oriented	• individual and group oriented
Economic	• income on a daily basis • minimal capital requirements • small scale	• income on an annual basis • medium capital requirements • small scale	• capital intensive • medium scale
Institutional	• minimal local or external institutional support • private and open access to resources	• major external institutional support (e.g., government programs) • private land tenure	• major external institutional support (e.g., government programs) • private land tenure
Technological	• traditional technology passed on from father to son	• modern technology associated with the green revolution	• modern technology associated with the blue revolution
Cultural	• family oriented	• family oriented	• family and business oriented
Physical	• minimal inputs or modification of the environment	• chemical inputs and modification of the environment	• chemical inputs and modification of the environment

monitoring of the sustainability of the current and emerging land use systems needs to become an integral component of the management process. Table 7.2 presents a summary of the opportunities and constraints for sustainable development associated with the land use changes, which will be discussed in more detail throughout this chapter.

7.2.1 Economic Viability

The economic viability of the land use changes is addressed in terms of the ability of the emerging land use changes to provide a sufficient income. Indonesians refer to this as *cukupan* (enough), and can be quantitatively assessed in relation to the poverty line. The national poverty line in Indonesia in 1992 was set at Rp. 10,295/person/month (US$5.50) for rural areas (Marshall 1993). Overall, the economic contribution of rice farming to Kampung Laut is still largely uncertain. This uncertainty arises from the relatively low levels of productivity and the varying stability of the rice yields, the ability to grow only one crop per year in most parts of the estuary, as well as the uncertainty over the future use of the new lands.

Table 7.3 illustrates the average income derived from fishing and farming per person per month. As of 1994, the results from rice farming could not, in most areas, generate a

Table 7.2: Summary of Strengths, Weaknesses, Opportunities and Constraints for Sustainable Development in Segara Anakan

	Strengths	Weaknesses	Opportunities	Constraints
Economic Viability	• increased diversity of economic opportunities	• low productivity of rice • declining productivity of estuary and potentially the commercial fisheries • best seasons for fishing and farming are the same • insufficient training	• increasing employment activities	• lack of water management for farming • increased pests
Social Equity	• informal exchange of agricultural information	• limited external intervention to assist farming • lack of resources to participate fully in rice and semi-intensive fishponds	• strong local initiative to participate in rice farming	• exchange of land with immigrant farmers • increasing influx of outsiders to the area
Ecological Integrity	• acknowledgment by government of the ecological significance of the area	• rapid deforestation of mangroves • loss of significant wildlife habitat • loss of fish, shrimp and crab nursery ground	• ecotourism to promote development and conservation for the mangroves and rainforest	• increasing pressure on the mangrove forests with an increase in population in the area, as well as activities requiring firewood (e.g., sugar and brick making) • continued sedimentation of the estuary from upland activities

Table 7.3: Estimated Monthly Incomes of the Fisherfolk from Fishing and Farming Activities in Kampung Laut, 1994

Activity	Average Income (/person/month in Rupiah)		
	Ujung Gagak	Ujung Alang	Panikel
Fishing	11,148	13,973	9,732
Farming	1,977	6,912	2,698
Combined	13,295	15,438	12,430

Source: Semi-structured interviews (1994)

subsistence level income on its own. The analysis indicates that the estuary fisheries still provides a higher level of income in all three villages. The income from fishing falls just below the poverty line in Panikel and is just above it in Ujung Gagak and Ujung Alang. The income generated from farming falls much below the poverty line in all three villages. The combined income of fishing and farming does raise all of the average income value to just above the poverty line. The combination of fishing and farming may allow for a smoother transition to only rice farming, if the need does occur. A weakness arises from the seasonal timing of these two systems, in that the best fishing time (i.e., January to May) occurs during the rice growing season. As of 1994, the productivity of the semi-intensive fishponds was still largely uncertain, making it difficult to assess its economic viability in terms of income generated.

Rice cultivation in Kampung Laut faces similar challenges found in other swamp land environments in Indonesia. The complex environment of a swampland introduces greater farming challenges than those found in more favourable rice growing areas (Siwi and Beachell 1984). Agricultural cultivation in swamp lands must contend with complex soil and water management issues, which result in higher costs and generally lower yields (Conway 1986).

The productivity and stability of rice farming in Kampung Laut is comparable to other swamp lands in Indonesia. For example, in Kalimantan one rice crop is cultivated annually, with an average yield on newly claimed lands being 1 ton/ha and on good lands (i.e., low acidity and low salinity) is reported to be 2 to 3.5 tons/ha (Conway 1986, 3). In Kampung Laut, productivity and stability of the rice yields are largely associated with water management issues, notably flooding, salt water intrusion and lack of water during the dry season. These physical constraints heighten the uncertainty of the economic viability of rice farming in the area, particularly if it is to replace the estuary fisheries.

The threat to economic viability and sustainability of rice is that water management issues will reduce the stability of the rice yields, and make the area unproductive for rice farming. Farmers and fisherfolk alike both suggested that the rice yields in the area, notably Ujung Gagak and Panikel, had decreased over the past few years. Some areas in Kampung Laut are more vulnerable than others, as indicated on the physical constraints map (Figure 5.21). An opportunity for economic growth is to encourage and support local initiatives to make the land more viable, notably through the construction of small irrigation and drainage canals. Large technical investments, such as the irrigation and drainage canals in the surrounding rice areas which were built as part of the Citanduy Project, require external assistance and as such are not feasible at the village and subvillage levels. The cultivation of secondary cash crops, such as fruits and vegetables, could also provide a more stable income.

Economic opportunities arose from rice development, mainly from the greater number of income generating activities, including farm labour, harvester, garden and dryland crops, and fishponds (*kolam*). Table 7.4 shows the degree of participation in these agricultural activities. It indicates that Ujung Alang has the most diversified agricultural activities, and it is mainly the farmers who participate in these activities. The majority of these secondary crops are cultivated close to the "mountain" of Nusa Kambangan, where the land is more stable. Nonagricultural related activities have also been included in Table 7.4 to illustrate the source of additional income for those not participating in these activities, notably the fisherfolk. The analysis indicates that generally the fisherfolk rely more on nonagricultural activities to supplement their main income.

7.2.2 Social Equity

The nature and magnitude of the land use changes have forced the fisherfolk to make changes in their way of living. A change in behaviour was the only real viable adaptive option for these communities, since only the central level of government has the technical, financial and political resources required to alter soil erosion in the Citanduy river basin and/or the impacts on the estuary (e.g., dredging). From the perspective of the fisherfolk, the land use changes

Table 7.4 Secondary Agriculture and Nonagricultural Economic Activities*

Agricultural related economic activities**	Ujung Gagak				Ujung Alang				Panikel				Total	
	Fisher		Farmer*		Fisher		Farmer		Fisher		Farmer			
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
farm labourer	7	6.5	0	0.0	1	0.9	2	1.9	0	0	1	0.9	11	10.3
harvest	12	11.2	1	0.9	6	5.6	6	5.6	1	0.9	1	0.9	27	25.2
vegetables	0	0.0	0	0.0	0	0.0	9	8.4	0	0.0	5	4.6	14	13.0
fruits	0	0.0	1	0.9	0	0.0	11	10.2	0	0.0	0	0.0	12	11.2
sugar production	0	0.0	0	0.0	1	0.9	8	7.5	0	0.0	0	0.0	9	8.4
fish ponds (*kolam*)	0	0.0	0	0.0	1	0.9	12	11.2	0	0.0	0	0.0	13	12.1
livestock (chickens, geese, ducks, goats)	1	0.9	3	2.8	6	5.6	11	10.3	0	0.0	0	0.0	21	19.6
Non related activities**														
collect firewood	5	7.2	1	1.4	2	2.9	2	2.9	1	1.4	1	1.4	12	17.4
children send back money	7	10.1	1	1.4	8	11.6	2	2.9	1	1.4	2	2.9	21	30.4
parents migrate for work	4	5.8	0	0.0	6	8.7	1	1.4	2	2.9	0	0.0	13	18.8
other work	5	7.2	2	2.9	8	11.6	6	8.7	1	1.4	1	1.4	23	33.3
Total	21	30.4	4	5.8	24	34.8	11	15.9	5	7.2	4	5.8	69	100

Source: Semi-structured interviews (1994)
*Includes both fisher-farmers and farmers
**May be more than one response per respondent

ultimately represent a compensation for the declining income from the estuary fisheries. The ability of the fisherfolk to participate actively and successfully in rice farming and other emerging land use activities is important in order to provide them with an alternative economic livelihood to fishing in the estuary.

The analysis indicated that the participation rate in rice farming by the fisherfolk is relatively high, with the exception of Ujung Alang where over half of the surveyed fisherfolk were not directly involved in farming. This participation trend can be associated with the spatial distribution of the impacts of sedimentation, reflected in the water-land ratio of the villages, the income derived from fishing, and the time frame of rice development. Most of the fishing grounds in Panikel have been replaced by new lands, and the fishermen must now travel much further distances to fish. In Ujung Gagak, the impacts have not been as substantial, although much of the water area to the south of Karang Anyar becomes a large mudflat during low tide. In Ujung Alang, the deeper rivers have provided more viable fishing grounds, particularly for the *apong* nets. Moreover, the development of rice agriculture occurred at a much earlier date, before the impacts of sedimentation on the estuary were felt. This, in conjunction with the

higher incomes from fishing in Ujung Alang, has resulted in less of a push factor for the fisherfolk in Ujung Alang to participate in rice farming.

Participation in the benefits of the emerging land use changes, notably rice agriculture and semi-intensive fishponds, varies among the village members. This variation is partially associated with issues of control, access, and knowledge, as discussed below.

7.2.2.1 Control

Control over resources in Kampung Laut can be viewed from two aspects: the interactions between the villages and the Government of Indonesia (GOI), and the interactions between the *Kepala Desa* and village community. The interactions between the villages and GOI has largely been concerned with use of new lands in the estuary and the associated institutional conflicts. These unresolved conflicts have generated much uncertainty at the local level. Although the fishing communities have been given the right to use the land, this right can be taken away at any time. The conflicts also highlight the increasing tension between government and *adat* law occurring throughout Indonesia (Hardjono 1991). The Basic Agrarian Law (1960) establishes state control over the allocation and use of resources, so that national interests often take precedence over those in the local area.

The institutional conflicts have impeded the implementation of a management plan for the area. This has resulted in an ad hoc and spontaneous development process. Development initiatives have not been conducted within a framework of a common vision or management goal for Segara Anakan, but instead have largely followed an iterative and sectoral approach. The spontaneous nature of the land use changes in Kampung Laut are similar to other research findings on spontaneous settlements:

> ...despite the impressive evidence that spontaneous settlers time and again make better farmers. As with poorly planned and implemented government-sponsored settlement, the major disadvantages of spontaneous settlements are the lack of legal access to land and secure land tenure, environmental degradation resulting from movement into marginal lands, a tendency for spontaneous settlers to displace the host population, and relatively low levels of productivity with few multiplier effects (Scudder 1991, 155)

This sentiment was reiterated by Vayda (1986, 123) who suggested that in conjunction with a quick response to new opportunities and the ensuing major transformation of the environment, new settlers generally orient their activities towards obtaining a profit, as opposed to sustained use, and stay only as long as the opportunity remains viable. The environment of Kampung Laut has indeed undergone rapid and major transformation, and the process has the potential to displace the fisherfolk, mainly those who do not yet have land, including the younger generation. The orientation of the farmers and fishpond developers to sustainable development is difficult to ascertain at this stage of development. The farmers are more family oriented, and have stayed in the area regardless of its hardships, such as isolation, no electricity and minimal fresh water. Similar to the farmers, some of the fishpond developers are also family oriented, looking for a long-term source of livelihood, but members of this group also include absentee businesspeople who are more speculative. If profits are not to be found in Kampung Laut, then they are more likely to leave the area.

The lack of response by the central level government to the institutional conflicts over the new lands is difficult to interpret. On one hand, the lack of response has been associated with the differing views of government officials on what should be done with the estuary. That is, to conserve or reclaim it for agricultural purposes (pers. com. consultant 1996). This dual orientation has been reflected in management plans since the beginning of the Citanduy Project (PRC 1974). Reclamation of swamp lands in Indonesia is consistent with the national development priority of food self-sufficiency, particularly in the face of a growing population and declining agricultural land base on Java (Noorsyamsi et al. 1984). In Indonesia there are at least ten million hectares of tidal swamp lands, the majority located in Sumatra, Kalimantan and Irian Jaya, of which the GOI has designated 5-7 million hectares for agricultural production (Noorsyamsi et al. 1984). The same interpretation can be applied to the development of semi-intensive fishponds (*tambak*). *Tambak* development is another GOI national development initiative to generate increased foreign revenue, particularly since the decline in oil-generated revenue (Hannig 1987; Fox 1991).

The development process in Segara Anakan reflects certain characteristics in the relationship between the government structure and the village, which has influenced land use change. Government intervention indicates a concern for the economic and social stability of the fishing

villages. On the other hand, the lack of strong commitment to the communities, particularly in regards to the institutional conflicts, keeps a level of harmony among the related institutions, notably *Perhutani*, the Ministry of Justice and the local people, as well as keeps options open for future development strategies. Future intervention by the central level government could dramatically alter the current path of land use change, in ways that may or may not be beneficial to the villages (e.g., forced transmigration or the development of an irrigation and drainage system). The development strategies selected by the central level government will indicate if it is sensitive to the needs of the fishing and rice communities, or if it is more oriented towards national development goals.

Issues of control within the village sphere arise from the interactions between the *Kepala Desa* and communities. The general consensus and vision of both the *Kepala Desa* and community that the new lands belong to the village and should be used for rice farming have enabled the *Kepala Desa* to represent the village's needs and concerns at the subdistrict and district levels of government. This was followed up with the village regulations of *bawon* and *maro*, which were initially established to assist the fisherfolk to begin farming. Views regarding these regulations are divided with some fisherfolk feeling that they are both necessary and beneficial, while others think that they are unfavourable to the communities and that encouragement, support and patience are all that is necessary.

Village level control over resources has been dominated by the *Kepala Desa*, as established by the government administrative structure. The leadership role of the *Kepala Desa* is complex, incorporating elements of subordination to the subdistrict and district level instructions, provision of flexibility for the local people and their situation, and personal gratification and well-being. Subordination to the subdistrict and district levels, and ultimately to the central level of government, is highlighted by land use conflict and closing of the lands.

Flexibility to the local people relates to maintaining a level of social harmony, and can be associated with what Sullivan (1992) referred to as a "turning a blind eye". That is, the *Kepala Desa* and perhaps subdistrict and district level staff are willing to allow smaller concessions to the local people in order to maintain a degree of harmony in the village and subdistrict. The exchange of land can be viewed in this context, as the village staff in all three villages often

suggested that it was difficult to reprimand the fisherfolk for exchanging land because of their poor economic situation. This allowance may also be stimulated by the perceived need to "make the lands productive", resulting in a greater reliance on immigrant farmers and fishpond developers who have more knowledge, skills and in some cases capital, to use the land.

The personal gains of the *Kepala Desa* were most evident in Ujung Gagak, where the exchange of village lands (*tanah bengkok*) with outsiders was most visible. The activities of the *Kepala Desa* have not been beneficial to the long-term development of the village, and have been more associated with person gain. The perceived exchange of land with outsiders had resulted in heightened mistrust between the *Kepala Desa* and community. Personal motivations underlying the actions of the *Kepala Desa* in Java have been highlighted in other research (Soetrisno 1993).

7.2.2.2 Access to Resources

Access to key resources by the fisherfolk for rice agriculture was discussed in Chapter 6 (Sections 6.3), and is summarized in Table 7.5. As mentioned above, the uncertainty created by the institutional conflicts has impeded government intervention and management of the area. The largely spontaneous nature of rice development has resulted in the fisherfolk fending for themselves, being forced to rely on their own capabilities, most notably economic. The lack of external intervention to compensate for differences in the ability for fisherfolk to adapt to rice farming has resulted in unequal access to resources. While the fisherfolk who have surplus income, or access to credit, can hire labour to clear and work the land, and even invest in semi-intensive fishponds, those who do not have the surplus income must continue to rely on fishing and/or adopt coping strategies which could increase their vulnerability. These coping strategies include selling land, working outside of the village, collecting firewood, and entering into unfair trade arrangements (e.g., *ijon* system). Other limitations in the participation of rice include: clearing only part of their land for rice farming; not being able to purchase fertilizer and pesticides, and not being able to hire labour.

Table 7.5: Summary of Access for Fisherfolk to Participate in Rice Agriculture

Resources	How Accessed	Why Important	Influence of Development Process	Impact of Development Process
Land	• claimed individually by fisherfolk • distributed by *Kepala Desa* and Village staff • bought • village regulation of *bawon* and *maro*	• need land to cultivate rice	• degree of regulation influences number of fishermen with land, and the amount of newcomers	• institutional conflicts have resulted in minimal external guidance or assistance in land use and distribution • large number of newcomers to the area
Credit	• no formal credit institutions in villages • depend on informal sources such as "village banks" and *ijon* system	• need credit to pay for labour to open and work the land • need credit to pay for rice inputs (seeds, fertilizers, pesticides)	• spontaneous nature of development has resulted in the establishment of no State credit institutions (BRI, KUD)	• influenced the selling of land by local people • the need to continue to fish in order to provide for every day needs • minimal external assistance
Skills	• limited government sponsored training (BLK, CRM); 30-40 people / village • informal exchange of information among fisherfolk and newcomers • limited village training/meetings • limited interaction with agricultural extension officer • training by NGO both in village and sending of cadres to training centre	• in order to grow rice successfully	• spontaneous nature of development • selection of limited people for training; little interaction with rest of community	• minimal external assistance
Equipment	• renting of tractors from outside of village; not always available when required • rice mills located throughout area	• to assist in rice agricultural management practices		• minimal external assistance
Leadership	• varies with villages limited interaction with *Kepala Desa* in two villages, and the agricultural extension officer	• ability to provide moral support for fisherfolk		• institutional conflicts have created uncertainty and provided minimal leadership direction

The informal exchange of information provided a widely accessible source of agricultural training for the fisherfolk in all three villages. An opportunity for increased and sustained training would be to combine the two sources of information, in that informal leaders at the neighbourhood level would participate in training sessions. Not only would this promote a more equitable diffusion of agricultural information, but concerns and needs which arise from the physical conditions which vary throughout Segara Anakan, could be directly addressed.

Leadership and organization which directly addressed the needs of the local people were most prominent at the subvillage level. This is highlighted by the informal exchange of information, as discussed above, as well as the exchange of labour (i.e., *liuran*), savings groups (i.e., *arisan*), and the construction of a small dam and irrigation system in Ujung Alang and drainage canals in Panikel. These activities were mainly organized at the RW/RT levels. This trend in organization is consistent with other village level research findings, which indicate that organization among families and neighbours is based more on cooperation and fulfillment of their needs, as opposed to participation in village level activities, which are often associated with the government demands (Tjondronegoro 1984; Sullivan 1992; Soetrisno 1993; Warren 1993). Leadership activities at the village level were dominated by the *Kepala Desa*, and included agricultural training, *gotong royong* activities, and the farming groups (*kelompok tani*). As indicated in the previous chapter, the utility of the farming groups and *gotong-royong* activities in Ujung Gagak and Panikel had been minimal. In regards to government administration and village level development, greater consideration of the role of the *Kepala Desa* in village development should be taken into account, and steps should be taken to create more effective mechanisms to achieve greater accountability, as well as broad based community participation.

In a general manner, rice development in Segara Anakan has focused more on developing the land, rather than developing the people. This development fixation on the land has increased the vulnerability of some members of the fishing communities, by partially or

fully excluding them from the participation in rice agriculture. Moreover, it has promoted a view of the change among the villages that does not include the mangrove forest. That is, the land is viewed more for rice, centred around the institutional conflicts, than as new mangrove forest.

7.2.2.3 Knowledge

Rice agriculture is a completely different land use system than the estuary fisheries, requiring a different set of skills, norms, values and behaviour, as indicated in Table 7.1. Research dealing with the loss of something familiar suggests that "new experiences are assimilated by placing them in the context of a familiar and reliable construction of reality. This structure, in turn, rests not only on the regularity of events themselves, but on the continuity of their meaning" (Marris 1974, 6). As the first generation of fisherfolk to become farmers, they are still largely establishing a new reality. It was repeatedly suggested by government officials, key informants, farmers and NGO field workers that the fisherfolk's knowledge base for rice farming was still minimal, and generally they "don't know what they don't know". The strong local initiative to learn farming provides an opportunity to encourage and support. This also highlights the importance of including the younger generation in training, and ensuring their access to land.

The main source of agricultural knowledge for the fisherfolk has been the immigrant farmers. This informal exchange of information has been a major strength for local adaptation. While extremely beneficial, in terms of its accessibility, a potential weakness arises from the extent of the farmers' understanding and ability to manipulate successfully the ecological conditions of the area. As the main source of agricultural information, it alone may not be sufficient to provide all the necessary skills. Opportunities arise to build on this informal exchange of information, and to work in collaboration with the NGO, agricultural extension officer and other government training. Threats exist if additional and sustained training is not provided to increase the skills of the fisherfolk and farmers.

7.2.3 Ecological Integrity

Sustainable development as it relates to ecological integrity was not a fundamental part of this research. That was only because emphasis was placed more on the human side of land

use change (i.e., social, economic and institutional). Given the ecological significance of the area, some general comments are provided which raise more questions than they answer. Difficulties arise when addressing the issue of ecological integrity in an area undergoing such dramatic changes. Any decisions must be made within the context of sedimentation. That is, ecological conservation not only involves the management of the mangrove estuary, but must contend with upland activities and impacts of sedimentation, as well as any reclamation activities, such as dredging. Issues of sustainability ultimately must involve a trade-off between economics and conservation, in which the cost of "saving" the estuary plays a significant role. The estimated cost of dredging the estuary varies, depending upon the technique and equipment, from US$ 0.5 million/annually to US$ 21.2 million for the initial procedure, followed by US$ 2.2 million per year for the first 5 years and then US$ 3 million annually (ATC Engineering Consultants 1994).

The issue of sedimentation of Segara Anakan is still very much alive at the central level, indicated by the continued Citanduy project funding by the Asian Development Bank (ADB). Despite many activities and external funding (US$ 16.75 million as of mid 1987), soil erosion in the river basin continues, although it may have leveled off (World Bank 1990, 64). Moreover, despite numerous studies on dredging the estuary, as part of a management plan, as of 1994 no major intervention had been taken in Segara Anakan. This may change with the continued funding of the Citanduy project by the Asian Development Bank.

General issues associated with ecological integrity in Segara Anakan arise mainly from the rapid and extensive loss of mangrove forests and estuary waters. In this context, the ecological issue becomes more one of the maintenance of essential ecological processes, biodiversity and wildlife habitat. Both of these land use systems support significant bird wildlife habitat, which includes that for the endangered Milky Stork, and nursery ground for fish, shrimp and crabs. Degradation of the nursery ground has implications for the fishermen in Cilacap, as well as for an important source of protein for the fisherfolk of Kampung Laut, and more generally for Java. The encroachment of rice agriculture has resulted in a loss of nesting sites of the Milky Stork. It is currently uncertain how sedimentation has impacted the nursery ground. At the community level, loss of the

mangrove forest is concerned with size, extent, distribution, quality and species, and how they interact to ensure the continued ecological functioning of the mangrove system. Another area which requires this type of attention is the plant and wildlife on Nusa Kambangan. The mangrove estuary and rainforest on Nusa Kambangan both provide ecosystems of interest and importance to the public and research community.

Other threats to ecological integrity arise from the compatibility of the surrounding land use systems, notably rice and settlements. The increased wastes coming from both these land use activities could have a negative impact on the health of the surviving species. Moreover, the increased population in the area is exerting greater pressures on the remaining mangroves for both domestic and commercial wood supplies.

7.3 SUMMARY

The interactions among land use change, community, environment and development present both opportunities and constraints for sustainable development in Segara Anakan. Overall, rice farming has contributed to the economy of the fishing villages, but to various degrees throughout Kampung Laut. The main opportunity for sustainable development includes a more diversified local economy, which has increased income generating opportunities for both men and women. Processes which have encouraged and supported the adoption of rice by the fisherfolk include: a strong local initiative, access to the use of the new lands for agriculture, and the informal exchange of agricultural information. Within the village, informal activities at the subvillage have proved to be more viable for organizing and implementing the local needs to increase the adaptive capabilities.

The constraints to sustainable development, on the other hand, arise from both the human and physical systems, and include: the low rice yields associated with the use of marginal lands for rice farming, low and seasonal income, limited and unequal access to the necessary resources, and uncertainty over the future use of the land. The processes of change which underlie these constraints involve: limited local control over resources arising from the institutional conflicts, minimal external intervention and compensation for the fisherfolk, actions of the *Kepala Desa* that are not accountable to community members, and high population densities on Java acting as a push factor into these marginal lands. While

one significance of the farmers to assist the fisherfolk to rice farm has been demonstrated, the important issue is now how many newcomers is enough. The long term impact on the fisherfolk may be their displacement and/or dependency on wage labour as a source of income.

Chapter 8
CONCLUSIONS AND IMPLICATIONS

8.1 INTRODUCTION

The main theme of this research has been land use change analysis, which has been studied for its own significance, as well as a platform to increase understanding of the interactions among society, environment and development, with particular reference to sustainable development. The regional focus has been the Segara Anakan, Java, Indonesia, where the nature, rate and extent of land use change from 1968 to 1995 have been documented, key interactions among society, environment and development identified, and prospects for sustainable development explored. The purpose of this chapter is to review the main findings of this research, to highlight conclusions and implications of these findings for sustainable development, and to offer recommendations for further research. In doing so, the empirical and conceptual questions outlined in Chapter 1, are revisited.

Empirical

- What have been the nature, rate, and extent of land use change in Segara Anakan, Java, Indonesia?
- How have land use change, society, environment and development interacted in Segara Anakan?
- What planning, management and decision-making challenges do these land use changes present and how can they be addressed with particular reference to sustainable development?

Conceptual

- How are society, environment and development linked to land use change, particularly at the village level?
- What data collection methods can be used to provide an increased understanding of land use change and its interactions with society, environment and development at the village level?

8.2 LAND USE CHANGE AND SUSTAINABLE DEVELOPMENT IN SEGARA ANAKAN: 1968 TO 1995

The analysis of land use change in Segara Anakan has highlighted its highly intricate nature at the community level. The perspectives, interests, values, and capabilities of the main actors have interacted in ways of competition, cooperation and dependency to produce adaptive strategies and their associated changes in land use. In Segara Anakan land use change can be viewed as a two-step process. The first step involved the cumulative effects of sedimentation which was largely associated with the activities of the people in the upland areas. This process was not addressed in this thesis. The second step involves the adaptive responses of the fishing communities of Kampung Laut and local government to the impacts of sedimentation on the local environment of Segara Anakan.

The main impacts on the human environment arose from the declining productivity of the estuary fisheries and the continual replacement of the fishing grounds with new lands. The main adaptive response by the fishing communities was to use these new lands for rice farming, which essentially involved the expansion of the modern Javanese rice landscape into the area. Participation in rice agriculture has played a significant role in the economic recovery process of the fishing communities to sedimentation. This adaptive response was supported by the government in terms of giving the fishing communities the right to use the lands, but the institutional conflicts also highlighted the conflicting interests, particularly over the new lands.

The dimensions of the change process have had implications for both the adaptive process and the nature of the land use changes (Table 8.1). Overall, the change process in Segara Anakan has been characterized by its rapidity and magnitude, and, since the mid-to-late 1980's, the changes have intensified. Over the 27 year span from 1968 to 1995, the cumulative effects of sedimentation have resulted in approximately 4,400 hectares of new lands being formed in the estuary, which was followed by about 4,300 hectares of new mangrove forest. Associated with these changes was a decline in the surface area of the estuary waters by approximately 8,420 hectares, as well as a decrease in water depth. Over the same period of time, some of the new lands and the older and newer mangrove forest were converted into rice fields, settlements

Table 8.1: Summary of Land Cover and Land Use Changes in Segara Anakan: 1968-1995

Land Cover Type	Land Cover Changes	Land Use Activities
New lands	• increase by 4,407 ha from 1968 to 1995 (including the lands under the mangrove forest) • in 1995 there was approximately 29 ha of new lands in the estuary	• land base for new land use activities • use of the new lands has caused institutional conflicts in the area • decreased mobility of transportation and decline in the number of feasible fishing areas
Estuary	• decrease in size by approximately 8,424 ha from 1968 to 1995 • decrease in depth of waters	• traditional fisheries • nursery ground for fish, shrimp and crabs • decline in the productivity of the estuary fisheries • excavation of sand for making bricks and construction materials • provides for the main mode of transportation • wildlife habitat, such as otters
Mangrove forest	• cutting of mangroves of approximately 15,075 ha from 1968 to 1995 • growth of about 4,304 ha of mangroves onto new lands from 1968 to 1995	• increased pressure for wood supply for domestic and commercial uses • supply of nutrients to the estuary waters • supports the nursery ground for fish, shrimp and crabs • wildlife habitat for birds and monkeys
Rice agriculture (and associated uses)	• increased by 15,075 ha from 1968 to 1995	• increased population by 45% from 1975 to 1994 with immigrant farmers • increased economic opportunities (labourer, harvest) • varied range of productivity and stability of rice yields, associated with physical constraints (lack of fresh water, salt water intrusion and flooding)
Settlements	• in 1995 there was approximately 197.6 ha of settlements in Segara Anakan • changes in extent from 1968 to 1995 is not possible to ascertain, as the land cover type of settlements was included with the rice fields	• increased number of people living in the area by 45% from 1975 to 1994 • some areas are inhabited mainly by immigrant farmers • home gardens in farming settlements
Semi-intensive fishponds	• an increase in semi-intensive fishponds from 0 ha in 1968 to approximately 100 ha in 1994 (located only in *dusun* Cibereum, Panikel) • ponds are about 1-2 ha in size, and requires much capital and special skills	• in 1994, 96 % of the ponds were owned by outsiders • inputs largely purchased from outside • productivity of ponds still uncertain in 1994
Rainforest	• in 1995, rainforest was approximately 3,592 ha in size (located on Nusa Kambangan) • satellite analysis indicated minimal change in extent of the forest	• limited information on qualitative changes in the forest • land use activities involve collection of wood and birds

and semi-intensive fishponds. Rice and associated land covers increased in area from 0 ha in 1968 to about 15,000 hectares in 1995.

The land use changes in the estuary have resulted in greater intensity of human activities. This has been brought about by the partial reorganization of the local social, economic, institutional and physical environment, which has introduced a new set of people-people and people-nature relationships in Kampung Laut. The reorganization has introduced a new context in which the fisherfolk must now operate. As a result, existing land uses have been converted to new ones, such as the farming of rice and other agricultural crops, and where they have remained, existing land uses have become more diversified, such as the building of bricks, mining of

sand, and the collection of wood. A significant aspect of the intensification process has been the substantial increase in the size of the local population, largely driven by the immigration of outsiders. Since 1975, the population of Kampung Laut has increased by approximately 45 per cent. This influx of immigrants has greatly accelerated the transformation of the area. Consequently, these land use changes have resulted in an overall decrease in the extent and diversity of the natural environment, most notably the mangrove forest and estuary waters.

As indicated above, the main driving forces of land use/cover change in Segara Anakan have been sedimentation, formation of new lands, mangrove encroachment, and the conversion of new lands and mangroves to rice fields, settlement and semi-intensive fishponds (Table 8.2). The underlying driving forces arose from both external and internal sources. External sources involved the response to sedimentation by the central level government and the large population density on Java. Internal drivers of change arose from the range of adaptive responses available to members of the fishing communities and local government, which have been influenced by a myriad of factors arising from the interactions among society, environment and development (Table 8.2).

The interactions among society, environment and development in Segara Anakan represent the convergence of a growing number of actors in the area, increased uncertainty associated with changes in the local physical, economic and institutional environment, and a largely spontaneous and ad hoc development process. The main actors involved in land use change in Segara Anakan were the fisherfolk, *Kepala Desa* and village staff, subdistrict, district and central levels of government, two NGO's and the immigrant farmers and fishpond developers. The adaptive responses and interactions among the various actors have largely been mediated

Table 8.2: Summary of Driving Forces of Land Use/Cover Change in Segara Anakan, 1968-1995

Proximate Driving Forces	Underlying Driving Forces
• sedimentation • formation of new lands • mangrove encroachment • development of rice agriculture • expansion of settlements • development of semi-intensive fishponds	• declining productivity of the estuary fisheries and need for economic alternatives • *Bupati* regulation which gave the fishing communities the right to use the land • exchange of lands with outsiders (buying, renting, sharecropping, *maro/bawon*) • high population pressure on Java acting as a push factor into the estuary

Table 8.3: Summary of the Actors and Adaptive Responses

Actors	Adaptive Responses
Fisherfolk	• rice farming (10.6% total response) • *rice farming and fishing* (65.3%) • fish (not farm) (23.8%) • neither (0.4%) • exchange of new lands with immigrant farmers
Kepala Desa	• promote rice development in the villages • strong commitment that the new lands belong to the villages • village regulations of *bawon* and *maro* • perceived exchange of village lands (*tanah bengkok*)
Subdistrict Level	• agricultural training in the villages • closing of the new lands in 1992 after demonstrations • request that the *Kepala Desa* establish farming groups
District Level	• *Bupati's* regulation which gave the fishing communities right to use the new lands • agricultural training in the villages • aid in the form of dryland crop seedlings • permit the trial of semi-intensive fishponds in the area
NGO's	• agricultural training • establishment of farming groups (*kelompok tani*) • construction of dikes
Central Level of Government	• unresolved institutional conflicts • selection of Segara Anakan for ICLARM study • commitment to Citanduy Project
Immigrant Farmers	• view the new lands as a good opportunity for a better life • informal exchange of agricultural information with the fisherfolk • access land through exchange, sharecropping arrangement and/or village regulation of *bawon/maro*

by their different perceptions of, and interests in the land use/cover changes, and their economic and political capabilities to achieve them (Table 8.3). The institutional conflicts which arose over the use of the new lands in the estuary highlights the power struggle among the various groups, most notably the fishing communities and the government agencies of *Perhutani* and the Ministry of Justice. The fishing communities strongly perceived, based on *adat* law, that the new lands belonged to them, while *Perhutani* and the Ministry of Justice argued on modern laws that the lands belonged under their authority. Although the fisherfolk were given the right to the use of the new lands for agricultural purposes in 1994, the ultimate question of who the Segara Anakan area and emerging land uses will serve in the future, and how, largely remains unanswered. It remains unanswered because the central level government, which has ultimate control over the land, has not yet made a public decision.

The ongoing land use/cover changes in the estuary have modified the local environment, creating an environment of uncertainty. Uncertainty was associated with the continual modification of the physical environment, the declining economic base of the estuary fisheries, and the institutional conflicts over the use of the new lands. The cumulative effects of sedimentation will, without significant technical, financial and political intervention, result in the permanent transformation of the physical environment. The relatively low socio-economic condition and political influence of the fishing communities has limited their ability to adapt to the changes in the physical environment. The only real option has been to alter their behaviour. The level of participation in rice farming by the fisherfolk varied among the three villages, mainly associated with the spatial distribution of the impacts of sedimentation. The highest level of participation has been in Panikel, followed by Ujung Gagak and then Ujung Alang.

The development process in Segara Anakan has occurred in a largely spontaneous and ad hoc manner. The spontaneous nature is associated with the strong, local initiative of the fisherfolk to use the new lands for rice farming and their limited control over how these lands were distributed within the communities. The ad hoc manner is associated with the lack of a management plan or strategies to provide goals and approaches for development activities. Overall, the local government development activities in Segara Anakan have been largely characteristic of the central governments approach to rural development--top down and along sectoral lines (Nainun 1987). Training and aid, the main forms of government intervention, originated from the various agencies, notably the Departments of Agriculture and Fisheries. The level of integration among the development activities of the various government sectors does not seem high and is basically uncertain.

Issues of sustainable development of the land use/cover changes were addressed in terms of economic viability, social equity and ecological integrity. Overall, the current changes have produced both constraints and opportunities for sustainable development. The constraints associated with the human environment arise from the different implications that these changes have had for the various actors, more specifically members of the fishing communities, and is highlighted in terms of their increased vulnerability. Vulnerability is associated with the declining economic livelihood for at least some members of the fishing communities, and their inability to recover from these economic losses. The forms and sources of vulnerability for the

fishing communities are complex and arise from the historical context of fishing and land use/cover change in the estuary. In the pre 1980's, the difficulty in selling fish, which was associated with the high isolation of the fishing villages and limited water transportation.

Poor markets also contributed to the relatively low economic conditions of the fishing communities. Once the demand and prices for seafood began to increase in the mid 1980's, along with better avenues for marketing fish locally, the cumulative impacts of sedimentation resulted in the decline of the estuary fisheries productivity.

The changing context of daily economic life in the fishing communities meant that the fisherfolk were not able to reap the full benefits of the increased markets. Moreover, the emergence of land based activities has heightened competition among potential users, which has mainly been driven by economic and institutional forces. While some of the fisherfolk have been able to compete, with varying degrees of success, others have not, thus increasing their vulnerability.

Sources of vulnerability in the fishing communities arose from both environmental and structural factors. The sources of vulnerability reflect the underlying drivers of land use change. Environmental factors have included the cumulative effects of sedimentation, the high population pressures on Java, low productivity of the rice fields, limited skills, lack of time and energy of the fishermen to participate in rice farming, continued reliance on fishing to provide for everyday needs, and the physical constraints on the productivity of the rice fields. The structural forces included the unresolved institutional conflicts, lack of capital to participate in rice farming, no formal sources of credit, minimal external intervention, lack of compensation for the fisherfolk forcing reliance on their own resources, and the use of marginal lands for farming. These forms of vulnerability relate well to Hewitt's (1997) categories of: exposure, weakness, lack of protection, disadvantage, lack of resilience and powerlessness (Table 8.4).

On the physical side, increased vulnerability is associated with the rapid rate of deforestation of the mangroves and the continual enclosure of the estuary waters. Although there has been limited research conducted in this area, these changes have the potential to threaten ecological

Table 8.4: Forms of Vulnerability in Segara Anakan, 1994

Exposure (related to geographic location)
- spatial distribution of impacts of sedimentation which has been changing the physical and human context in which the fishing communities exist
- highly isolated
- limited transportation and communication with the outside

Lack of Resilience/Disadvantage
- limited financial means to participate in rice farming and fishponds (i.e., decrease in access)
- limited time and energy to commit to both fishing and farming (i.e., decrease in access)
- limited external intervention to support the shift to rice farming (i.e., reliance on individual capabilities)
- limited skills and experience to participate in rice farming and fishponds (current knowledge of fishing has been rendered less useful with the changes in the physical environment)
- use of marginal lands for farming resulting in low and seasonal yields
- low and seasonal income generated from both fishing and farming
- limited economic opportunities in the villages (must migrate seasonally)
- increased consumption of outside material goods

Powerlessness
- limited financial, technical and political means to stop or alter the impacts of sedimentation
- limited financial, technical and political means to change the physical environment to better adapt to rice agriculture (i.e., construction of a drainage and irrigation system)
- limited local control over decision-making and use of the new lands
- limited participation in village development

Adapted from Hewitt (1997)

processes and resource productivity of the estuary. This, in turn, can threaten the role that the mangrove estuary plays as a nursery ground for fish, shrimp and crabs, and as a wildlife habitat for birds, monkeys and otters. Under the current land use changes, pressure on the mangroves will increase, mainly from the increased need for domestic and commercial wood supplies. Increased water pollution from agriculture and human settlements could also threaten the ecology of the mangrove estuary. On a regional level, the implications of the physical changes in the estuary have economical and ecological implications. Economic implications arise from the impacts these changes may have on the commercial fishery in Cilacap, as well as the contributions this fishery has for national foreign exchange. Ecological implications arise from the potential loss of the bird migratory ground, suggested to be one of the last on the south coast of Java (AWB 1988).

Opportunities for sustainable development are associated with the processes of land use/cover changes in Segara Anakan that have acted to increase the resilience of the fishing communities to recover from the economic losses of the declining estuary fisheries. These included a strong commitment of the fisherfolk to the area, increased income generating opportunities for both

men and women which arose from the land based activities, the informal exchange of agricultural information that occurred between the fisherfolk and immigrant farmers, and the *gotong royong* activities at the subvillage level, such as *liruan* and the digging of canals.

The discussion of land use/cover change and vulnerability has, so far, concentrated on the fisherfolk. Land use/cover change has provided more favourable circumstances for other actors, notably the immigrant farmers and fishpond developers. Both groups viewed the opening of these new lands as a valuable opportunity. Their ability to exploit this opportunity and compete has been greater than the fisherfolk, mainly because of their skills in manipulating the land and their sometimes greater financial capabilities. In some cases, the circumstances which "pushed" immigrant farmers to the area arose from government expropriation of their lands, lack of capital to purchase land elsewhere, and/or lack of land to buy. While perhaps not experiencing the same degree of vulnerability, the farmers and fishpond developers have faced the same uncertainties as the fisherfolk, notably the continual changes in the physical environment, economic uncertainty arising from farming on marginal lands, and the institutional conflicts over the use of the new lands.

Sustainable development in Segara Anakan is intrinsically linked with the ongoing land use/cover changes, and how these changes have generated and reproduced vulnerability for the human and physical environment. While the nature and dimensions of change arising from sedimentation acted as the trigger of change, vulnerability itself arose largely from structural and environmental factors emanating from the interactions among society, environment and development in both the internal and external environment.

From the analysis of land use/cover change in Segara Anakan from 1968 to 1995, several conclusions can be made related to: the nature of change; the key interactions among society, environment and development; and their implications for decision-making and planning for sustainable development.

- The rapidity, magnitude and extent of the land use/cover changes in Segara Anakan has resulted in the alteration of the physical and human environment and the evolution of a new human ecosystem. These changes have altered the context in which the fisherfolk, if they want to remain in Kampung Laut, must now operate.

- The interactions among society, environment and development in Segara Anakan have been strongly influenced by the elements of control, access, knowledge, productivity and stability. Overall, the changes in Segara Anakan reflect the trend of land use change on Java. These changes have historically been associated with extraction to serve and profit dominating groups, such as the Sultans, the Dutch and most recently the New Order Government (Peluso 1992). The institutions which now govern how resource decisions are made, how they are allocated, and who benefits from their use, have been built around this perspective of extraction and control, and have been largely oriented towards national development needs.

- The adaptive responses of the fisherfolk have been strongly influenced by economic and institutional factors, particularly how they have influenced control over, and access to the necessary resources to recover from the impacts of sedimentation.

- The land use changes in Segara Anakan have increased the vulnerability of many members of the fishing communities. Vulnerability is associated with economic and institutional factors and relates to how these factors have excluded some community members from fully participating in land based activities of rice farming and semi-intensive fishponds. The manifestation of vulnerability is largely associated with the loss of control, access and accountability over local resource use.

- This research indicates that under the current village structure, increasing village control over local resources may not necessarily result in sustainable development. The conflict over the distribution and exchange of the new lands is testimony to this issue.

8.2.1 Implications For Sustainable Development In Segara Anakan

Land use change analysis in Segara Anakan has highlighted key implications for decision-making, planning and management in terms of sustainable development in Segara Anakan. These implications relate to the resilience of the fishing communities and the natural environment of Kampung Laut to adapt to the cumulative effects of sedimentation and land use and environmental change. They include:

- control over, and access to the necessary resources to cope with the stress and change
- participation and accountability in village development

Issues of control over, and access to resources in Segara Anakan were highlighted by the institutional conflicts over the use of the new lands. Reasons for this conflict arise from how *adat* law, by which the fisherfolk claim rights to the new lands, has been, to a large degree, overridden by government laws and institutions.

> Officially, Indonesian law only applies to local affairs in administrative matters and formally acknowledges the independent existence of customary systems (UU Dasar/1945: Sec. 18), but with powerful qualifiers that make clear their intended subordination to the interests of central government. National law continues to recognize the authority of adat '... so long as it promotes the continuance of development and national security' (UU 5/1979: Penjelasan; Medagri 11/84) and 'does not conflict with higher laws and regulations' (UU 5/1960: Sec.I/3) (Warren 1993, 291).

The replacement of *adat* by government laws has been noted as an increasing source of tension in Indonesia (Hardjono 1991). In the case of Segara Anakan, it has heightened tension and mistrust between the fishing communities and the district and subdistrict government agencies, most notably *Perhutani*. The tension between the fisherfolk and *Perhutani* is illustrated by the different perspectives, which have largely arisen from the formalization of the natural resources. Rather than viewing the changes of the mangrove estuary from a perspective of a whole ecological system, *Perhutani* sees the changes in terms of mainly the mangrove forest, while the fisherfolk view the changes in terms of the new lands which belong to the village. This arising tension and opposing perspectives has created a management environment of winner-loser, whereby each view has become defensively entrenched. This has led to barriers to potential cooperation in the management of the mangroves and the estuary.

Peluso (1992) has documented a similar process in the management of teak forests on Java, whereby the replacement of *adat* laws and ways with scientific management policies and government institutions has largely resulted in local poverty, local resistance and local environmental degradation. Moreover, she argued that peasant resistance to state control is "derived from the progressive criminalization of customary rights to forest access" (236). While the issues of land use change in Segara Anakan present a different context to teak forests, the outcome is similar in that who pays and who benefits is largely mediated and legitimized by the central government and its guardians at the lower levels. This reaffirms the dominant position that the central level government has in development and resource management at all levels of society in Indonesia. Moreover, as of 1994, the development activities of the government in Segara Anakan had not been sufficient and/or appropriate to create an environment of economic viability, social equity or ecological integrity-in other words, sustainable development.

The limited participation and accountability in village development indicates the internal power structure in village development activities, which has largely been established by the modern government administrative structure. The village security council (LKMD) was established by the New Order government to promote village participation in development. The effectiveness of this council in village activities has been shown to be limited. The level of public participation is often left to the discrepancy of the *Kepala Desa* and other government officials (i.e., the *Camat* and *Bupati*) (Soetrisno 1993; Warren 1993). Discussions with LKMD members (past and present) in Segara Anakan indicated a general dissatisfaction with the level of participation, and the ultimate control of the *Kepala Desa* in village affairs. The accountability of the actions of the *Kepala Desa* to the rest of the community was also highlighted by the exchange of village lands (*tanah bengkok*), while some of the local people did not yet have any land, or only a small amount (e.g., 1/4-1/2 ha). The mistrust which incurred from the *Kepala Desa's* perceived exchange of land, as well as limited village development activities, has generated a sense of defiance, fear and/or contempt among some community members towards the *Kepala Desa*.

8.2.2 Recommendations for Segara Anakan

Based on the findings of this study, and their implications to sustainable development in Segara Anakan, several recommendations are presented. These recommendations arise from the need to increase the resilience of the fishing communities and the natural environment to stress and change. Given the uncertainty around land use activities in Segara Anakan, these recommendations are given in the spirit of assessment and monitoring of both human and physical conditions as they relate to issues of economic viability, social equity and ecological integrity. Some of these recommendations can be implemented within the current government structure; others will require a re-examination and possible re-structuring of institutional mechanisms which mediate control, access and accountability in village level development. The main recommendations are:

- To establish an institutional mechanism that can be used to resolve the institutional conflicts over the use of the new lands, and promote more cooperative forms of management.

- The need for greater autonomy of the village security council (LKMD) to provide a more effective mechanism for broader based participation and accountability in village planning

- Provide greater compensation and/or assistance to the fisherfolk, including sources of credit, additional aid and sustained training, with special attention given to the issues presented by the physical conditions of the area (i.e., flooding and salt water intrusion). The collaboration of the local government with the two NGO's already working in the area could provide a more effective avenue to support and encourage local initiatives at the subvillage level.

- Provision of additional physical and social infrastructure by the government to support community development, including roads, dikes, rice mills, schools and health facilities

- Monitor water quality in the estuary, particularly as it relates to impacts on the health of humans, the fish, shrimp and crabs, and other wildlife. A joint monitoring approach could be established between the villages of Kampung Laut and the district level government.

- Establish alternative fire-wood supplies to alleviate the increasing pressure from the mangrove forest. A form of cooperative management between *Perhutani* and the fishing communities could form the basis of such an agreement. It also needs to incorporate the use of the mangroves by those living outside of Segara Anakan

- Identify alternative economic opportunities for both the wet and dry seasons. This needs to take into account that while there have been many similarities in the process of change among the three villages, there is also much variation in the condition and circumstances of the human and physical environment. Moreover, short and long term activities should be identified.

- The need to better manage the number of people moving into the area. This would require rethinking the village regulations of *bawon* and *maro*, and providing alternative means to assist the fisherfolk to open the new lands. Ultimately this requires the actions of the *Kepala Desa* and village staff, but external monitoring may be required to ensure that the exchanging of lands is not continued on a large scale.

8.2.3 Future Research Directions for Land Use Change in Segara Anakan

Future research needs identified in this study are associated with two main themes. The first theme specifically addresses information needs in Segara Anakan. The second theme, while derived from the experience in Segara Anakan, is related to broader issues of society, environment and development in Java and Indonesia. The first set of research directions arise from the need to obtain a better understanding of how vulnerability is being manifested at the subvillage level. They include:

- How is the household level being impacted by, and adapting to the land use/cover changes in the estuary?

- How are social, economic and institutional forces arising from the regional, national and international level have influenced land use change, adaptation, vulnerability and sustainability in Segara Anakan?

- What are the long and short term impacts of the land use changes for the women fisherfolk and the younger generation?
- What is the necessary size and structure for the mangrove forest to support its continued ecological functioning, including its role as nursery ground for fish, shrimp and crab nursery ground, and as a wildlife habitat?
- What cooperative management schemes would best address management of the estuary on an ecosystem basis (i.e., the estuary as a whole human and ecological unit)?

The people and government of Indonesia are, in theory, currently working towards sustainable development (Hardjono 1991; Brookfield and Byron 1993). Recent national plans and policies acknowledge the importance of maintaining the natural environment and fulfilling basic needs as part of the development process. For example, in *Repelita* IV and V, the Indonesian government committed in writing to sustainable development and set a national objective to more equally distribute the benefits of development (Hardjono 1991, 11; Peluso 1992). Sustainable development in traditional coastal communities, such as those in Kampung Laut, has been specifically targeted in the National Policy on Coastal Village Development (1992). This national policy indicates both long and short term strategies to improve environmental and coastal village quality, through "identifying coastal village basic needs development in support of implementing conservation of coastal and marine natural resources and increasing peoples' income" (EMDI 1992,3-English translation of the policy). This is to be achieved by emphasizing "physical development with 'bottom-up' characteristics based on identification of basic needs according to the local conditions, socio-economic and cultural development, including education, health/environmental sanitation and community income, and sustainable environment development program to maintain the sustainable use of coastal resources (EMDI 1992,3-English translation of the policy).

In order for these government policies to be effective, certain structural aspects of the decision-making and development process must be addressed. Ultimately, these questions address the need to better balance the bottom-up and top-down planning process in Indonesia, necessitating a re-examination of the decentralization and deconcentration to better distribute the power for decision-making and the ability to implement programs. A fundamental issue highlighted by this study has been the inability of the modern institutional mechanisms at the village level to

support community adaptation to change in a sustainable manner. While certainly not an exhaustive list, this research has identified the following questions:

- **What form and function could a more autonomous village security council (LKMD) take in order to support sustainable development in current day Java and Indonesia?** Achieving greater autonomy for the LKMD would require a re-examination of the relationship between the village and the central level government in order to alter the village administrative structure as established in Law No. 5 1975.

- **What are the social mechanisms of the subvillage level organization (i.e., informal/traditional) and can they play a more substantive role in village level development in Java?** Of potential value to the structure, role and place of the LKMD in village level decision-making is the strength of the informal organization and leadership at the subvillage level (RW and RT). In all three villages in Segara Anakan, informal activities at the RW and RT levels were instrumental in operationalizing activities to support local level needs. This role of subvillage level organization in Javanese villages has been documented in other research (Tjondronegoro 1984; Warren 1993).

- **What institutional changes need to be made to ensure greater accountability of the actions of the *Kepala Desa* as well as upper government levels to the community members and vice versa?** This could involve returning the role of the *Kepala Desa* from being an "errand boy of the *Camat*" to that of being a community leader as well as being accountable to the community needs (Soetrisno 1993, 25).

The Segara Anakan represents a valuable opportunity to further explore possible approaches for sustainable development, including integrated management approaches to coastal environments in Java, and more generally Indonesia. The area has a foundation to build on, including the ICLARM integrated coastal management project, the established task force, various research reports, several Universities in the general area, many of which have conducted research in the estuary, two NGO's working in the area, and a strong commitment by the fishing communities to the area.

The ICLARM management project provides an avenue to identify opportunities and constraints encountered in promoting and implementing an integrated management approach in Java. This involves an assessment of a variety of topics thought significant for management, such as methods and approaches to exchange information, institutional barriers, financial constraints and public participation. This would be beneficial in designing integrated planning processes that are consistent with principles of sustainable development within an Indonesian context.

8.3 CONTRIBUTIONS OF RESEARCH

This research contributes to a human ecology of Segara Anakan, and in doing so has added to the understanding of the causes and consequences of land use/cover change from 1968 to 1995. This is timely in that the district level government is in the process of formulating development strategies for the area. The analysis of land cover change has indicated that both environmental and structural factors need to be addressed if sustainable development is to become a realistic option. While these factors have been identified from the context of land use change, they have relevance for other development activities, such as continued fishpond development and tourism. A central issue in sustainable development in Segara Anakan involves increased broad based participation and accountability in decision-making, and more specifically in the allocation of, and benefits from resource use. **A re-examination of the historical and current forces which have produced and reproduced the institutions which govern resource use would be valuable.**

On a broader level, this research contributes to a growing body of literature that studies land use change analysis within a broader scope of the interactions among society, environment and development (Turner et al. 1990; Lawrence and Nelson 1992; Blaikie et al. 1994; Krummer and Turner 1994; Ojima et al. 1994). A range of academic disciplines were consulted throughout the study, including hazards research, community and rural development, sustainable development, land use change and human ecology. The main purpose of this process was to review the various perspectives of adaptation and vulnerability for the community level. Five key elements were identified as being central to both adaptation and vulnerability within the context of land use change analysis. They were: control, access, knowledge, productivity and stability. These elements provided a good basis to study land use change within a broader human ecological context. They provided a means to study how the various actors and organization interrelated within the social, economic, institutional, cultural, technological and physical context of the local and external environment, particularly as they pertained to land use change. **These five elements are not presented as a complete list, and as such additional research would be valuable to identify other potential elements that are fundamental to add to our understanding of the causes and implications of land use change.**

Overall, this research has contributed to land use change analysis by showing how vulnerability plays a fundamental role in how people and communities use land. In doing so, it was possible to view land use change not simply as an issue of productivity and economic returns, but as an inherent part of the interactions among society, environment and development which were carved from the conditions and circumstances of the people and place. In the case of the Segara Anakan, vulnerability at the community level was associated with economic and institutional aspects which influenced control over, and access to resources. The structures which gave rise to these sources of vulnerability can be traced to the historical development process on Java, as discussed in Chapter 4, which has resulted in greater external interactions and control over the village level, as well as the replacement of traditional ways with modern ones. In this context, Hewitt's (1997, 143) statement that "vulnerability is surely decisive for the growing concern of 'sustainable' human communities and environment relations" carries much significance for land use change analysis.

The drivers of land use change identified in Segara Anakan support other research findings that indicate that population, affluence and technology are not always reflective of land use change at the local level (Palm 1992; Blaikie et al. 1994; Krummer and Turner 1994; Ojima et al. 1994). As discussed in detail already, economic and institutional issues were more prevalent forces in Segara Anakan. Drivers of land use change in Segara Anakan can be better described in terms of regional and local contexts, although the two are not mutually exclusive. As discussed in Chapter 4, the history of land use change on Java has been inherently linked to the variables of population, economy and politics. The high population density and the history of economic development, including the rapid economic growth pursued by the New Order government, have created much pressure on the limited land base of Java. This has acted as a strong push factor into the Segara Anakan as the new lands have become available for agricultural purposes. The large immigration of farmers into the area has provided another adaptive option for the fisherfolk, which under other historical circumstances may not have existed.

At the local level, the driving forces of change were mainly associated with economic and institutional variables, which have influenced how control and access to resources have been allocated in the changing environment. Again, to view these two variables as separate from

social and cultural forces would be a mistake. For example, the migration of younger people in Segara Anakan to the cities to work is not entirely an involuntary act based on the poor economic condition of the family, although for some it may indeed be, but it also arises from social changes in Java which have youth seeking "adventure" outside of their village[36]. Moreover, the infiltration of the images and expectations arising from globalization has driven increased consumption of modern goods in the villages, such as televisions and the reconstruction of houses, which has increased the exchange of lands by the fisherfolk. This process has been heightened in the communities by the notion of *gengsi*, or face.

Areas of future research of land use change that would be beneficial in Segara Anakan involve a more in-depth analysis in two areas. The first area involves the interactions among the institutions involved in the area. This thesis has provided some insight into the interactions among various actors and institutions involved in the area, but a more comprehensive analysis would be beneficial. Table 8.5 provides a list of the main institutions involved in the area, as identified by ICLARM (1992). The second area involves relating these changes back to the development theories of modernization and dependency theory, as discussed in Chapter 2.

The multi-method data collection approach, which employed remote sensing, rapid rural appraisal (RRA) techniques, and the collection of existing data, is the third contribution of this research. Each data collection technique provided a different perspective of land use/cover change, but it was through their integration within a GIS that it was possible to combine their

Table 8.5: Selected Institutions Involved in Segara Anakan

Ministry of Agriculture	State Ministry of Population and Environment
Ministry of Defence and Security	Provincial and District Boards of Planning and Development
Ministry of Forestry	Universities
Ministry of Health	Ministry of Public Works
Ministry of Home Affairs	Ministry of State for Research and Technology
Ministry of Justice	Ministry of Tourism, Post and Telecommunications
Ministry of Mining and Energy	

Source: ICLARM (1992, 69)

[36] The idea that the youth in Kampung Laut were migrating as "to find adventure" was uncovered during discussions with younger men and women in the villages.

strengths and to study land use/cover change within a broad context of society, environment and development. The application and more specifically, the integration of these data collection techniques and technologies contributes to an emerging body of literature which employs geomatic technology to complement and/or enhance conventional and emerging field methods for decision-making, and planning at the community and regional levels (Nelson et al. 1991; Lawrence and Nelson 1992; Brehens 1994; Moran et al. 1994; Kempe and Brooke 1995; Poole 1995; Nietschmann 1995; Olive et al. 1996). This research has indicated the complementary nature between rapid rural appraisal techniques, such as group mapping, and remote sensing and GIS for land use change analysis.

The advantages and limitations of each approach encountered in this research were addressed in Chapter 3 and are summarized in Table 8.6. Benefits of integration arose from bringing together the complementary aspects of land use/cover, as well as providing a means to triangulate the data. Remote sensing provided data on the location, extent, distribution and nature of land cover and land cover change. RRA techniques provided a means to access local perspectives, knowledge and histories of land use change. Collection of existing data provided data on government programs and policies, development plans and proposals and statistical accounts of both community and land use/cover activities. The combination of the spatial data in the GIS provided mutual aid in interpretation of both the group maps, in particular the boundary of the classes, and the satellite data. Brehens (1994) has referred to this later process as "people-truthing"--in which information derived from satellite data, such as land cover, is interpreted in terms of local management issues.

The integration of the various data sources within a GIS environment presented several challenges, the main being data inconsistency, notably the varying scales and projections of the group maps. The approach employed in this research provided a way of overcoming this barrier, but in a way that has restricted the utility of the data to a qualitative analysis. Overall, the benefits of this multi-method approach for land use/cover change analysis included:

- bringing together various perspectives, including local knowledge
- analysis at varying spatial scales (i.e., regional and local)
- analysis over temporal scales (i.e., 27 years)
- information on both human and physical aspects of land use/cover change

Table 8.6 Summary of the Strengths and Limitations of the Multi-Method Data Collection Approach and Recommendations for Future Research

Technique and Data Collected	Strengths	Limitations	Future Research Needs
Remote Sensing (land cover and land cover change mapping)	• current and historical land cover and land cover change data • synoptic view of the area • use for medium scale basemap (1:50 000)	• cloud cover impeded the number of useful images • difficulty in mapping some land cover classes (i.e., difficult to spectrally separate) in the coastal environment • high cost of data and training to use	• A more detailed review and/or testing of classification techniques to increase the accuracy of the land cover classification of this type of coastal environment
Rapid Rural Appraisal (RRA) (land cover, land use and the history of land use change)	• local perspectives on land use and land use change • obtaining data not available elsewhere • flexible to adapt to new information • methods could easily be adopted by the local community and/or government officials to collect data	• raised expectations of the local people in terms of product	• examine the utility of a global positioning system to increase the positional accuracy of the group maps • to test through ground checking the accuracy of the group maps
Existing Data (various aspects of land use change, and the history of change)	• supplemented field data • provided historical information on development projects in the area	• often incomplete, outdated or the scale was not appropriate	
Geographic Information Systems (GIS)	• provided a means to integrate the spatial data into one database	• high learning curve to obtain necessary skills • difficulty of accessing current spatial data for the area	• examine alternative methods of integrating RRA spatial data into a GIS

Future research directions in the application of this multi-method approach to land use/cover change analysis include:

- Review and test various land cover classification procedures for multispectral satellite data to increase the accuracy of land cover classifications of coastal wetland environments
- Test the utility of a global positioning system (GPS) to increase the accuracy of the group maps (e.g., boundary and attribute data)
- Define acceptable levels of accuracy (i.e., locational and attribute) necessary for the various types of applications (i.e., strategic, normative and operational)

- Examine possible ways that these methods be used to support and enhance participatory development at the community and regional levels. Projects on the west coast of Canada, and elsewhere, indicate that this is a feasible and desirable direction, in that it puts information, knowledge and increased power in the hands of the local people (Nelson et al. 1992; Kempe and Brooke 1995; Poole 1995; Nietschmann 1995). In this sense, the need is to develop people-centred information systems.

- Further test the utility of the RRA techniques to strengthen the role and activities of the Village Security Council (LKMD) in village development planning.

The utility of the methodological approach of this thesis has been demonstrated for Segara Anakan. The feasibility of continuing to apply this approach in the Segara Anakan or other areas in Java or Indonesia is a valid question, mainly because of the values attached to rapid rural appraisal techniques, as well as the use of the technology. RRA techniques, and participatory rural appraisal (PRA) have been employed in various settings in Indonesia (Wickham 1992; Ferrazzi et al. 1993). Both Wickham (1992) and Ferrazzi et. al. (1993) have indicated the potential utility of RRA to the planning process in Indonesia, particularly in terms of strengthening the bottom-up portion. This research is supportive of this finding. The activities of group mapping and semi-structured interviews provided a means to access local perspectives, needs and concerns regarding land use change. In most cases, the data collected through these approaches were not available elsewhere.

The benefits of RRA techniques arise from the relative simplicity, flexibility and low cost involved in the application of RRA techniques. The applicability of RRA is based more on the willingness of local people, NGO's, government officials, and others, than it is on available technology. RRA could be conducted by the villages on an independent basis, or in conjunction with subdistrict or district level agencies to enhance bi-directional lines of communication and understanding. Ferrazzi et al. (1993) suggest that training emphasis should first be directed towards the district and then subdistrict levels. This training could be used to build on and strengthen participatory approaches necessary to resolve some of the management issues in Segara Anakan, such as use of the new lands and conservation of the forest. The current practices in the area have, for the most part, not been very successful. The institutional conflicts and highly degraded nature of the mangrove forest pay witness to this. The application of RRA techniques could provide one means of enhancing communication

and interaction among the various actors and lead to more broad based participation in village development.

In Indonesia, remote sensing and GIS technology are not yet available at the village, or even district level of government. It is, although available and used within various central government agencies, universities and foreign aided projects (Subaryono 1996). As such, the direct application of the methods is not feasible in Indonesia at the district level and below. The cost of remote sensing and GIS technologies is a barrier to implementation at the lower levels of government, but with the trend of decreasing computer costs and simpler software packages it may become feasible in the future. According to Subaryono (1996), GIS development would be most optimal at the district level because of the more routine and operational data needs at this level. Co-operation among universities could help fill this technology gap, until if and when these tools become available to the local level. This cooperation could also be used as a building block for RRA training for government officials and local people, as well as introducing the local people to the technology.

8.4 REFLECTIONS ON LAND USE CHANGE AND SUSTAINABLE DEVELOPMENT

The goal of this research was to study land use change as a means to identify, analyze and understand the key interactions among society, environment and development. Through its analysis in Segara Anakan it was possible to identify the key interactions among society, environment and development. While the findings are specifically related to the Segara Anakan, and as such difficult to apply to other areas, they do highlight significant issues for sustainable development. These issues relate to the ability of the communities to adapt to change. In Segara Anakan, the social and institutional mechanisms which make the decisions and allocate the necessary resources was central to the adaptability of the communities. Moreover, it was these mechanisms that were at least partially responsible for increased vulnerability of some members of the fishing communities. Vulnerability, in turn, acted as the underlying drivers of land use change, producing changes that in the long term may not be sustainable. The planning implications which arise from these findings support the growing literature which suggests that it is the process of planning and development that is central to sustainable development, as opposed to focusing on the product. The process of planning and

development needs to incorporate elements of cooperation, consultation and mediation among the people and groups involved (Saunier and Meganck 1995). Just as land use changes are carved from the characteristics of the people and place, so must the ongoing solutions. This process will be a significant one in Java and Indonesia, as a balance between the central level government and the communities must be sought. Moreover, in Java this requires redesigning and/or finding new institutional mechanisms, particularly at the village level. This redesign may look to the past to draw on values and a sense of what is important to Javanese communities, but also look to the future to deal with the uncertainty from the increasing changes and stresses introduced by capitalization and globalization. This is indeed a difficult task, and will continue to be a challenge to the people and government of Indonesia, as it will for all countries. The analysis of land use change can provide a useful means to monitor and assess the continual strengths and/or tensions between the land users and communities, and the influences arising from the society in which they exist.

Appendix A
SEMI-STRUCTURED INTERVIEW GUIDE

1. Name
2. Address
3. Origin birth place

For Immigrant Farmers

4. When did you move here
5. How did you hear about Kampung Laut
6. Before, what did you as
7. Did you have land there

For Fisherfolk and Immigrant Farmers

8. What is your main occupation
9. Do you have land (how much and location)
    a) rice
    b) garden
    c) house
10. What year did you get the land
11. How did you obtain the land
12. Do you have other land
    a) rent
    b) sharecrop
13. Do you work the land alone, or do you have help
14. Have you ever exchanged land with someone else
15. If you do not have land, have you ever tried to get land. What was the result
16. Do you have other work (sources of income)

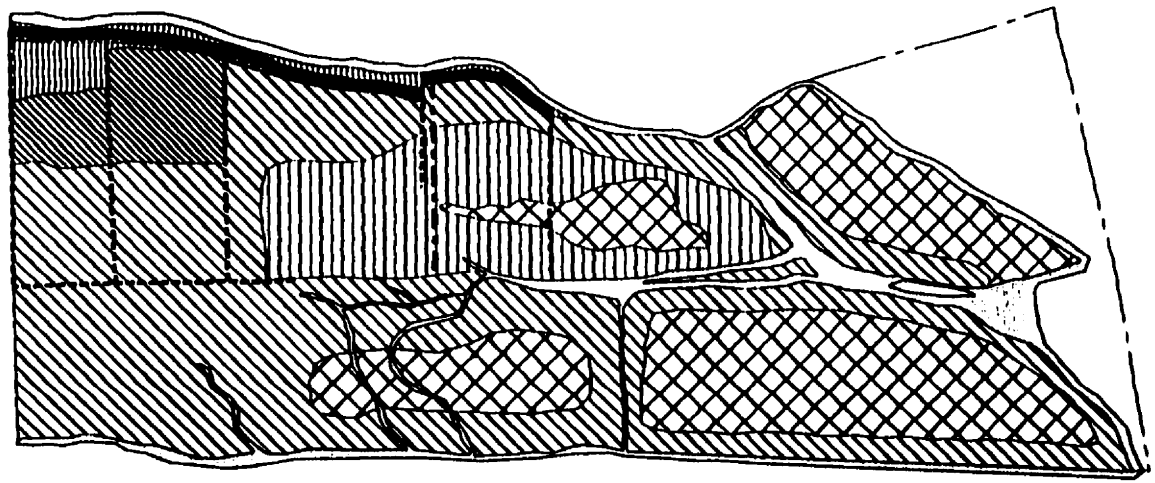
Fishing

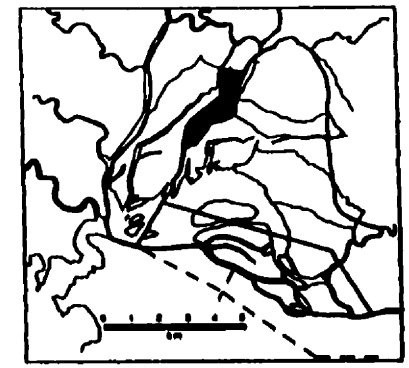
Yields per day (income or kg)
Equipment used
Number of days fished
Number of hours fish per day
Labour arrangement (self or with help)
Changes in yields over time

Rice Farming

Yields (tons/ha)
Number of crops per year
Type of rice species
Use of fertilizer
Use of Pesticides
Equipment
Labour (hiring practices)
Harvest
Markets
Training (what and from where)
Aid (what and from where)

APPENDIX B
GROUP MAPS





Legend

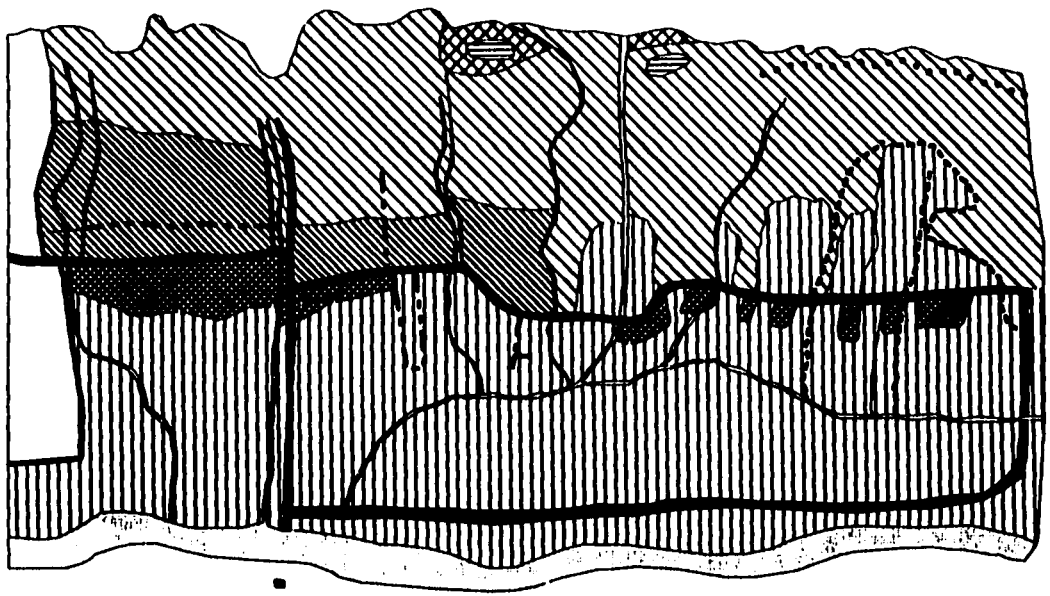
- Rice (3 tons/ha)
- Rice (2.5 tons/ha)
- Dryland crops
- Forest
- Rice (land too low)
- Houses
- River
- Planned canal
- Dike/Path
- Path
- Village border

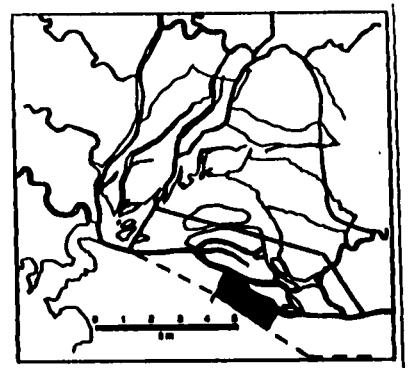
Not to Scale

Note: The boundaries and proportions of this map are estimates.

This map is a direct computer copy of a landuse map produced by a small group of key local people mapping landuse on a large blank sheet of paper.

Figure B1: Landuse: Dusun Motehan Baru, Desa Penikal Group Mapping by Key Informants, August 1994





Legend

- Rice: good (3 tons/ha)
- Rice: poor
- Forest
- Dryland/Fruit crops
- Houses
- Rock outcrop
- School
- Bridge
- River
- Dike/Path
- Path
- Small river
- Irrigation

Not to Scale

Note: The boundaries and proportions of this map are estimates.
This map is a direct computer copy of a landuse map produced by a small group of key local people mapping landuse on a large blank sheet of paper.

Figure B2: Landuse: Dusun Motehan Baru West, Desa Ujung Alang Group Mapping by Key Informants, August 1994

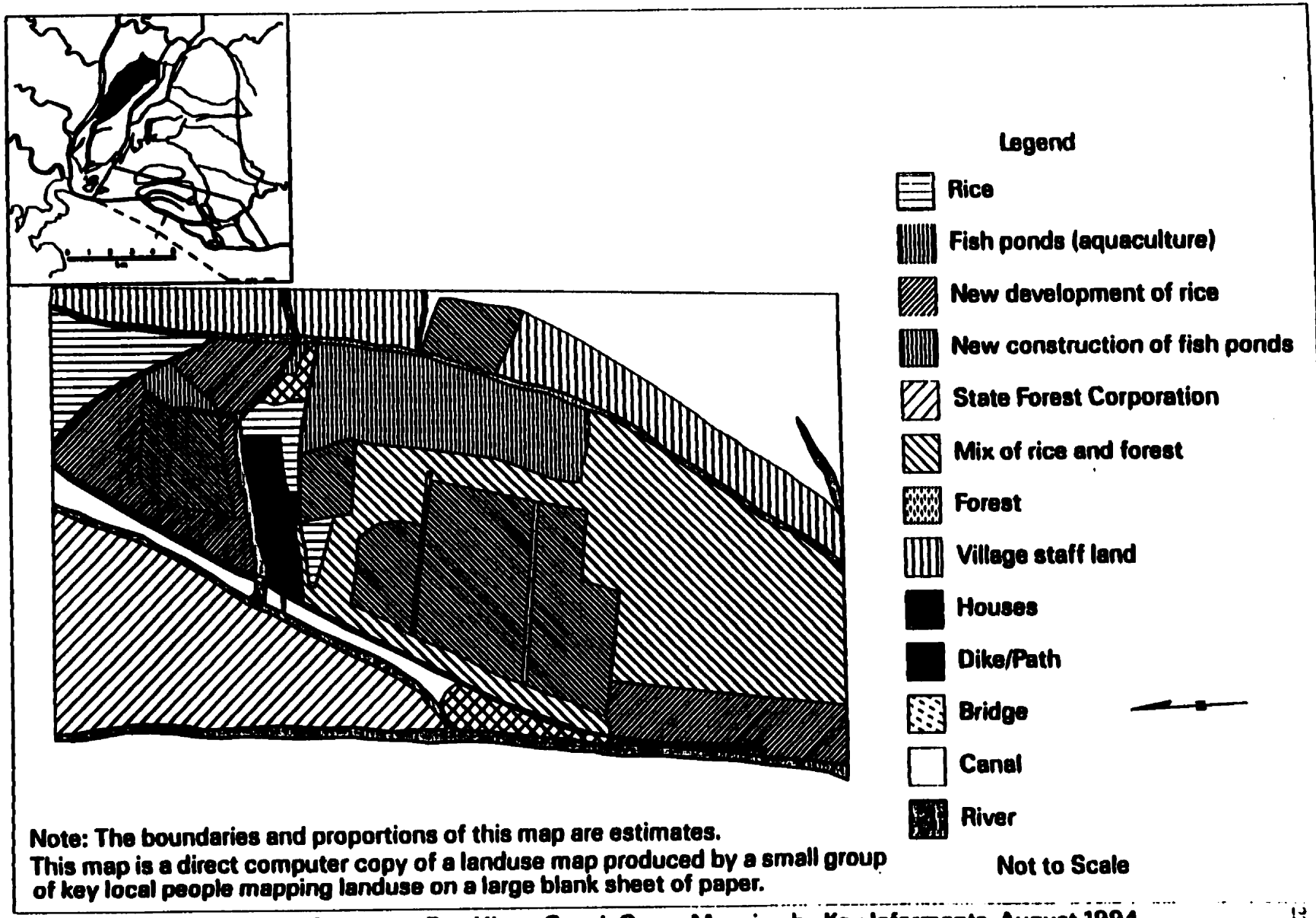
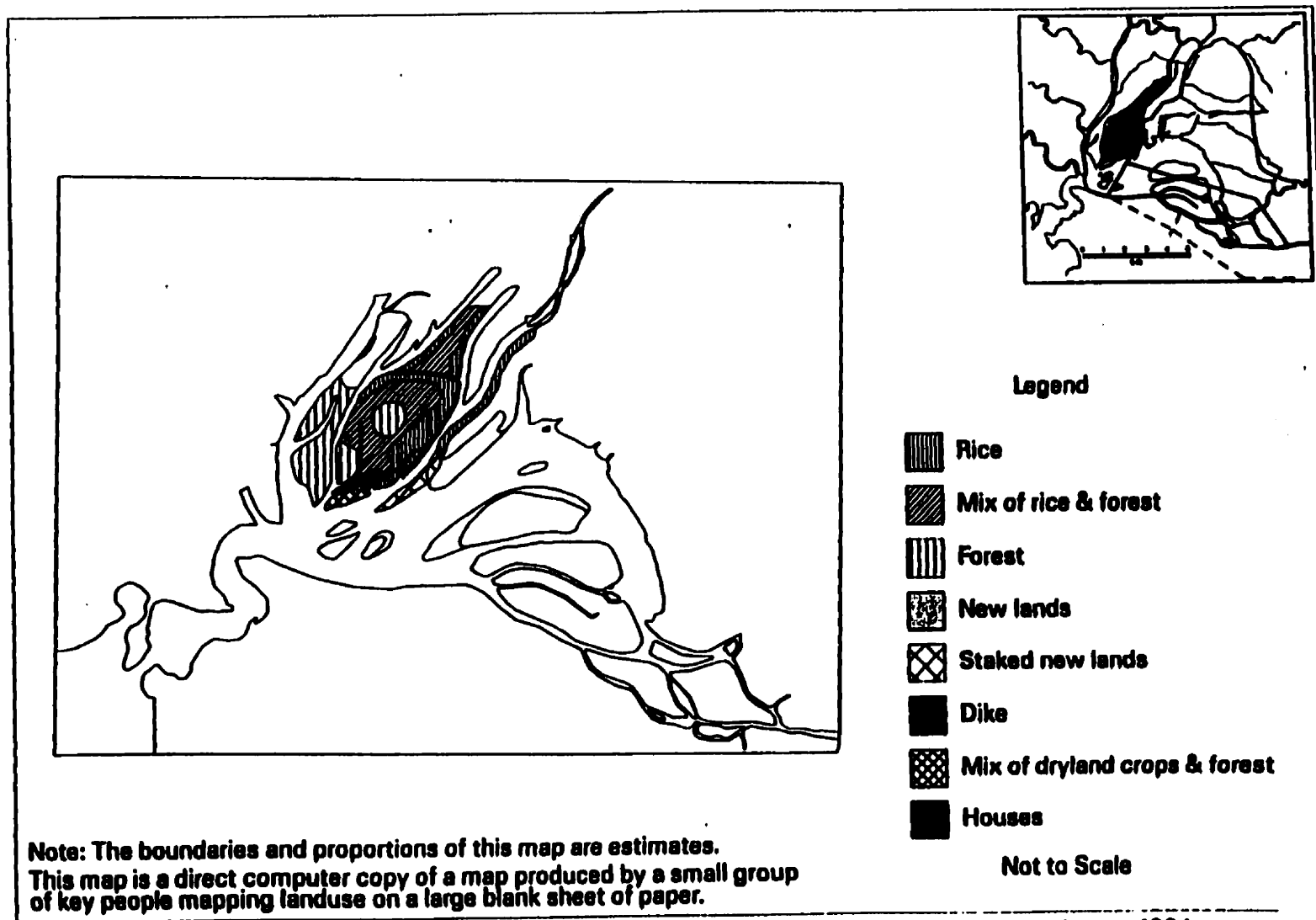


Figure B3: Landuse: Dusun Ciberum, Desa Ujung Gagek Group Mapping by Key Informants, August 1994



Note: The boundaries and proportions of this map are estimates.
This map is a direct computer copy of a map produced by a small group of key people mapping landuse on a large blank sheet of paper.

Figure B4: Landuse: Dusun Karang Anyar, Desa Ujung Gagak Group Mapping by Key Informants, August 1994

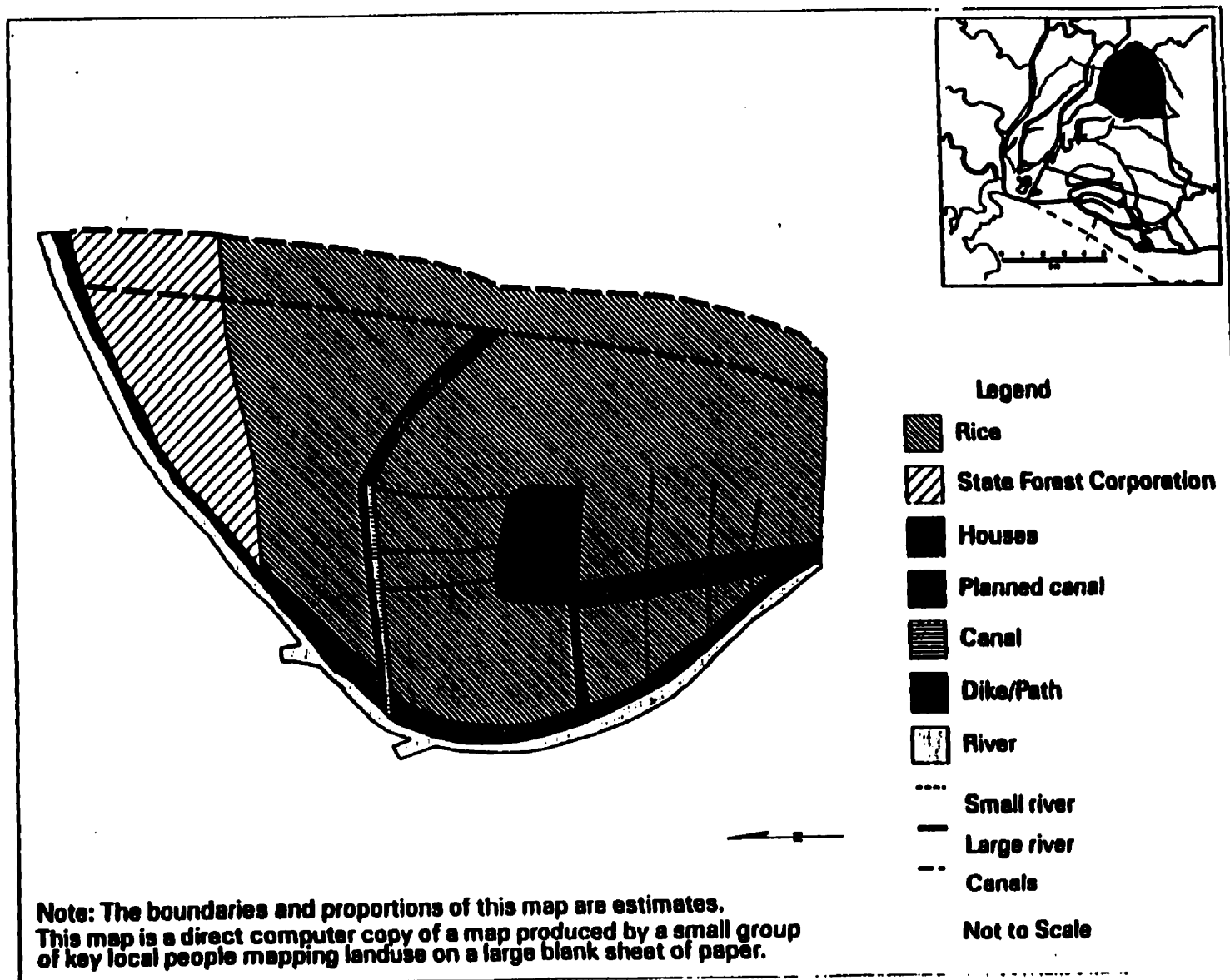
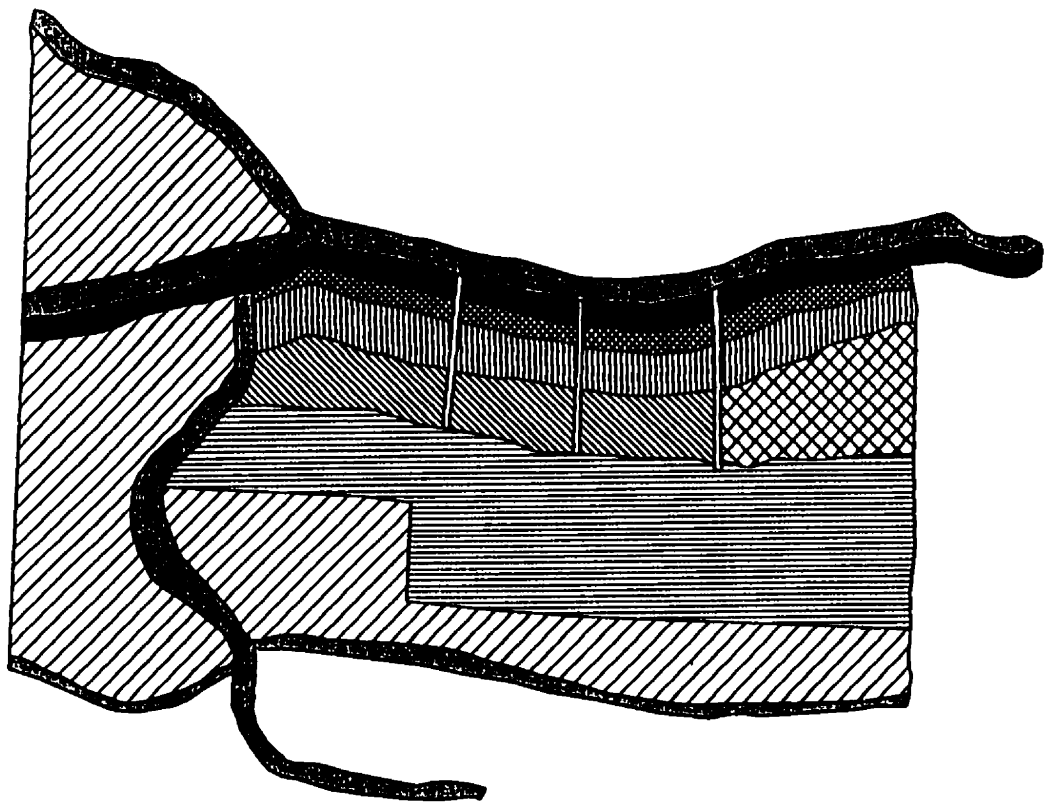
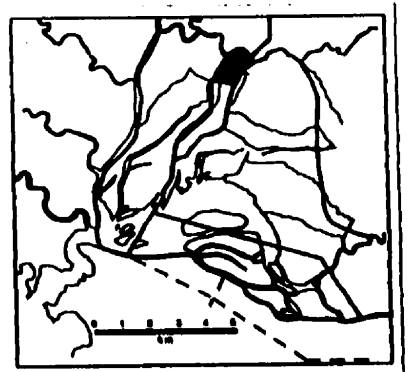


Figure B5: Landuse: Dusun Penikal RW07, Desa Penikal Group Mapping by Key Informants, August 1994





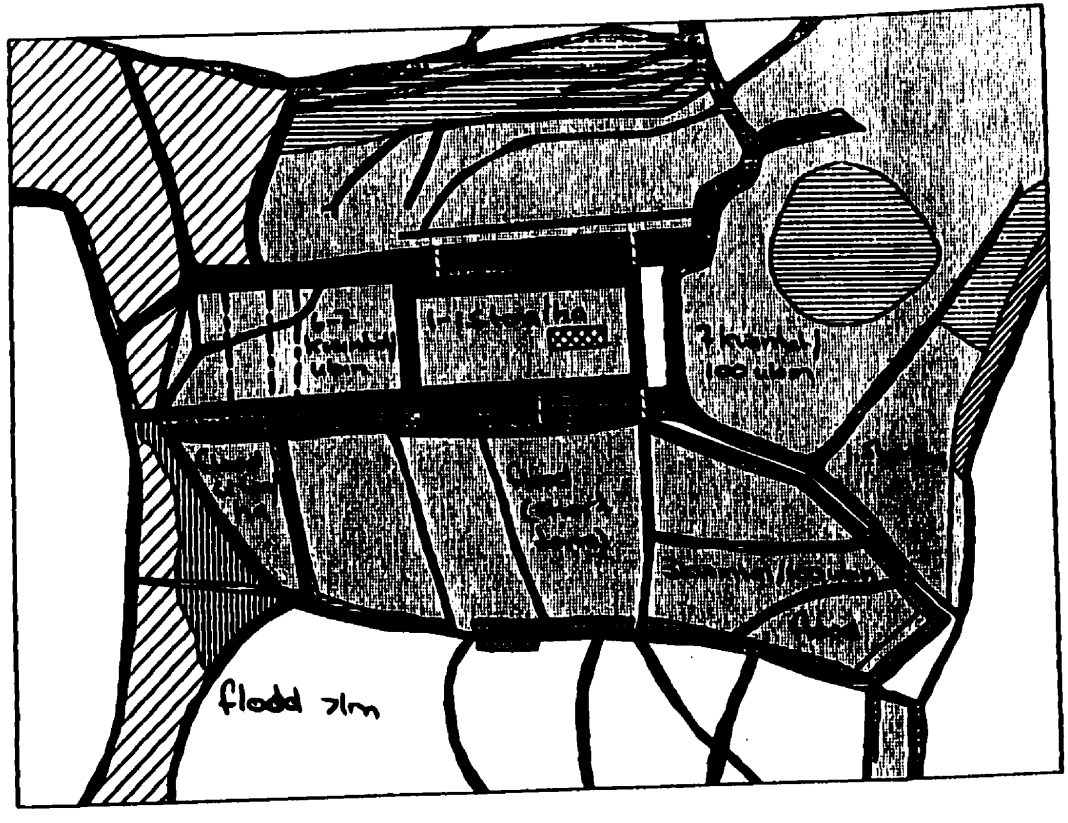
Legend

- State Forest Corporation
- Rice (1 kwintal/100 ubin)
- Rice (4 kwintal/100 ubin)
- Rice: no harvest, land too low
- Dryland crops
- Houses
- Canal
- Dike/Path
- River

Not to Scale

Note: The boundaries and proportions of this map are estimates.
This map is a direct computer copy of a map produced by a small group of key local people mapping landuse on a large blank sheet of paper.

Figure B6: Landuse: Dusun Penikal RW08, Desa Penikal Group Mapping by Key Informants, August 1994



Legend

- Rice-flooding, no harvest
- Rice
- Forest
- Rice-not yet planted
- State Forest Corporation
- Houses
- Dryland crops
- Dike/Path
- River
- Soccer field
- Bridge
- Planned path
- Needed canal
- Needed canal

Not to Scale

Note: The boundary and proportions of this map are estimates

This map is a direct copy of a map produced by a small group of key local people mapping landuse on a large sheet of blank paper

Figure B7: Landuse: Dusun Maradua, Desa Panikel, Group Mapping by Key Informants, August, 1994

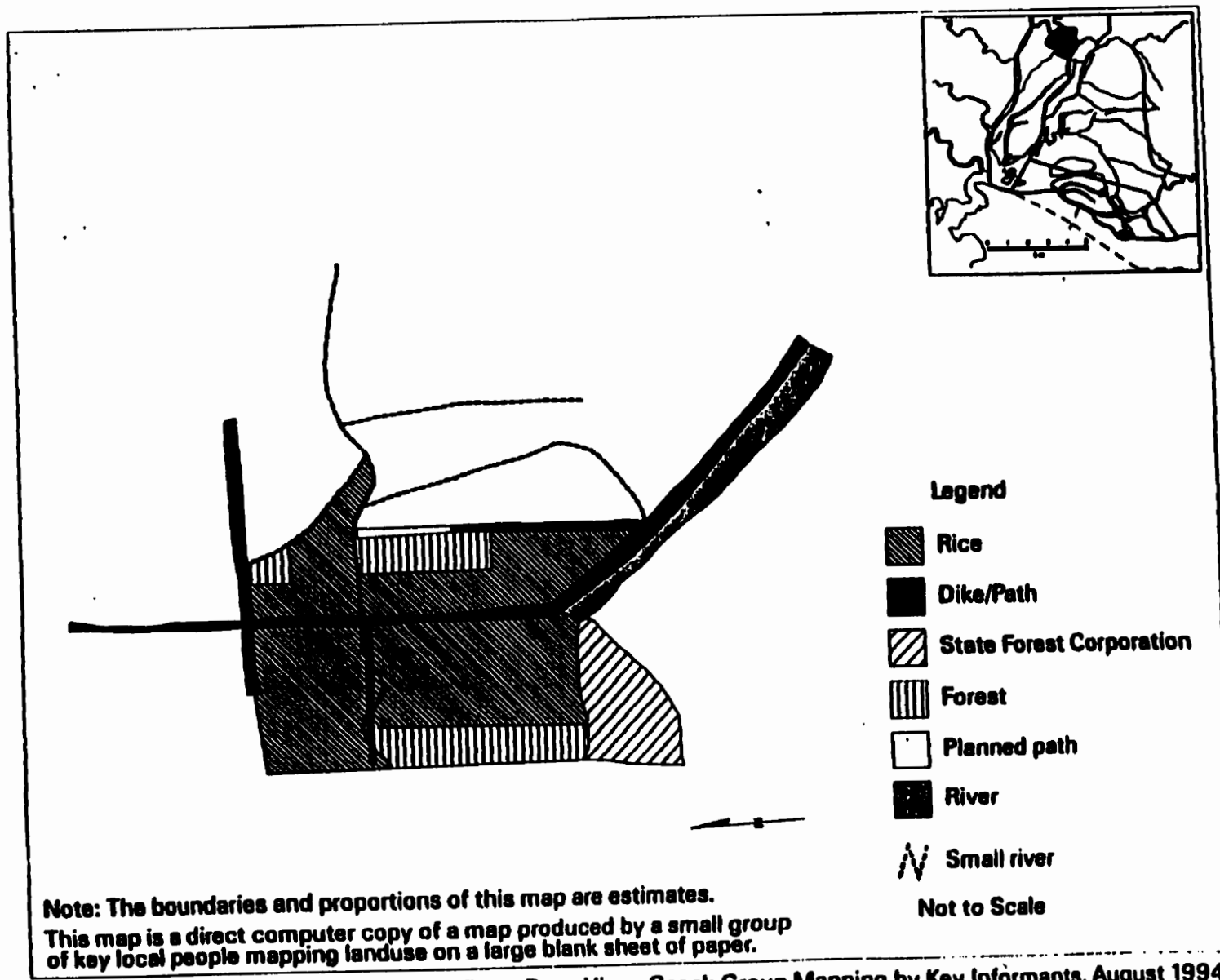


Figure B8: Landuse: Dusun Ujung Gagak Baru, Desa Ujung Gagak Group Mapping by Key Informants, August 1994

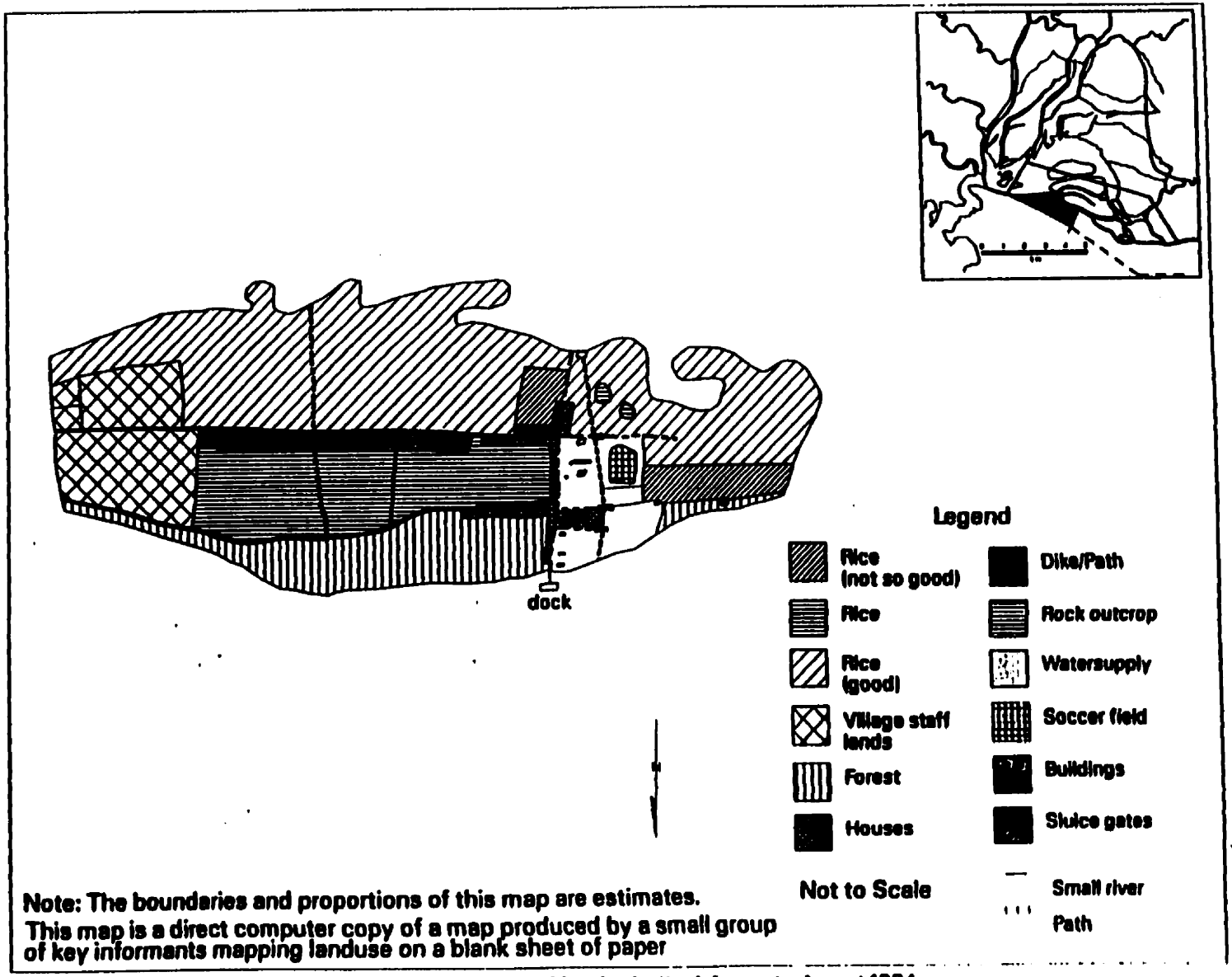
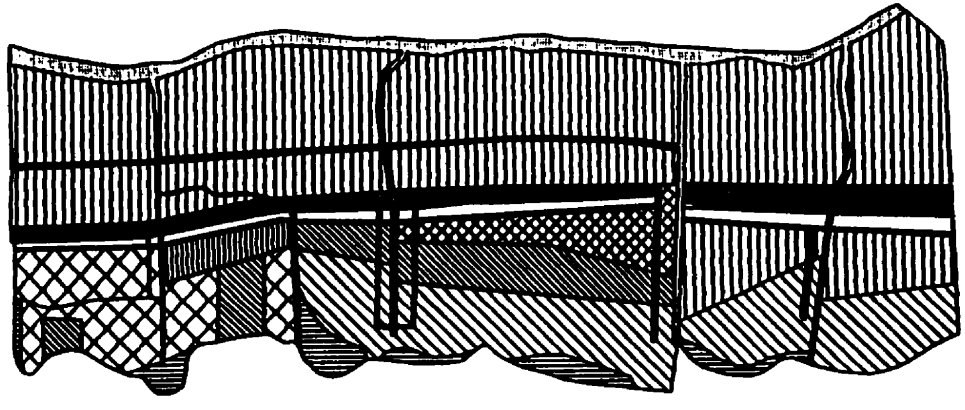
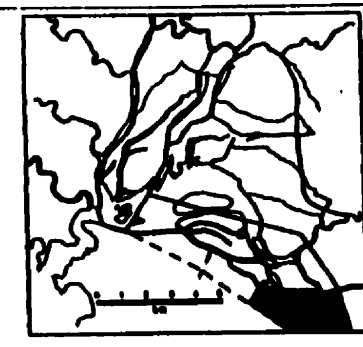


Figure B9: Landuse: Dusun Klaces, Desa Ujung Alang Group Mapping by Key Informants, August 1994





Legend

- Rice: poor (3.5 tons/ha)
- Rice: good (4.8 tons/ha)
- Rice: not yet good (2 tons/ha)
- Rice
- Dryland crops
- Forest
- Salt water intrusion
- Dike/Path
- Gate
- River
- Canal
- Houses

Not to Scale

Note: The boundary and proportions of this map are estimates.
This map is a direct computer copy of a map produced by a small group of key local people mapping landuse on a large blank sheet of paper.

Figure B10: Landuse: Dusun Motehan Baru East, Desa Ujung Alang Group Mapping by Key Informants, August, 1994

Appendix C
SHORT SURVEY

SURVEI

Kepada yang terhormat Bapak dan Ibu warga Kampung Laut. Saya Caron Olive, mahasiwa dari Universitas Waterloo, Kanada bekerjasama denagan Pusat Penelitian Lingkungan Hidup, Universitas Gadjah Mada, Yogyakarta, bermaksud melakukan penelitian mengenai ekologi manusia di daerah Kampung Laut. Saya sangat mengharapkan kesediaan Bapak dan Ibu untuk mengisis survei ini. Hasil survei ini sangat bermanfaat untuk perencanaan pembangunan berkelanjutan di daerah Kampung Laut ini. Atas kerelaan Bapak dan Ibu menyediakan waktu untuk mengisi survei ini, saya mengucapkan banyak terima kasih.

Cilacap, September 1994

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1) Nama: _____

2) Alamat: _____
(Dusun, RW)

3) Asli dari mana?

4) Kalau bukan asli dari sini, tahun berapa pindai ke sini?

---

5) Untuk pekerjaan utama, Bapak / Ibu bekerja sebagai apa?
   a. nelayan
   b. petani
   c. petani-nelayan
   d. buruh: i) sawah ii) pembanguna iii) dan lain lain
   e. dan lain lain _____

6) Kalau beker ja sebagai nelayan, biasanya berapa hari per bulan (atau minggu) Pak mencari ikan di laut? _____

6b) Pakai jaring apa: _____

7) Apakah Bapak / Ibu pernah mempunyai tanah sawah? YA TIDAK

8) Kalau ya, mempunyai berapa lokasi _____; dan berapa luas (ubin, bau, patok, ha) _____

9) Saat ini, mempunyai berapa lokasi_____; dan berapa luas (ubin, bau, patok, ha) _____.

10) Sekarang berapa luas tanah tersebut sudah menjadi sawah?_____.

10b) Apakah Bapak / Ibu pernah mengganti rugi tanah? YA TIDAK

10c) Kalau Ya, diganti rugikan ke Siapa? i) penduduk asli ii) pendatang

10d) Kenapa mengganti rugikan tanah? (pakai uang) untuk apa?

11) Bagiamana membuka sawah:
   a. trukah sendiri
   b. bawon / maro
   c. ganti rugi tanah yang sudah dibuka oleh orang lain
   d. dan lain lain _____

12) Bapak / Ibu mendapat sawah tahun berapa saja (sudah berapa kali panen)?
_____

13) Apakah sawah diker jakan:
   a. sendiri
   b. bagi hasil (dengan orang lain)
   c. sistem gadai (dengan orang lain)
   d. sewa (oleh orang lain)

14) Kalau sawah diker jakan sendiri, apakah ada orang lain yang membantu? YA TIDAK
   a. istrinya / suami
   b. anak-anak
   c. buruh tani

15) Kalau belum mempunyai sawah apakah Bapak /Ibu pernah mencoba mendapat sawah? YA TIDAK

16) Kalau ya, mencoba mendapat sawah dari siapa atau dari mana:
   a. pemer intah: RT, RW, Kadus, Kades
   b. orang penduduk

17) Selain petani dan nelayan, apakah Bapak / Ibu mempunyai usaha lain? YA TIDAK
   ya
      a. kolam
      b. embret / buruh
      c. merantau
      d. pedagang
      e. dain lain lain_____

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GLOSSARY

Arisan	Rotating lottery
Bakul besar	Larger business trader
Bakul kecil	Small business trader
Bappeda	Government Planning Board at the Provincial and District levels of government
Bupati	Govenor (head of the district level government)
Camat	Head of the subdistrict level government
Desa	Village
Dusun	Subvillage or hamlet
Ganti rugi	Compenstation for losses
Ganti tenaga	Compensation for labour
GOI	Government of Indonesia
HYV	High yield variety of seed (from the green revolution)
ICLARM	Integrated Coastal Living Aquatic Resources Management
Kabupaten	District level government office
Kecamatan	Subdistrict Government office
Kepala Desa	Village Head
Liuran	Informal exchange of labour
Nelayan	Fisherman
Paceklik	season of harship
Perhutani	State Forestry Corporation
Petani	Farmer
Petani-nelayan	Farmer-fisher
Repilita	Five year development plans of the Central level government
RT	Rukun Tentengga (smallest subvillage division)
RW	Rukun Warga (second smallest subvillage division)
Sawah	wet rice agriculture
Tambak	semi-intensive fishponds (aquaculture)
UGM	Universitas Gadjah Mada