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Contribution of Aquatic Resources in the Mekong Delta of Vietnam: Reconnaissance of Two Hamlets

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Contents

Executive Summary

The Mekong Delta is home to numerous aquatic animals and it is the most productive agricultural area of the Mekong. However, the infrastructure developments in Yunnan province and the removal of rapids between Lao PDR and Myanmar to improve river transport are seen to have adverse potential impacts on the major rice-growing region and the breeding grounds of migratory fish species in the Mekong Delta of Vietnam.

The major hydrological patterns of the lower basin that result from the course of the Mekong River are likely to be altered by the large-scale infrastructure developments in the Mekong River Basin. Upstream developments will have the greatest impact on the ecology and production capacity of aquatic habitats and fishery resources in the Lower Mekong River Basin. The adverse effects of these developments will be most apparent to the communities of the Mekong Delta of Vietnam that are totally dependent on the quantity, quality, and timing of waters entering from the upstream. Moreover, changes in productivity will be felt the most by the people who depend on the aquatic and fishery resources for their livelihood.

The Mekong River Basin Research and Capacity Building Initiative Program emerged in response to the concerns regarding the upstream developments that alter river flows and threaten the livelihood of the people downstream. The program aims to strengthen the voice of communities living in the Lower Mekong Basin and to enable a process of continuous consultation with institutions and policy makers who determine the course of infrastructure developments in the Mekong Basin.

The Policy Research and Impact Assessment Program (PRIAP) of the International Center for Living Aquatic Resources Management (ICLARM) spearheaded the socio-economic component of the program. This component focused on the assessment of the contribution of aquatic resources to food and nutritional security in the Mekong Delta.

This study examined the dependence of two hamlets in Vietnam on aquatic resources of the Mekong River and analyzed the effects of local, national and transnational interventions on the ecological, social and economic health of the Mekong Delta communities.

Building the capacity of the local partner institution through this program provides the local communities the capability to evaluate and monitor their social, ecological and economic dependence on the aquatic resources and carry their concerns forward to policy makers who make decisions that affect their livelihood.

List of Figures

List of Tables

1 Background

The Mekong River traverses six countries in Southeast Asia, with the Yunnan province of China, and Myanmar at the Upper Mekong Basin, and Lao PDR, Thailand, Cambodia, and Vietnam at the Lower Mekong Basin (Figure 1). It flows from its source on the north-east rim of the Tibetan Plateau to the South China Sea through the Mekong Delta of Vietnam (Figure 2).

Aquatic resources in the Mekong River Basin support a large number of fish species. Aside from being a major source of low-cost but high quality animal protein for the rural areas, capture fisheries provide economic opportunities for the unemployed and the under-employed. The dense network of Mekong Delta's waterways contributes to a diverse fishery. Many of the fish species inhabit both fresh and brackishwater areas. During flooding, the fish migrate to the rice fields and reproduce in the paddies until the water recedes.

The major hydrological patterns of the Lower Mekong Basin are a result of the course of the Mekong River. During the monsoon season, the Mekong River feeds into the Tonle Sap, causing the flow of the Tonle Sap River to reverse into the Great Lake of central Cambodia (Ahmed et al. 1996). The Great Lake acts as a "bladder", taking up in reverse flow about 20% of the Mekong River floodwaters during the wet season (Hirsch and Cheong 1996). This process acts as a natural flood stabiliser for the downstream areas of the Mekong Delta.

These flooded forests of the Tonle Sap are the spawning grounds for many of the Mekong basin's fisheries. In the wet season, the floods bring organic material, fish fry, and adult fish to these areas. In the dry season, the fish migrate from the lake as far north as Yunnan and down the Mekong into the South China Sea.

Of the total fish production at the Lower Mekong Basin, capture and culture fisheries contribute 90 and 10 per cent respectively. As for the Mekong Delta, fisheries products, mainly comprised of brackishwater shrimps, contribute about 10% of the country's foreign earnings (MRC 1997).

2 Rationale and Objectives

To date, regional concerns for biodiversity, sustainability and food security bring to the fore issues concerning resource management. Particular attention and focus are given to the case of the Mekong Delta where current conditions threaten the livelihood of people who are dependent on the natural catch for subsistence and source of income. The staggering population growth, poverty and lack of environmental awareness have led to environmental degradation and increased pressure on the fishery resources. Aquaculture, though considered as an additional source of supply, depends highly on fingerlings from the wild (Philips 1995) and could take away capture fishery resources from the people's diet and income. More alarming than the conditions resulting from direct human exploitation of resources are the implications of change in water regime, which does not figure in the reconciliation equation. The adverse effects of the change in hydrological patterns will be felt most by the communities of the Mekong Delta of Vietnam whose wellbeing is totally dependent on the quantity, quality, and timing of waters entering from the upstream.

The Mekong River Basin Research and Capacity Building Initiative Program (MRB-RCBIP) emerged in response to the concerns that upstream developments will alter river flows and threaten the livelihood of the people downstream. The program aims to strengthen the voice of communities living in the Lower Mekong Basin and to enable a process of continuous consultation with institutions and policymakers who determine the course of infrastructure developments in the Mekong Basin.

The MRB-RCBIP is being undertaken by four partner institutions from three different countries, namely Can Tho University (CTU) in Vietnam, the Institute for Development Anthropology in New York, USA, and the International Institute of Rural Reconstruction (IIRR) and ICLARM-The World Fish Center. The activities of the program are executed in close co-ordination with the Oxfam America-Southeast Asia Regional Office (SEARO). SEARO will take immediate and overall responsibility for the implementation of the program in the region. Meanwhile, all the other organisations have their own respective roles in contributing to the fulfilment of the overall goal of the program.

With CTU as its main partner, ICLARM-The World Fish Center spearheads the Assessment of the Contribution of Aquatic Resources in the Mekong River Basin to Food and Nutritional Security of the Fishing and Farming Populations. The general objective of the project is to provide a baseline information on the current state of fishery resources. The database will contain information on the role of fishery resources in household food security. It will serve as a basis for assessing and monitoring the effects of local, national and transnational interventions in the Basin on fishery resources. Consequently, the impact on communities will be evaluated by assessing the role of aquatic resources in the people's diet and livelihood.

Another major objective of the project is to build the capacity of CTU staff for assessing and monitoring socio-economic values of resources. To this end, ICLARM-The World Fish Center will conduct a training workshop for the CTU partners. The workshop is divided into two parts: the first part is the design and application of methods for socio-economic studies. Data management and analysis follows. This second part includes hands on activities in setting up a database and generating descriptive and statistical analyses. Also, both CTU and ICLARM-The World Fish Center will learn on the job while they work together on the field, with ICLARM-The World Fish Center providing guidance in socio-economic field surveys and CTU providing the knowledge and information regarding the study area.

ICLARM-The World Fish Center takes the lead in data gathering on aquatic resources and aquatic resource use. As part of capacity building, ICLARM-The World Fish Center trains CTU staff in field survey and data gathering. ICLARM-The World Fish Center will assist CTU to establish a baseline database that contains the information from the household survey for this study. The training workshop will give CTU staff the capability to do queries and extract information that are relevant in assessing the state of the aquatic resources in the study area.

3 The Study Area

In general the water conditions in the Mekong Delta are characterised as either deep or semi-deep areas. For this study, Binh An-Thanh Loi hamlet represents the deep-water regime while Loi Du-B hamlet represents the semi-deep water regime. Loi Du-B in the village of An Binh is in Can Tho province, the central part of the Delta. Binh An-Thanh Loi in the village of Vinh Thanh Trung is in An Giang province, at the western side of the Delta, near the Cambodian border.

Can Tho Province

Can Tho Province is located in the center of the 12 provinces of the Mekong Delta (Figure 3). Its capital, Can Tho City, is the political, economic, cultural and transportation centre because it is connected to most other population centres by a system of rivers and canals in the Mekong Delta (Nguyen 1996). Annual flooding of the Hau River, which is to the north of Can Tho province, allows deposition of large quantities of alluvial soil and contributes to the fertility of the rice fields. The climatic features of the province are similar to other provinces of the Mekong Delta, *i.e.*, air temperature rarely falls under 15°C and the rainy season lasts from May to November (Nguyen 1996). The water conditions of Can Tho can be classified under semi-deep areas. Agricultural practice integrates fish and prawn culture partly with modern rice varieties and mainly with tall, traditional rice (Duong 1994).

The province has an area of 2 965 km^2 and has a population of 1 855 830 as of 1995 (Vietnam Department of Statistics 1995). Can Tho is comprised of 7 districts namely Can Tho City, Thot Not, O Mon, Chau Thanh, Phung Hiep, Long My, and Vi Thanh. The study area belongs to Can Tho City District. Some of the available socio-economic statistics for the district are shown in Table 1.

AN GIANG PROVINCE

An Giang Province is located at the western part of the Mekong Delta between Tien Giang and Hau Giang Rivers (Figure 4). It has a tropical monsoon climate and an annual average air temperature of 26°C to 28°C. It has two distinct seasons - dry season from December to April and rainy season from May to November (Nguyen 1996). The water conditions of An Giang can be classified under deep areas. In the agricultural context of Vietnam, deep areas are also known as floating rice areas. In contrast to Can Tho where the water conditions allow rice-fish farming, neither farming nor fishing activities are propitious for An Giang. Because of the adverse conditions in these areas, floating rice requires extensive cultivation and gives very low yields, ranging from 1.4-1.7 t/ha (Catling 1992). For fishing activities, the deep water during flooding makes difficult the construction of dikes to prevent fish from leaving the rice fields.

The province has an area of 3 424 km^2 and has a population of 2 320 600 as of 1995 (Vietnam Department of Statistics 1995). An Giang is comprised of 11 districts namely Long Xuyen Town, Chau Doc Town, An Phu, Tan Chau, Phu Tan, Tinh Bien, Tri Ton, Chau Phu, Cho Moi, Chau Thanh and Thoai Son. The study area belongs to Chau Phu and some of the available district socio-economic statistics are shown in Table 2.

3.1 THE HAMLETS

The hamlet is the smallest administrative subdivision of Vietnam. Of the 4 hamlets in An Binh, Loi Du-B was chosen by the CTU team because it is one of the most densely populated areas in the central part of the Mekong Delta. The hamlet is along the Rau Ram Channel, which is connected to the Can Tho River, which in turn flows directly to Mekong River. Because of the area's proximity to the river system, its economic activities are adversely affected by problems related to Mekong River. For the same reason, Loi Du-B has access to very diverse aquatic resources and the livelihood of the community is very much influenced by the Mekong River.

Binh An-Thanh Loi, being at the upstream of the Mekong Delta, benefits from the diversified resources provided by the Mekong River. Vinh Tre Canal, which drains into Hau Giang River, contributes to the livelihood of Vinh Thanh Trung village. Binh An-Thanh Loi, in particular, benefits from its proximity to Bassac River and Hau Giang River. Local hamlet residents are highly dependent on the Binh An-Thanh Loi Channel for their fishing activities. The population of the hamlet is mostly comprised of fisher-farmers. Paradoxically, the water bodies that offer so much in terms of aquatic resources are the same water bodies that make it almost impossible for farmers to raise more than one rice crop per year because of the consistently deep flooding of rice fields (pers. comm. with hamlet residents). Although this is the sentiment expressed by some of the residents of Binh An-Thanh Loi, they have qualified that this was the case prior to the adoption of modern cropping techniques. Presently, most of the areas of An Giang province have adapted the two-crop irrigated modern rice cropping pattern (Catling 1992).

4 Methods and Results

This project makes use of several approaches for gathering information both on the livelihood activities of the hamlet dwellers and the aquatic resources. The most basic information on how the community depends on the aquatic resources and on how the aquatic resources are managed in relation to the current use patterns by the communities are obtained through rapid rural appraisal. Key characteristics, resource base, and agro-ecological system information on the communities are obtained through transect and participatory mapping and key informant survey. For the key informant survey, the reconnaissance team asked questions on the institutional and management systems (Appendix 1) and the market systems (Appendix 2) in the communities. CTU staff conducted seasonal calendar and trend analyses for Loi Du-B, with participation from local residents. Without adequate long-term information from local residents, CTU staff could not make seasonal calendar and trend analyses for Binh An-Thanh Loi.

During the two consecutive visits of ICLARM staff at CTU, transect and participatory mapping exercises and the key informant surveys were fully accomplished. A pre-test of the socio-economic household survey was also accomplished in the second visit.

At a later stage, the project will investigate the factors contributing to household food security and will assess the effects of interventions on fishery resources through a comprehensive household survey. This current report focuses on the agro-ecosystem analysis of the hamlets and the key informant surveys. For each of the two project sites, the activities for the rapid rural appraisal and environmental mapping exercises and the information from the key informant surveys are discussed in turn. The socio-economic household survey procedure and results will be discussed in a separate report.

4.1 RAPID RURAL APPRAISAL

One popular approach for preliminary reconnaissance and survey of a prospective study area is agro-ecosystem analysis and mapping (Conway 1986). This approach is very useful in the rapid appraisal and environmental mapping of the general agro-ecosystem of targeted research areas.

As part of the program's capacity building initiative ICLARM staff conducted an in-house training activity in CTU on agro-ecosystem mapping and analysis in July 1998 prior to the actual field survey exercise. The material used in the training gives an overview of the concept and outlines the steps involved in the procedure (Appendix 3).

Transect mapping and participatory mapping are the two techniques used by the team to obtain topographic, hydrologic and agronomic characteristics of the study area. *Transect mapping* is a method used to define system boundaries and identify problem areas. It is used to distinguish important spatial relationships both between and within farms. A transect line is an imagery line laid down cutting across and arranging in an imaginary sequence the different agro-ecosystem categories of the area. *Participatory mapping* is a method by which villagers or key informants indicate relevant information on the map based on their knowledge of the physical, biological, social and economic conditions/resources of their area (Conway 1986).

For each hamlet, the base map was taken from the District Agricultural Office. Participatory mapping and transect mapping were done for both of the hamlets. This was a joint effort between ICLARM and CTU, with CTU staff acting as the lead, both in exploring the geography of the area and in talking to local residents to fill in the transect description matrix. The hamlet characteristics and pattern of economic activities gleaned from these appraisal methods serve as guide both in the design of the key informant and household questionnaires and in sampling for the household survey.

4.1.1 Loi-Du B

Topography and hydrology were obtained through participatory mapping. The key informants indicated on the map the administrative boundaries of the hamlet and the main rivers present in the area. At the center of the hamlet is the Rau Ram Channel that allows navigation, fishing, domestic use, and irrigation water for the agricultural lands. Although the main occupation is farming, a lot of people are also engaged in fishing activities for home consumption.

The map of An Binh Village shows the location of Loi Du-B relative to the other hamlets (Figure 5). This map gives a bird's-eye view of the hamlet, the position of the main channel that the hamlet depends on for fish and other aquatic resources, and the spot where the transect was drawn. For the transect mapping, the team traversed the area in the north-south direction, along the narrower of the two roads flanking the Rau Ram channel. This trek revealed that the settlements are generally along the two roads. At about the midpoint of the area, the team laid a transect cutting the roads and the channel in the east-west direction.

The team observed that the land use patterns for the area are the same on either side of the channel and that the general layout is symmetrical with respect to the roads and the channel, i.e., channel-road-settlement-orchard-vegetable garden-rice land (Figure 6).

4.1.2 Binh An – Thanh Loi

The map of Vinh Thanh Trung Village shows that the north-east corner of the Binh An – Thanh Loi hamlet is very close to the Hau Giang River and it is bordered by Cai Dau town on the east side (Figure 7). Based on key informant interviews, Binh An and Thanh Loi were two separate hamlets separated by a channel not too long ago (time frame indefinite). To the east of the channel was the hamlet of Binh An and to the west was Thanh Loi. Both hamlets shared the channel between them for their fishing and domestic use. The two separate hamlets had the same layout with respect to the channel that they shared, i.e., channel-settlement-crops. After the merging of the two hamlets, the channel is most appropriately called the Binh An-Thanh Loi Channel.

As in Loi Du-B, topography and hydrology were obtained through participatory mapping. A detailed map of the hamlet (Figure 8) shows the network of canals and waterways inside the hamlet and shows the position of Binh An-Thanh Loi Channel, the channel that separated the two hamlets before they merged together.

Being at the upstream of the Mekong Delta, the hamlet benefits from the diversity of fishery resources in the area. Fishing is done for trade and home consumption. Flooding during the wet season is a common occurrence therefore the agricultural lands are planted to floating rice.

For the transect mapping, the team traversed the area in the north-south direction, along the roads on either side of Binh An-Thanh Loi Channel, first on the Binh An side, then the Thanh Loi side. This trek revealed that the settlements are generally along the two roads. At about the midpoint of the area, the team laid a transect across the roads and the channel in the east-west direction. The team observed that the land use patterns for the area are very similar on either side of the channel, showing that the households instinctively build their homesteads along the channel to be near their source of livelihood. The main difference is in the layout of the settlements, with the Binh An side having settlements on either side of the road while the Thanh Loi side has settlements only to the west of the road. The transect map (Figure 9) describes the pattern of land use in the hamlet, i.e., channel-road-settlement-rice field-settlement-canal. On the Binh An side, most of the households are along the road and further away from the rice fields.

These hamlet experience very deep waters during the flood seasons-orchards do not thrive and houses are built on stilts. Whatever few trees grow around the settlements are utilised only for their wood. Farmers try their very best to grow more than one crop of rice per year but more often than not the water levels just would not allow this. At the time of this agro-ecosystem mapping (October 1998), the farmers were in the process of draining the waters from the rice fields into the canals in preparation for their Vu Dong-Xuan (lit. trans. Winter-Spring) rice crop which lasts from November to February. In the years that the fields are not too flooded, the farmers opt for a Vu Xuan-He (lit. trans. Spring-Summer) rice crop which they seed in March and harvest in July.

4.2 KEY INFORMANT SURVEY

Personal communications with the head of hamlet provide the basic socio-economic and demographic information on the hamlets. More detailed information on economic activities, and people's attitudes and perceptions are obtained through key informant surveys. The surveys focus on the market attributes, and the institutional and management issues related to fisheries resources. People's awareness of the importance of the fisheries sector to their livelihood is elicited through questions on the resource management and product marketing. The key informants interviewed include the head of the hamlet and heads of the women's, youth's, farmers', and fishermen's organisations.

4.2.1 Loi Du-B

Except for the women's organization, all organization heads are male. Their ages range from 26 to 49, all married, two are high school graduates and the other two are elementary graduates.

Loi Du-B has a land area of 16.24 km^2. The main economic activity in the hamlet is farming and 157.17 ha or 97% of the land area are devoted to agriculture. The agricultural area is characterised as semi-deep water regime and is predominantly planted to irrigated rice (92.96 hectares), allowing two crops of rice a year and one cropping season of cash crops such as corn. Perennial crops like banana and citrus are planted which occupy some 642 hectares of land. Table 3 shows additional socio-economic and demographic information on Loi Du-B.

4.2.1.1 Institutional and Management Issues

Management Issues and Interventions

The respondents identified issues related to the utilization and management of the fisheries resources (Table 4). With probing from the interviewer, the majority of the respondents identified that overfishing and agroecological loading are the major issues affecting fisheries resources. The next most serious problems identified were inappropriate exploitation patterns and domestic waste pollution. Without

probing, the respondents recognized flooding, reduced biodiversity and migration patterns as major issues of concern for resource management.

For some of the issues, the respondents provided suggestions for improving management practices. Education/public awareness is the most frequently suggested means of addressing the issues identified above. The respondents believe that with government officials as the implementing body and the source of information, an intervention will be very effective because the public is generally responsive to initiatives introduced by the government. The head of the women's organization, however, maintains that implementation of interventions at the hamlet level is ineffective unless done by government officials. This was particularly pointed out in the case of inappropriate exploitation patterns and use of destructive fishing practices where education and penalties are seen as ineffective interventions. The reasons for their ineffectiveness are poverty and poor implementation of the regulation by the local organizations.

The suggested interventions for addressing fisheries-related management issues are pooled and grouped under two general categories, where the first three interventions may be categorized as regulation of activities and the last three may be categorized as supervision of fisheries-related institutions (Table 5). Instruments for implementing the interventions are also suggested. Enforcement of regulations and penalties for limited entry, and regulated fishing activities are currently found to be ineffective because of poor implementation at the hamlet level. The same reason holds true for the ineffectiveness of bans on destructive fishing gears. The establishment of fish conservation zones, and bans on destructive fishing practices are not unanimously seen as effective instruments for intervention. Improvement of institutional facilities is generally accepted as an effective way of management intervention to improve fisheries management.

Violations commonly observed and identified by the respondents include the use of battery traps, fishnets with small mesh size and other destructive devices, and duck fishing (Table 6). Policies, regulations, ordinances, and laws related to fisheries management created at the national government level are implemented in the hamlets by the formal organizations. Policies related to the above mentioned violations include:

- property rights in terms of access, withdrawal, management, exclusion and transfer;
- rules on fishing operations;
- regulatory mechanisms (e.g. quota, closed season, etc.); and
- penalties or incentives (e.g. taxation, fines, licensing).

Fines ranging between 200,000 VND (US$14.50) and 500,000 VND (US$36.00) are the most common penalty recommended by the respondents. Despite the fact that they want to see these regulations and policies implemented, they are of the opinion that these regulations and policies are ineffective mainly because they are not properly enforced. They suggest that the government should come down harder on offenders and push for stronger enforcement of the policies. Furthermore, the respondents believe that education, information dissemination, and public awareness can help tremendously in enforcing these policies.

State of Aquatic Resources

All key informants unequivocally affirm that the state of aquatic resources is deteriorating (Table 7). Declining fish population and decreasing diversity of fish species support this observation. The decline in fish population results in low fish production and reduced quantity of fish for consumption. One respondent claims that the decrease in fish production may also be attributed to the increase in the number of fishers who are competing for limited resource.

The respondents state that when flooding occurs, the fish population in the area is negatively impacted because their nets and dikes are not adequate to keep the fish fenced in. From the viewpoint of fishers, habitat protection has a negative impact on fish production because it restricts people from accessing certain fishing grounds, which deters fishing activities and further decreases catch per unit effort. According to the respondents, strict enforcement of the fishery regulations, use of aquaculture as another source of supply, and improvement of people's livelihood through alternative sources of income are tools that will lessen pressure on the fish resources and will promote biodiversity and fish population stabilisation. Existing livelihood programs designed by the government for alternative sources of income are piggery and store selling basic home-consumption dry goods.

Related evaluations of the state of aquatic resources were done by CTU staff using PRA techniques of trend analysis of time line (Table 8) and seasonal calendar (Figure 10), the information for which was acquired through personal communications with key informants. The trend analysis uses 1968 as the benchmark for different categories of information related to fishing activities. The categories include fish quantity, fish species, number of fishermen, and fishing gears. After 1968, fish population has been decreasing, diversity of species has gone down, number of fishermen has been increasing, and fishing gears have become much more complex than the simple handline. The seasonal calendar depicts the abundance/scarcity of fish for the most common species found in the water bodies around the hamlet throughout the year, and relates fishing effort to the fish supply.

Organisations

There are only two hamlet organizations considered formal and recognized by the government: people's committee and police/local military. Other hamlet organizations are informal and are not recognized by the government. The informal organizations existing in Loi Du-B are farmer's, women's, and youth's organizations, extension workers' group, and veterans' and elders' clubs. The formal organizations are involved in fisheries resource management while the informal ones are not (Table 9).

These organizations, both formal and informal, have various administrative functions (Table 10). For the formal organizations, functions and responsibilities are mandated by the government. The people's committee, the farmers' organization, and the youth's organization are all involved in providing community assistance in livelihood projects and extension work. The women's organization mainly focuses on family planning and Red Cross activities.

4.2.1.2 Market Attributes

The Rau Ram Channel provides different species of fish (Table 11). Of these, the snakehead is the most commonly caught with catch ranging from 0.5 - 3 kg per fishing trip of approximately 2 hours. Gourami, climbing perch, and catfish are

caught at a range of 0.2-0.5 kg per fishing trip. Carp, sandgoby and shrimp are also most commonly sold in the market but catch information is indeterminate. Market prices for these species range from 10,000 VND to 30,000 VND per kg, with carp at the lower end and snakehead at the upper end of the range. Market prices are not only determined by the fish species but by other factors as well including prices of substitutes. Abundance of marine fish which is much cheaper than freshwater fish helps push the price of freshwater fish down. This factor, however, is countermanded by the steadily decreasing freshwater fish population, which, in effect, persistently brings their price up.

Loi Du-B being a farming community, with fishing seen only as a source of supply for home consumption or a supplementary source of income, fishing boats are small and non-motorised, and are not seen as a priority for investment. Fishing gears used are handline, trawl net, cast net, gill net, trap net, shock-electricity, scoop net, and drag net. Fishing grounds include ricefields, channels, canals, and rivers. Fishing activities are not concentrated on any specific ground. Fishers minimise fishing in ricefields so as to avoid pesticide-contaminated environments. The river is a favourite fishing ground because this is where big mature fish are usually found. The peak months for fishing are from September to November coinciding with the tidal cycle and flooding season. Lean months are from December to August when the tide is low and fish migrate to various bodies of water connected by the Mekong River.

4.2.2 Binh An-Thanh Loi

It is typical of the Vietnamese society for organizations to be headed by a man and it is only due to organizational composition that a woman heads the women's organization. The ages of the respondent's range between 42 and 60, they are all married, and two are elementary graduates while the other two are high school graduates.

Binh An-Thanh Loi is characterised as deep flooded area. The hamlet is basically submerged in water during the flooding season, which makes the area

unfavourable to farming. Despite these water conditions, over 90% of the land area are devoted to agricultural production (pers. comm. with head of hamlet). Of the gross production of 8 865 tons per year, 8 657 tons come from rice farming. The hamlet has a population of 6 799 and a population growth rate of 2.5% between 1997 and 1998 is attributed to migration (Table 12). Although households are generally classified as fisher/farmer, the main source of economic subsistence is fishing. Rice farming proves a challenge given the frequency and severity of flooding in the area.

4.2.2.1 Institutional and Management Issues

Management Issues and Interventions

Table 13 shows the issues identified by the respondents to be affecting fisheries resource management. Of these, overfishing is considered the most serious issue and respondents recognize this problem even when there is no probing from the interviewer.

For overfishing and use of destructive fishing practices, the respondents anticipate good results from educating the public as a means of dealing with these issues. They believe that education and promotion of public awareness will be very effective if government officials will carry these out. In general, the public is highly responsive to interventions implemented by government authority.

Instruments that are suggested for implementing management interventions are seen by the respondents to be effective (Table 14) because they are recognized by the public to be appropriate to the situation. People recognize that there is a need to regulate the use of toxic chemicals to reduce agro-ecological loading. However, the community is of two minds about this and the regulation is not widely accepted because application of less chemical inputs implies a reduction in agricultural yield.

For Binh An-Thanh Loi, there was very little discussion around policies and laws related to fisheries management (Table 15). In fact, the respondents are not aware of the amount of penalties charged in case of violation. They are aware that fishermen use destructive devices, in particular, electric fishing, but they do not know

if the fishermen are penalized for their violation. They see policies to be ineffective because they believe that hamlet officials do not have the authority to impose fines.

State of Aquatic Resources

The key informants observe that the water in their fishing grounds is greener due to the abundance of phytoplankton (Table 16). These organisms are a source of food for fish but despite their high population, the fish population is steadily decreasing. The decline in fish population is attributed to overexploitation, illegal fishing practices, water pollution, and reduced water flow. The impact of decline in fish population is felt in terms of lower catch per unit effort. The reduced catch per unit effort in turn means lower fish consumption in the household. Because fishing is the main source of income for Binh An-Thanh Loi, the amount sold remains basically the same despite lower production. This means that the portion left for consumption decreases relative to the total production.

Though aquaculture is seen as a means of reducing pressure on natural aquatic resources, the idea of trapping fingerlings is received with misgiving because it threatens the supply of capture fishery. Most of the people are highly dependent on catch from the wild for their income and protein in their diet. Furthermore, the community being poor, fishermen do not understand the merits of sustainable management. They see habitat protection solely as deprivation of access to certain fishing grounds and overlook the merits of protection to stabilize the fish population and diversity of fish species. Other tools that are seen to lessen pressure on fishery resources are strict enforcement of regulations and government support for livelihood programs. To date, the government supports efforts in pig raising, and although very limited credit is extended to people engaged in this activity, the program has so far been effective in boosting people's livelihood.

Organisations

There are eight organizations in Binh An-Thanh Loi, two of which are formal and recognized by the government. These formal organizations are the people's committee and the police/local military. The informal organizations are the farmers', women's, and youth's organizations, veterans' club, Red Cross, and the national front. As in Loi Du-B, the formal organizations are involved in fisheries resource management while the informal ones are not (Table 17).

The functions and activities of the organizations vary depending on their civic involvement. The women's organization is mainly involved in teaching housewives family planning and birth control measures. The people's committee and the farmers' organization are both involved in agricultural extension work, although at different capacity because the people's committee is a recognized government organization while the other is not.

4.2.2.2 Market Attributes

Binh An-Thanh Loi has more variety of fish species and has higher fish population compared to Loi Du-B (Table 19). The most commonly caught species are the common carp and the white lady carp (*Cirrhinus spilopleura*), with catch ranging from 10-1,000 kg per fishing trip. The informal discussion with the key informants revealed that fishermen's average fishing trip could range anywhere from 2 to 6 hours per day. This depends on the time of the year and the availability of fish. Other species are caught in the range of 1-30 kg per fishing trip. As in Loi Du-B snakehead demands the highest price of up to 17,000 VND per kg and white lady carp as the lowest priced at 1,500 VND per kg. Gourami and common silver barb are the highest priced at the landing site, with price ranging from 10,000 to 20,000 VND per kg, which can even be higher at the market. Binh An-Thanh Loi depends so much in fishing as a source of income. For this reason, people invest in motorized fishing boats and use different kinds of nets and gears such as handline, lift net, barrier net, trap net, bamboo net, and gill net, for catching fish. Fishing grounds can be anywhere from rice fields to rivers, with canals and channels in between. Peak months for fishing are from August to January when the water bodies are flooded and lean months are from February to July when water level is low and fish migrate to different area.

5 Concluding Remarks

The MRB-RCBIP funded by OxFam America-SEARO is being implemented with four partner institutions in three countries: CTU in Vietnam, IDA in U.S.A., and IIRR in the Philippines and ICLARM in Malaysia. The objectives of the program are to strengthen the voice of communities living in the Lower Mekong Basin and to enable a process of continuous consultation with institutions and policy makers who determine the course of infrastructure developments in the Mekong Basin. Each partner institution contributes to the program through individual projects that are complementary in meeting the program's overall goal.

In collaboration with CTU, ICLARM undertakes the "Assessment of the Contribution of Aquatic Resources in the Mekong River Basin to Food and Nutritional Security of the Fishing and Farming Populations". The general objective of the study is to provide information on the current state of fishery resources. This information will constitute the basis for evaluating the role of fishery and aquatic resources in household food security. Impacts of national and transnational interventions on fishery resources will be assessed and weighed against their consequent impact on the livelihood of communities depending on the resources.

Two hamlets in the Mekong Delta of Vietnam were selected for the study. These are Loi Du-B in Can Tho province, which is classified under semi-deep water regime and Binh An-Thanh Loi in An Giang province, which is a deep flooded area. Several methodologies were adopted in order to gather basic information regarding the land and water resources as well as the socio-economic conditions of the two hamlets. These methods include agro-ecosystem mapping, trend analysis, seasonal calendar, and key informant interviews.

Loi Du-B at 162.38 ha is smaller than Binh An-Thanh Loi at 756.8 ha but is more densely populated (Table 20). Both hamlets devote the same proportion of land to agricultural production (97% of total land area) but Loi Du-B gets a rice harvest that is nine times as much as that of Binh An-Thanh Loi. This can be attributed to Loi Du-B being more suited to rice farming than Binh An-Thanh Loi, and to its use of high-yielding varieties and chemical inputs. Given their respective water regimes, Loi Du-B residents are primarily farmers who engage in fishing for home consumption only; Binh An-Thanh Loi is mainly a fishing community, with catch sold for income while leaving enough fish for home consumption.

The two hamlets both use rice fields, man-made canals, natural channels, and rivers as fishing grounds. The commonly caught fish species include snakehead, catfish, climbing perch, gourami, carp and freshwater shrimps. Because of its proximity to Tonle Sap River in Cambodia and its being in the upstream of Mekong River relative to Loi Du-B, Binh Anh-Thanh Loi has more diverse fish species. The abundant fish population in Binh An-Thanh Loi allows for a much longer fishing season with peak months lasting for six months from August to January while Loi Du-B only has three months of peak fishing activities from September to November.

There are relatively more poor households in Binh An-Thanh Loi than in Loi Du-B as shown by the proportion of poor households to the total number of households. This has major implications on the pressure on agricultural resources and fishing grounds to meet subsistence needs and food security. Recognition of such implications are shown by the people through their genuine effort and desire that management regulations be enforced so that resources are managed sustainably.

According to the people, the most serious issues affecting aquatic resources are overfishing, agro-chemical loading, inappropriate exploitation patterns, domestic waste pollution, and use of destructive fishing practices (Table 21). For all of these issues, the most common management intervention suggested by the communities is education, coupled by proper implementation of regulations. It is a common tragedy though that regardless of implementation efforts, meeting basic food needs among poverty-stricken communities results in exploitation of resources.

These preliminary findings further support the serious concern regarding sustainability and food security in the Mekong Delta. To the few who are aware of the extent and severity of the problem, to enforce management intervention and to educate the general public is the most obvious approach to attaining sustainable resource management. But this is not a cut and dried solution when staggering population growth and poverty are the factors that lead to environmental degradation and increased pressure on the fishery resources. Policies have to balance between resource protection and economic exploitation, between current subsistence and setting aside for later use, between upstream development and survival downstream.

The people are more and more sensitised to the deteriorating state of natural resources in the Mekong Delta. They recognise the changes in the quality of water, decline in fish population and reduced species diversity. The problems are staring them in the eye and they now see the need to have the policies and regulations properly carried out. This program hopes to give people the capacity to voice out their concerns to policy makers who make decisions on the management of resources and plan development guidelines regarding the future of the Mekong Basin.

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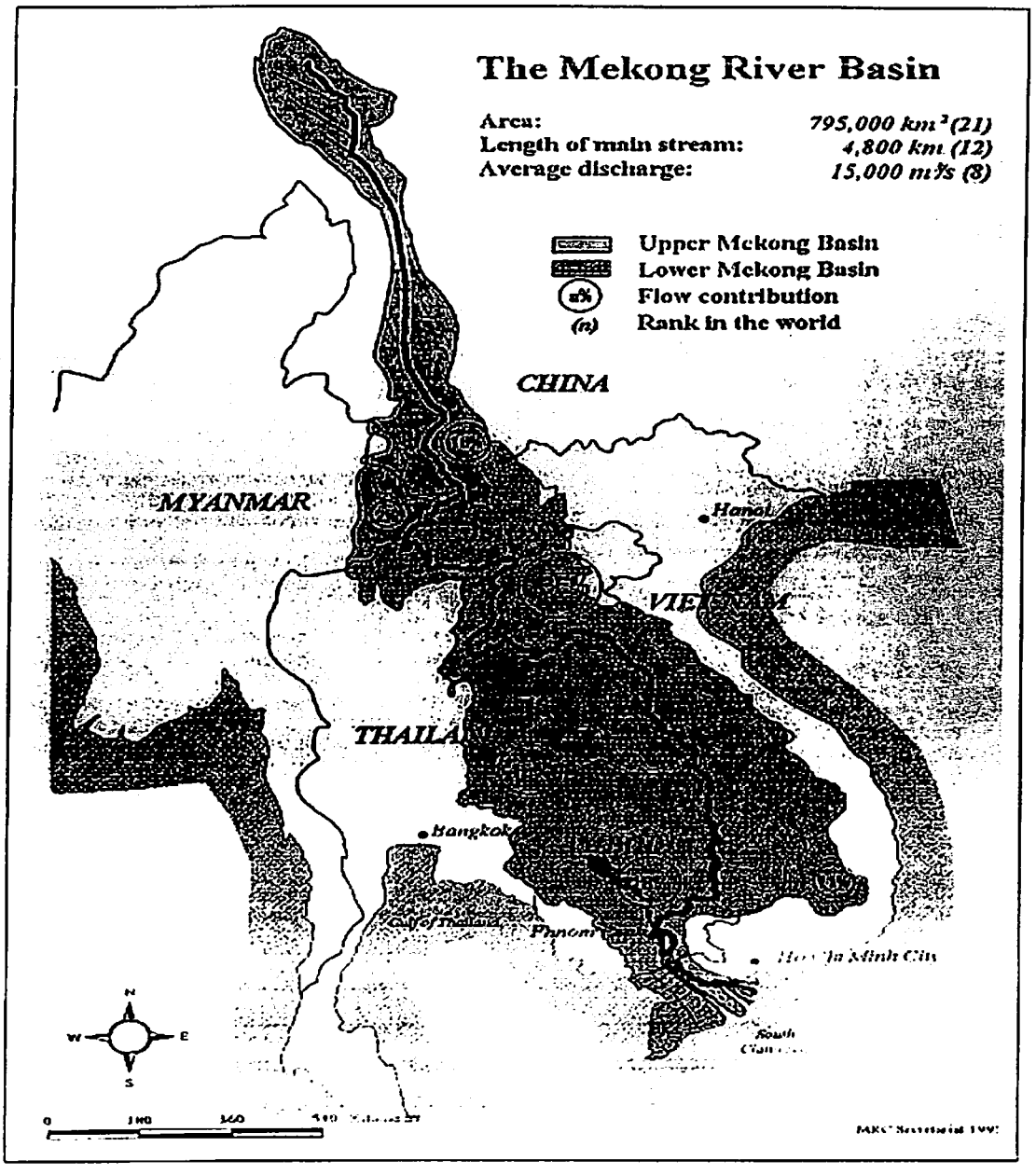
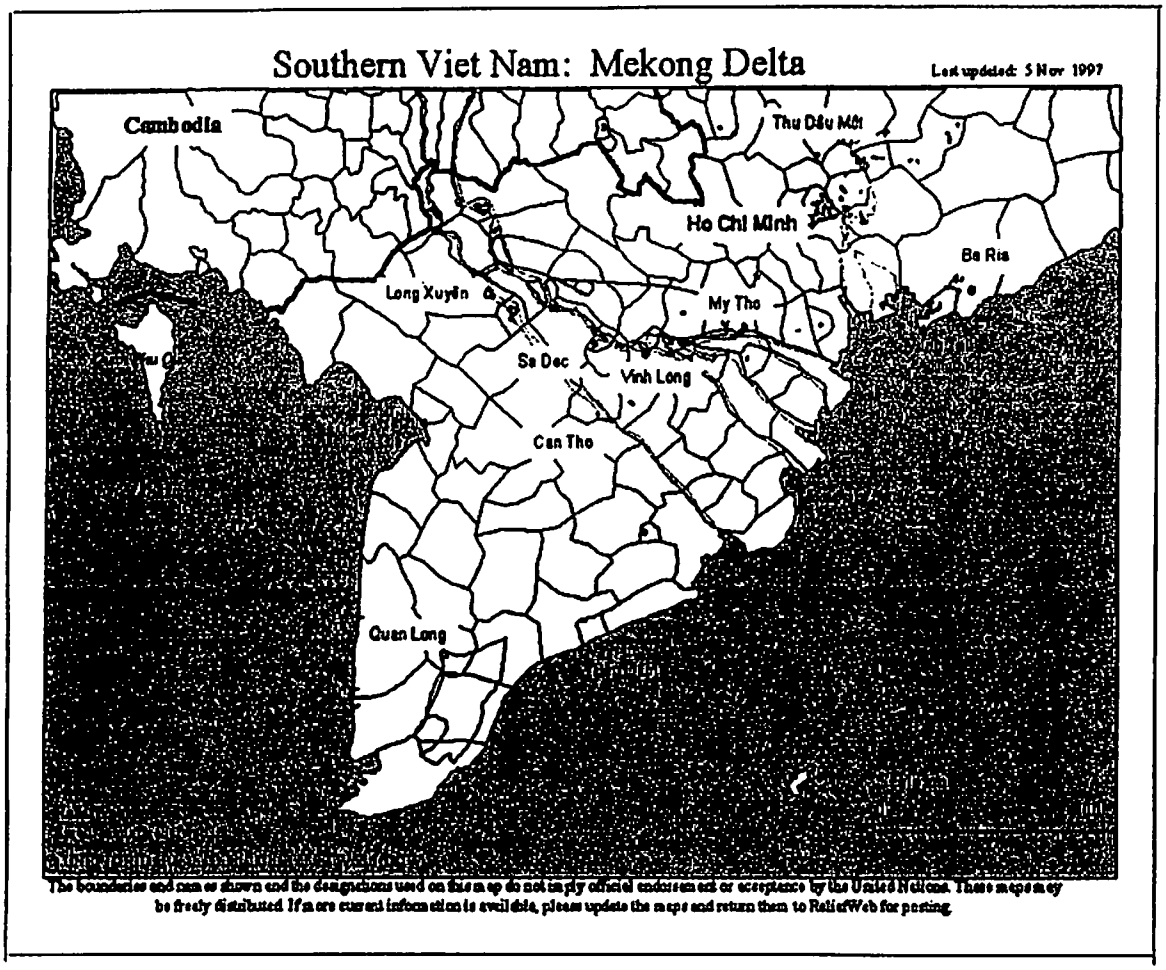
Figure 1. Mekong River Basin



Source: MRC 1997

Figure 2. Map of Mekong Delta.



Source: http.www.reliefmap

Figure 3. Map of Can Tho province.

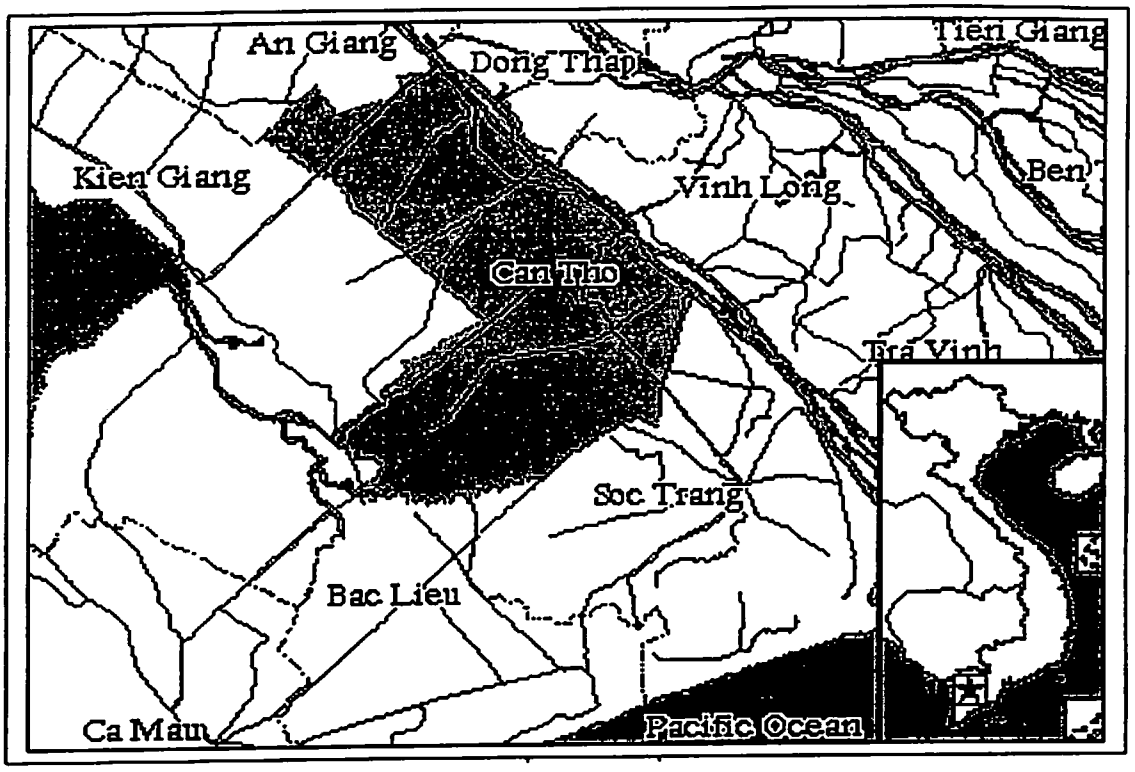
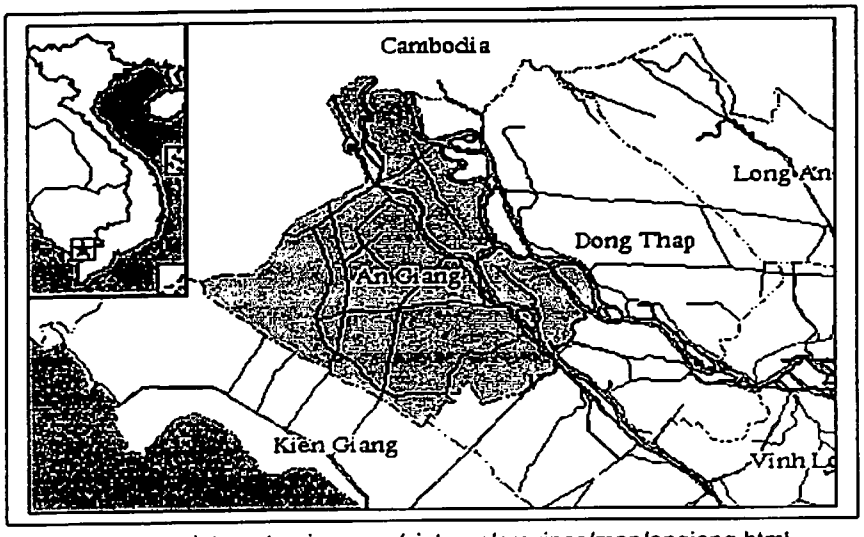


Figure 4. Map of An Giang province.



Source: www.vietnamtourism.com/vietnam/province/map/angiang.html

Figure 5. An Binh Village showing Loi Du-B.

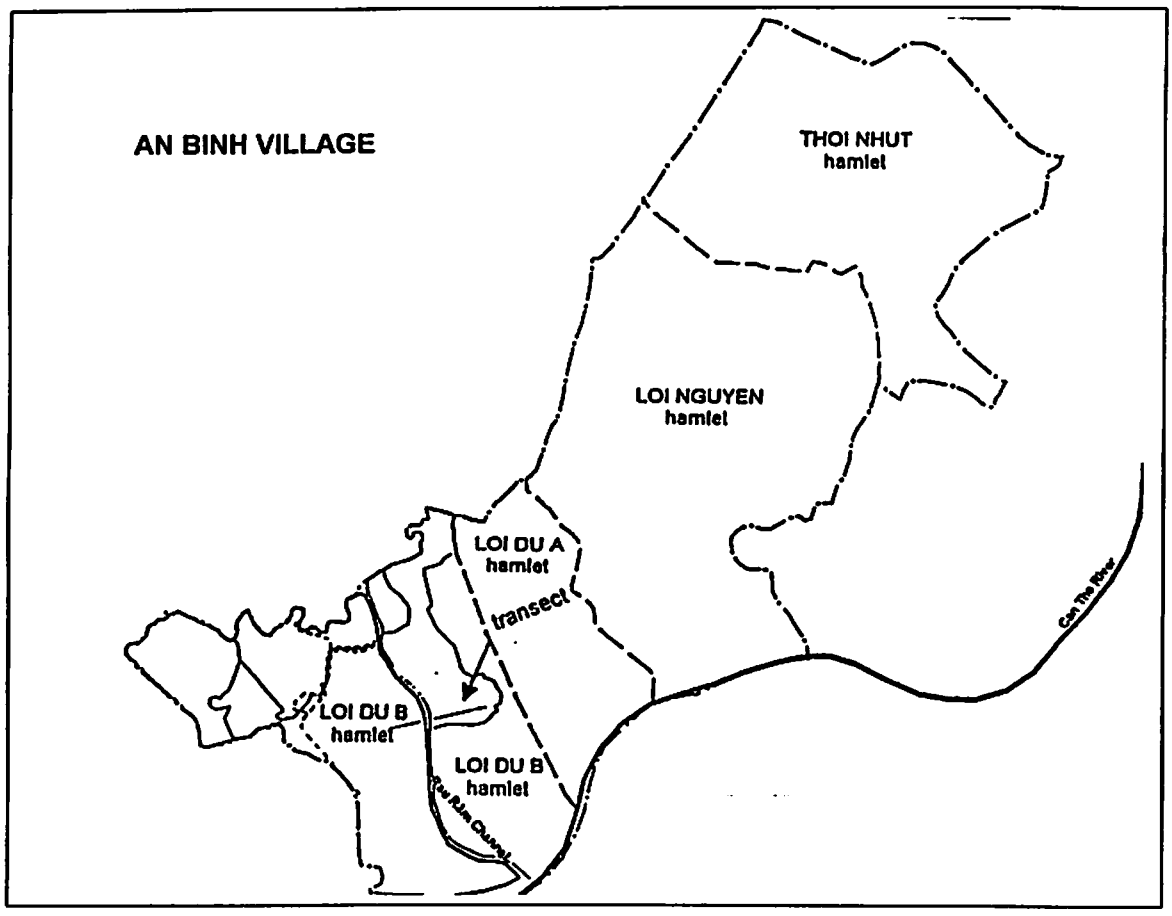
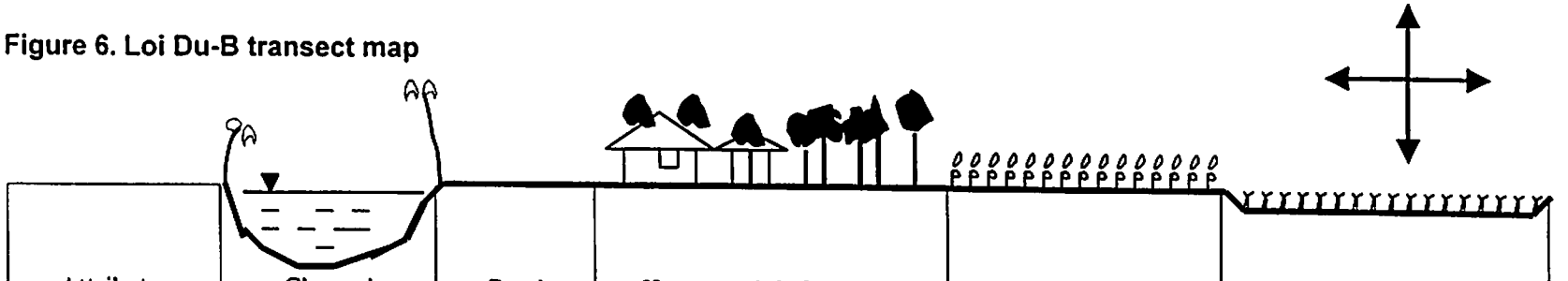


Figure 6. Loi Du-B transect map



Attributes	Channel	Road	Homestead & Orchards	Vegetable Garden	Ricefield
Distance	W=10m; L=2.8km	10m	120m	100m	300m
Soil Type	←		Alluvial soil	→	Silt with clay
Vegetables				Corn Cucumber String-beans	
Trees			Orange Mango Sapodilla Banana Citrus		
Livestock			Ducks Chicken Cattle		Ducks
Others			Bees		
Aquatic Resources	Fish		Fish pond		Fish
Problems			- Orchards were damaged by greening disease - Livestock and aquatic culture are not developed		
Opportunities	Transportation				- in-field irrigation systems - sediment load from the flood

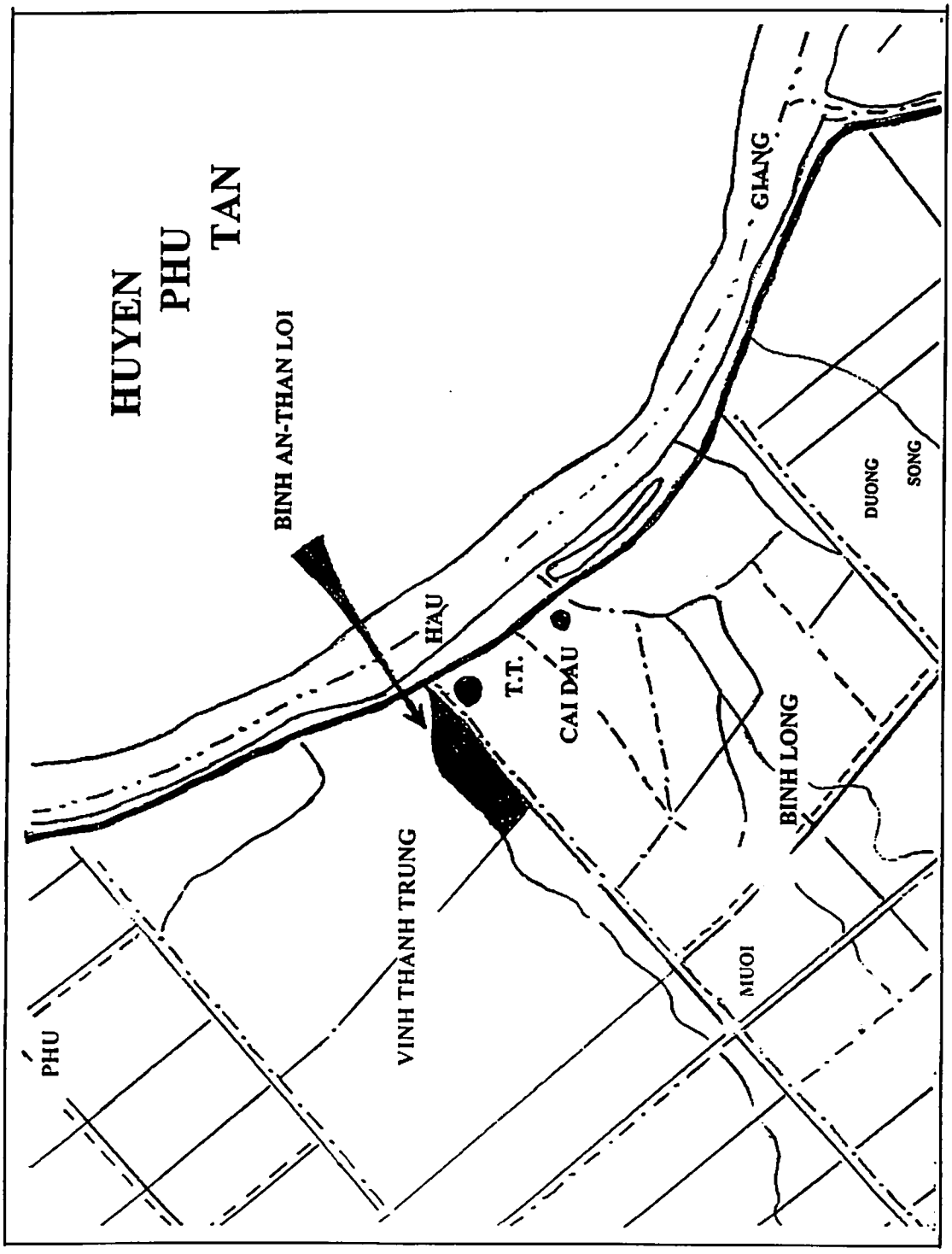


Figure 7. Vinh Thanh Trung village showing Binh An-Thanh Loi

Figure 8. Map of Binh Anh-Thanh Loi.

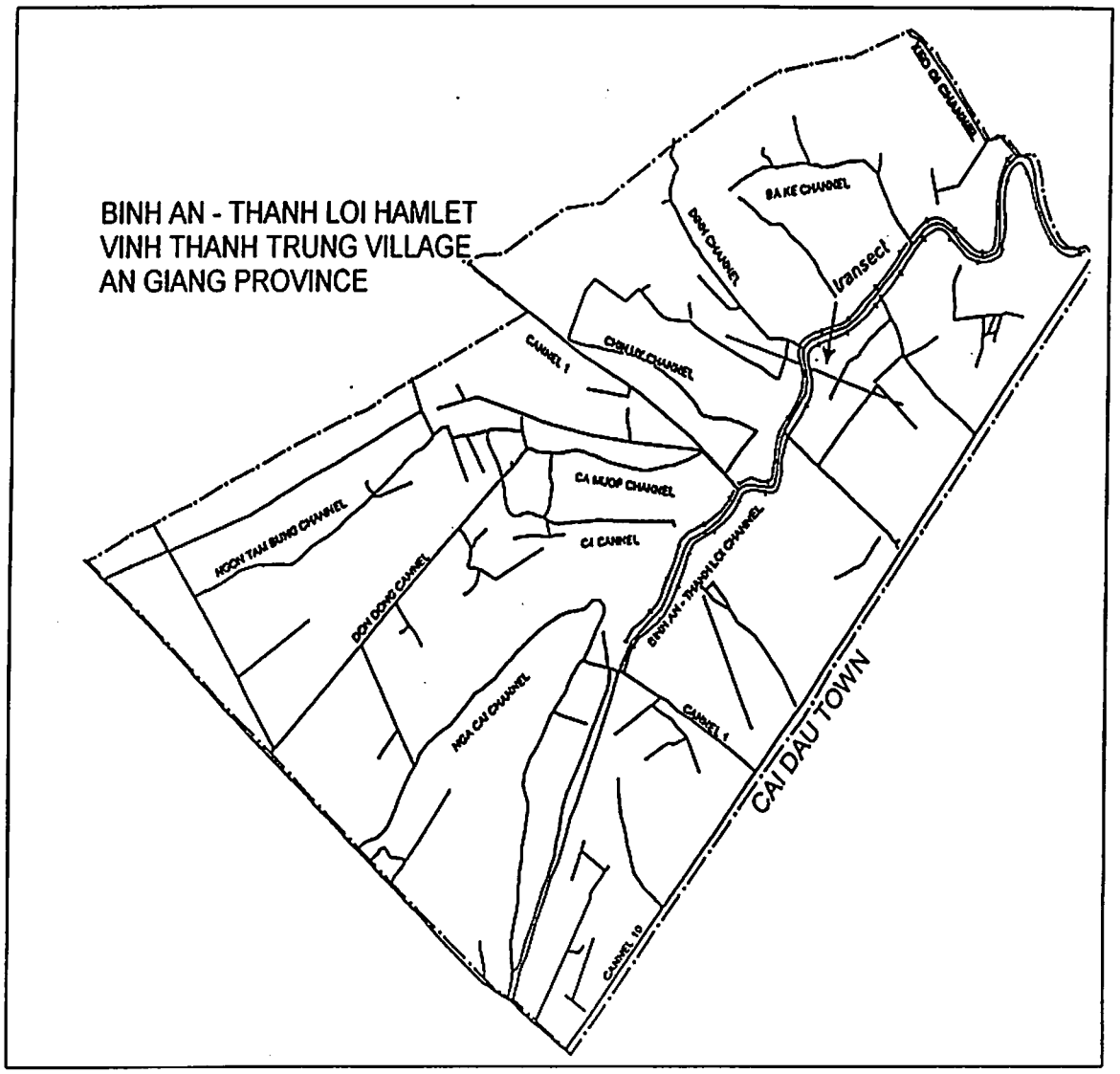
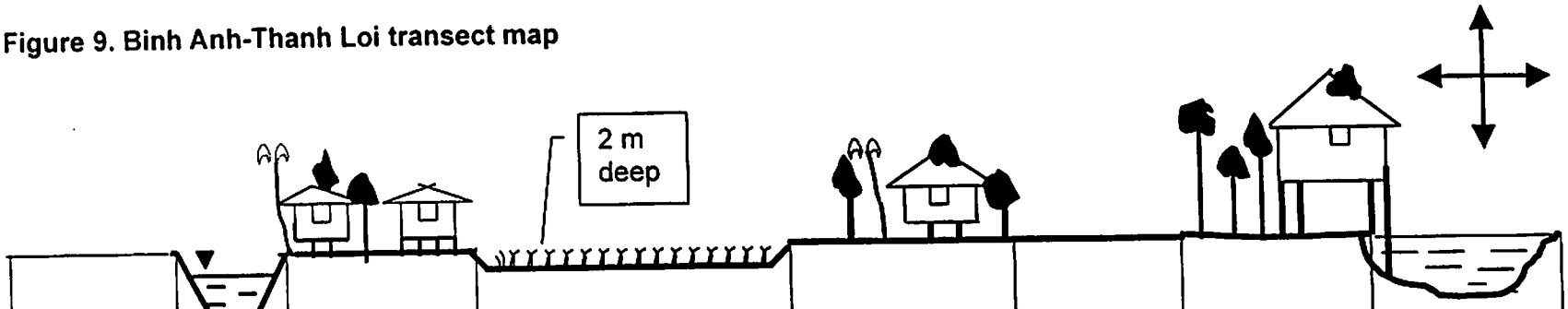


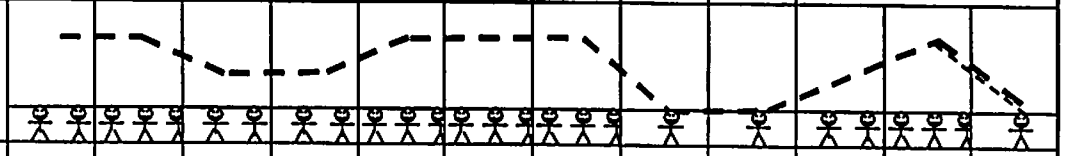
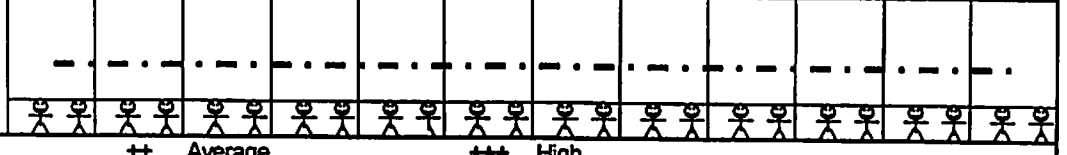
Figure 9. Binh Anh-Thanh Loi transect map



Attributes	Canal	Houses	Ricefield	Homestead	Road	Houses	Channel
Distance		50 m	800 m	80 m	4 m	15 m	W=15 m; D=4 m
Soil Type	Alluvial soil	Alluvial soil	Alluvial – clay	Alluvial soil			
Crops			Rice ar)	Bamboo Banana Trash-woods			
Livestock			Ducks	Ducks Chicken Cattle		Ducks Chicken Cattle	
Aquatic resources	Fish	Fish ponds	Fish	Fish pond			Fish
Problems			Cannot grow rice during the flooded season	High population Orchards cannot grow			
Opportunities			Much more fish during flooded season Alluvial soil from the flood If perfected irrigation systems, rice production will be higher				Transportation

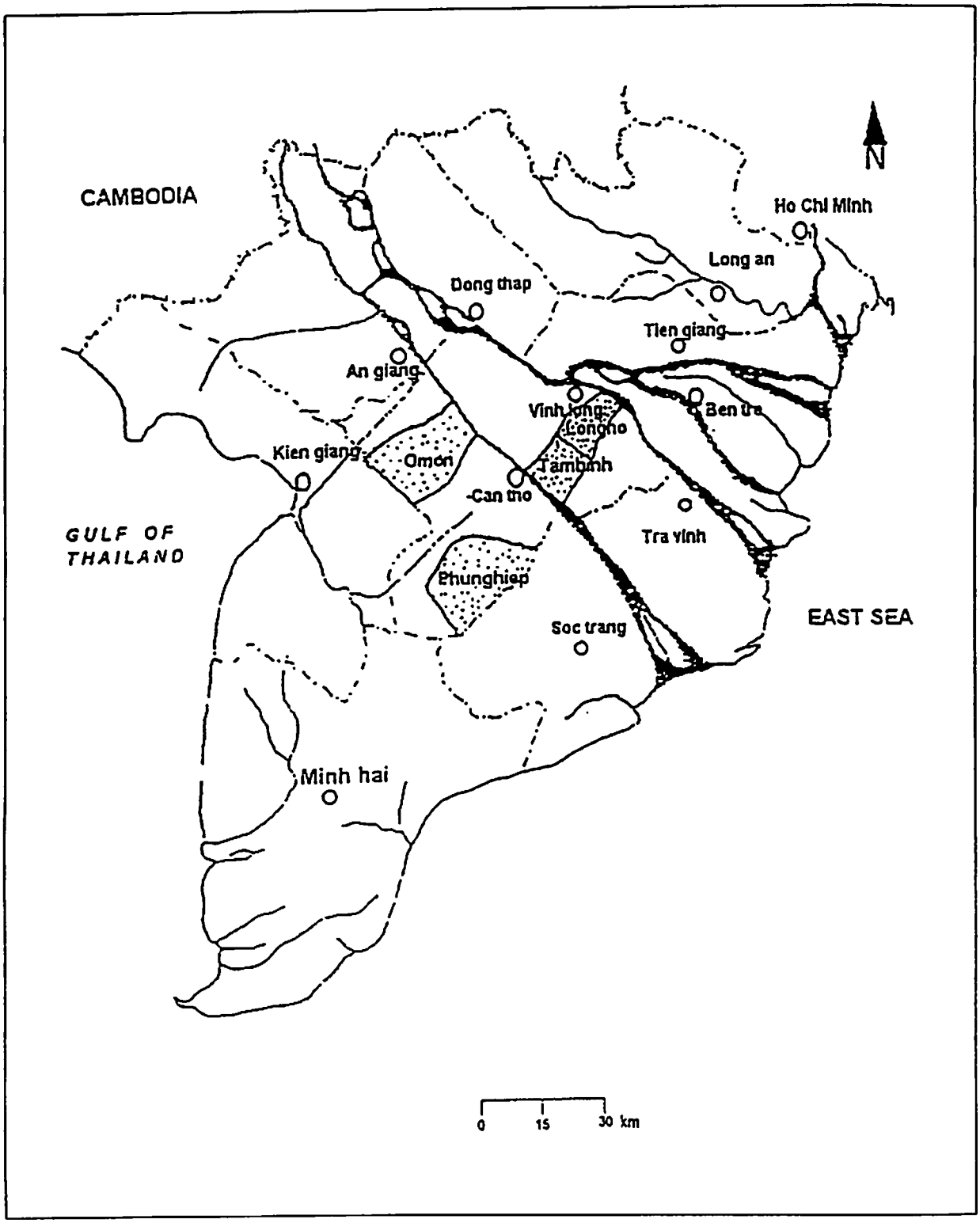
Figure 10. Seasonal calendar for fish species and fishing effort, Loi Du-B

SEASONAL CALENDAR FOR FISH SPECIES AND FISHING IN LOI DU - B HAMLET

Fish species and Activities			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Snake head	Represented seasons	Small fish	0	0	0	0	+	++	+++	0	0	0	0	0
		Aver. Fish	0	+	+	+	+	+	+	+	+	++	+++	+++
		Adult fish	0	0	0	+	+	++	+	+	0	0	0	0
	Fishing seasons		0	+	+	++	+	+	+	++	++	++	++	0
Catfish	Represented seasons	Small fish	0	0	0	+	+	++	0	0	0	0	0	0
		Aver. Fish	0	+	+	+	+	+	+	+	+	++	+++	+++
		Adult fish	0	0	+	+	+	++	0	0	0	0	0	0
	Fishing seasons		0	+	+	++	+	+	+	++	++	++	++	++
Climbing perch	Represented seasons	Small fish	0	+	+	+	+	++	++	+	+	+	0	0
		Aver. Fish	0	+	+	+	+	+	+	+	+	0	0	0
		Adult fish	0	0	0	0	+	+	+	0	0	0	0	0
	Fishing seasons		+	+	+	+	+	++	++	++	++	++	++	+
White lady carp	Represented seasons	Small fish	0	0	0	0	0	0	+	+	+	+	0	0
		Aver. Fish	0	0	0	0	0	0	0	+	+	++	+	0
		Adult fish	0	0	0	0	0	0	0	0	++	+++	0	0
	Fishing seasons		0	0	0	0	0	0	+	+	++	+++	0	0
Sandgoby	Represented seasons	Small fish	0	0	0	0	+	+	++	+	+	+	0	0
		Aver. Fish	+	+	+	+	+	+	+	+	+	+	+	+
		Adult fish	0	0	0	0	0	+	++	+	+	0	0	0
	Fishing seasons		+	+	+	+	+	+	+++	+	+	0	0	0
Labor power	Male													
	Female													

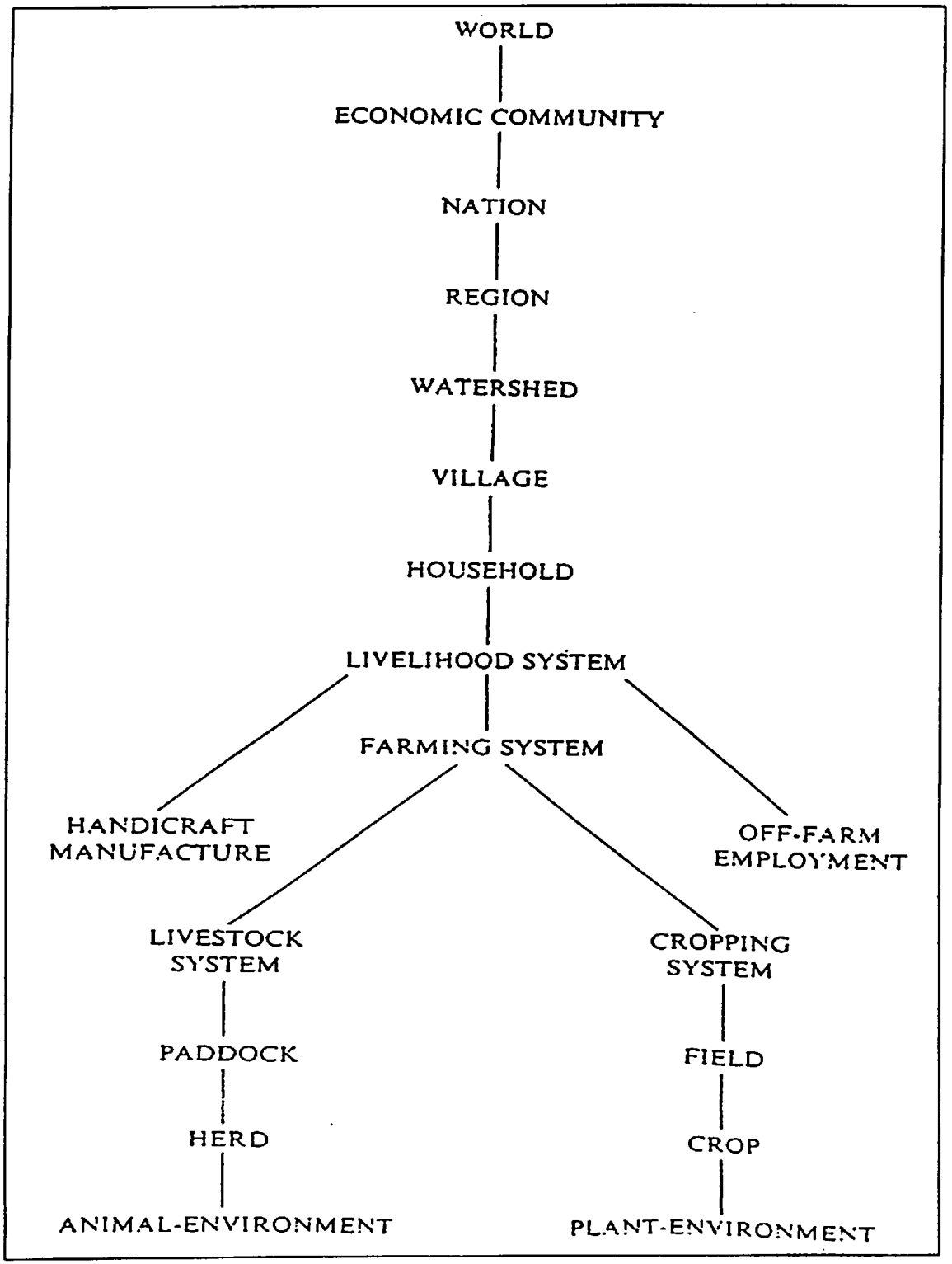
Note: + Low ++ Average +++ High

Figure 11. Map of the Mekong Delta Region



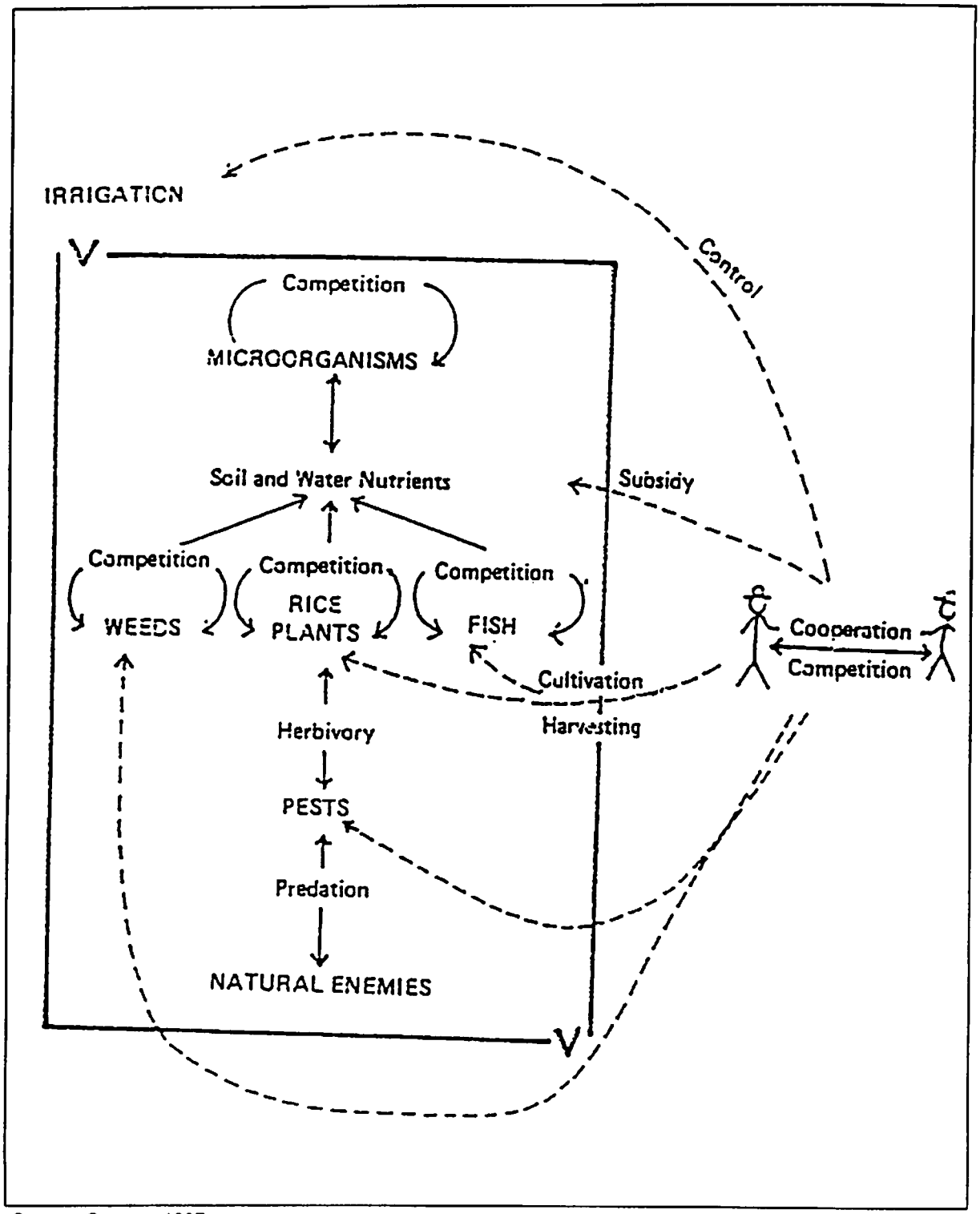
Source: CTU 1997

Figure 12. The hierarchy of agroecosystems



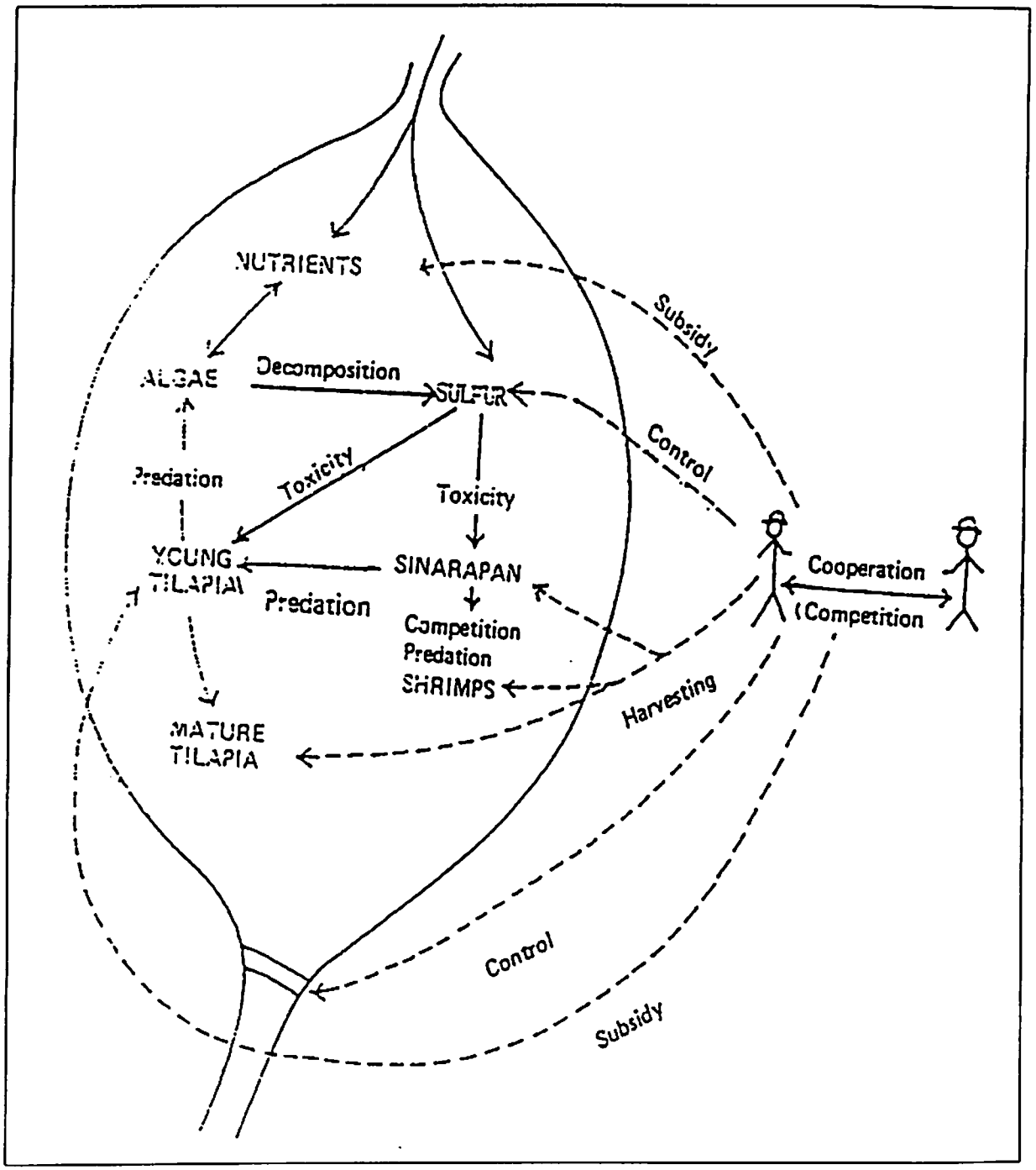
Source: Conway 1987

Figure 13. The ricefield agroecosystem



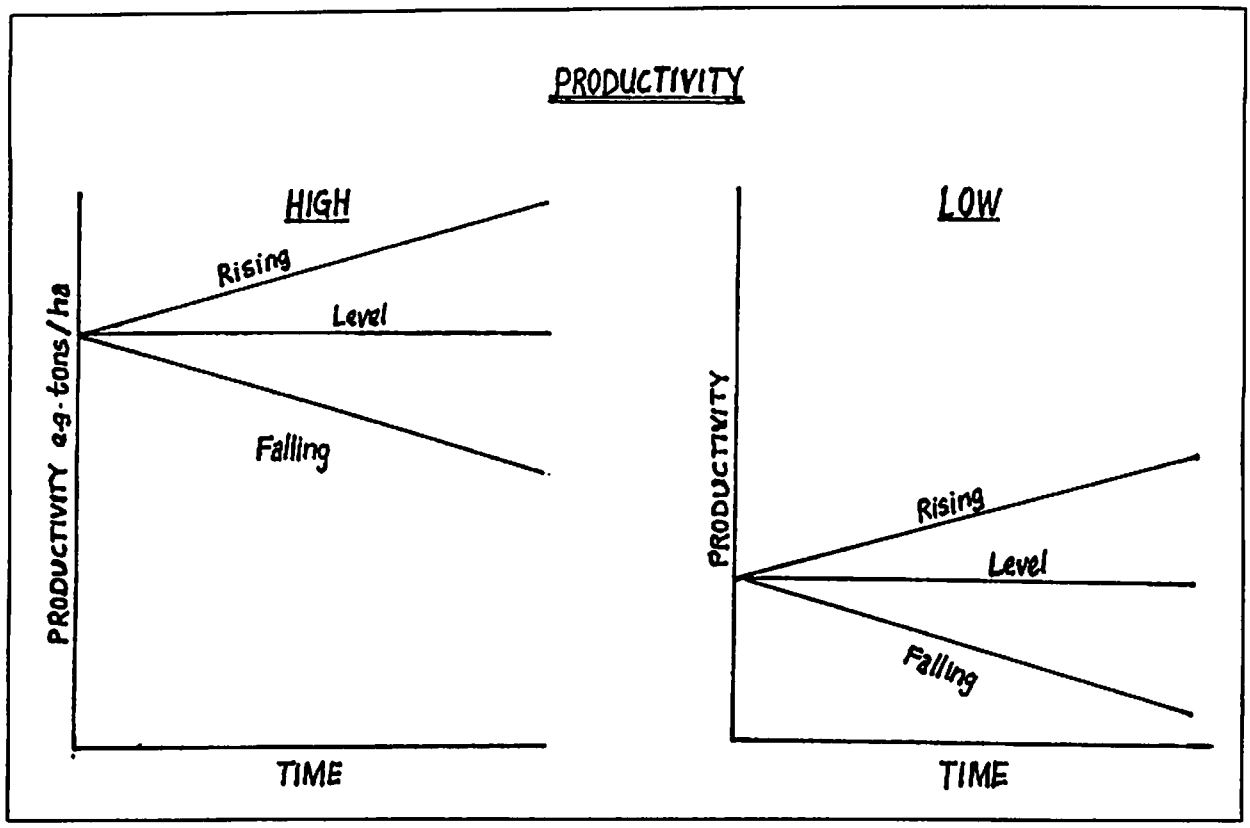
Source: Conway 1987

Figure 14. The Lake Buhi (Philippines) agroecosystem



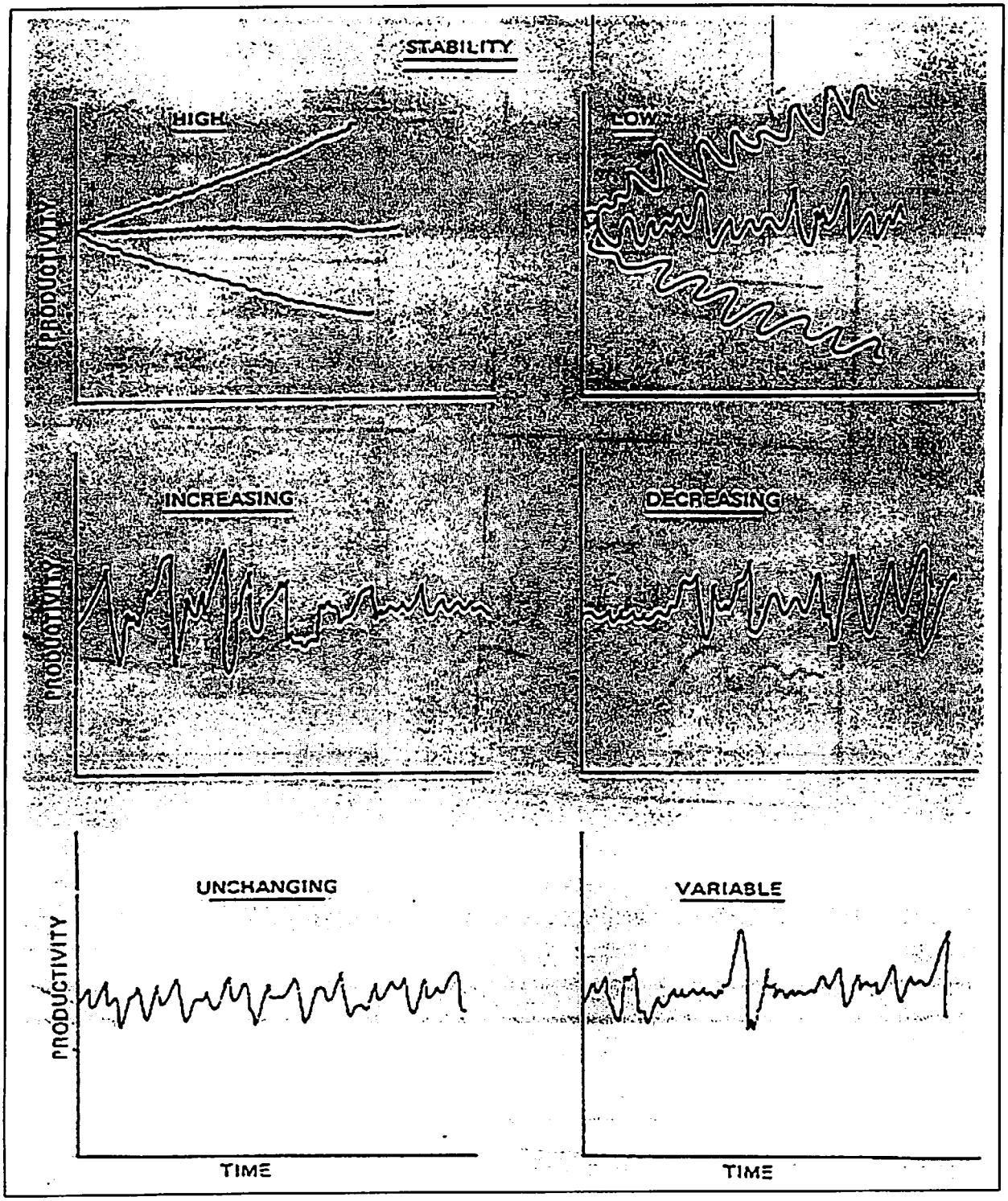
Source: Conway 1987

Figure 15. Agroecosystem productivity



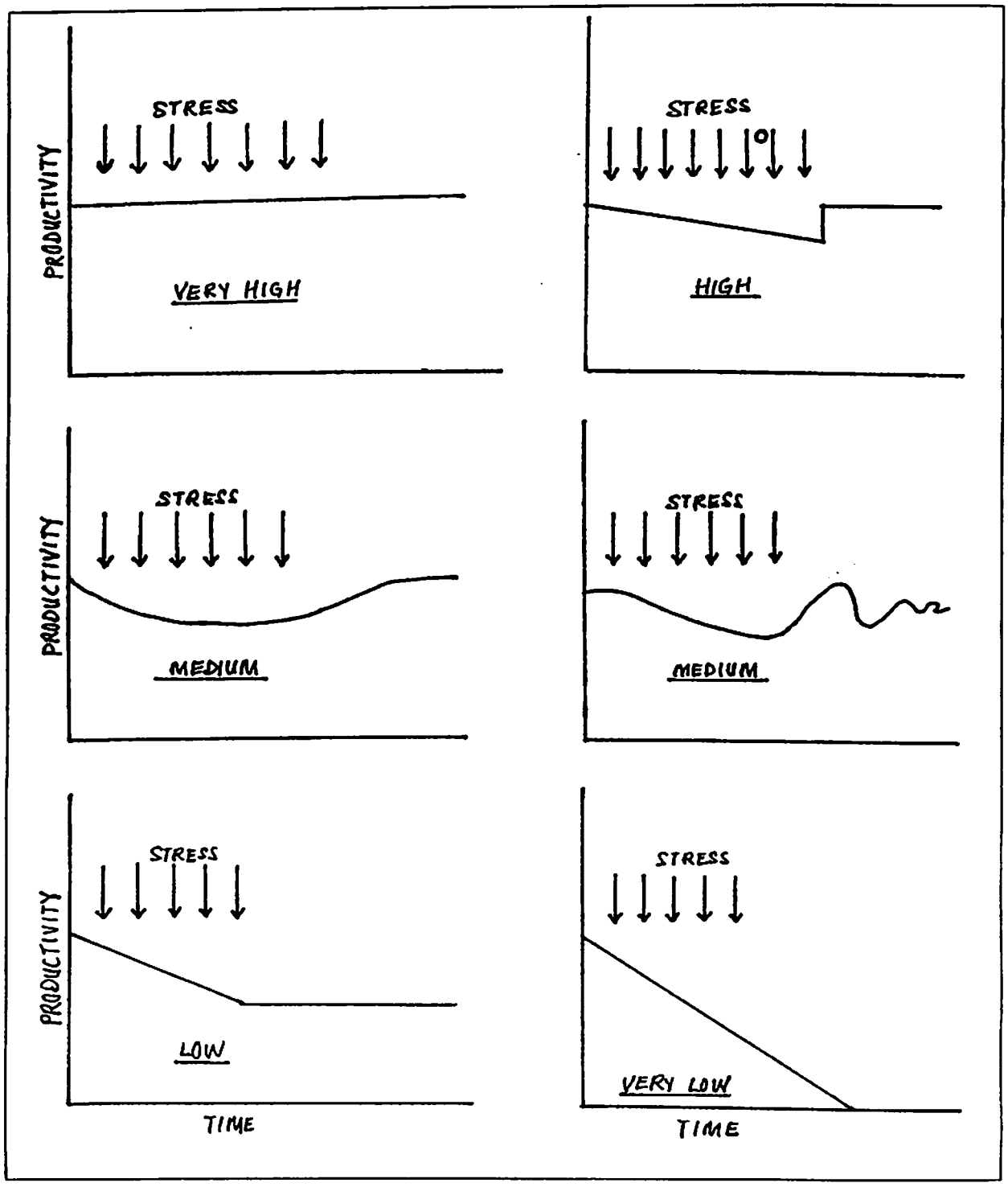
Source: Conway 1987

Figure 16. Agroecosystem stability



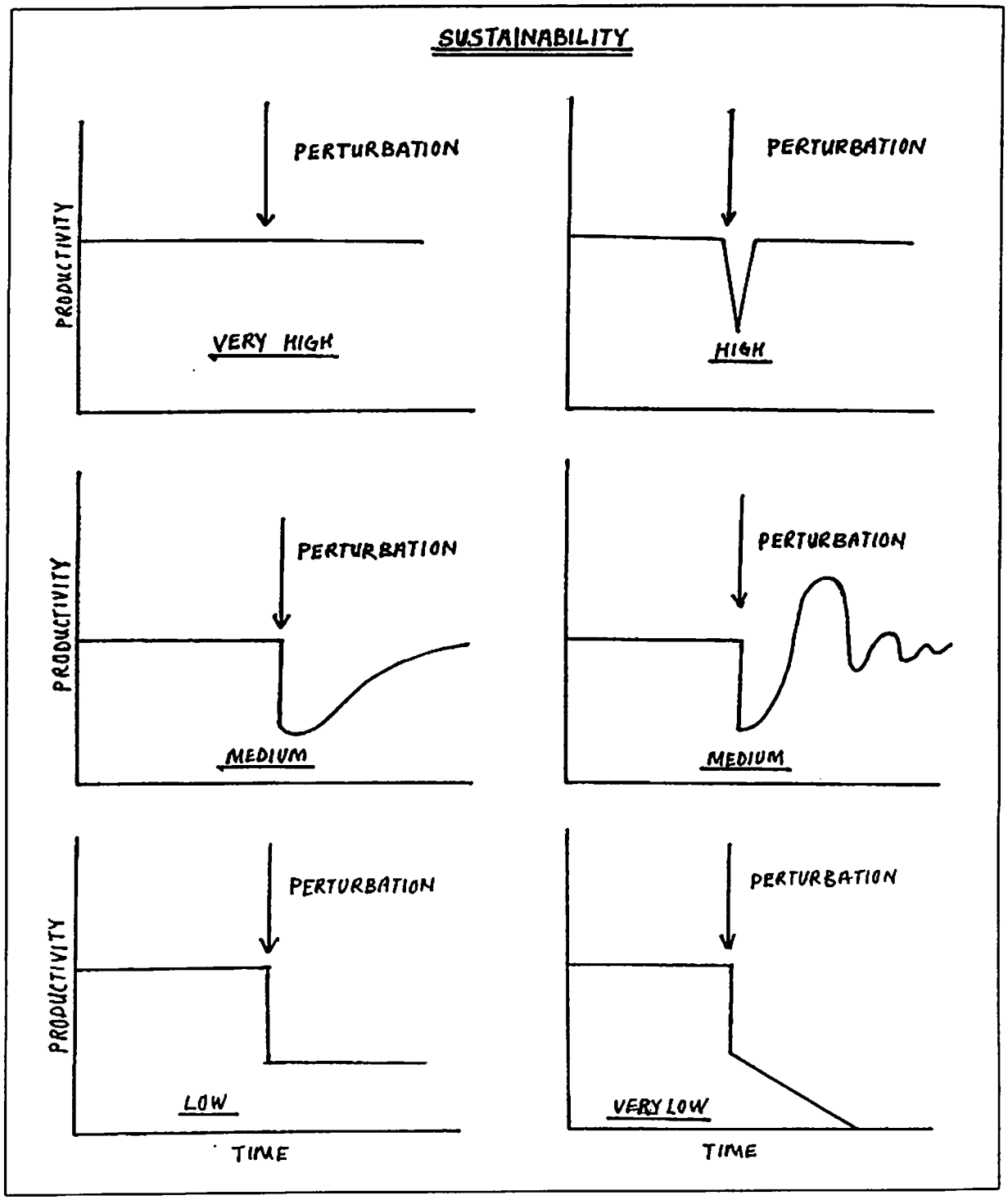
Source: Conway and Sajise 1985

Figure 17. Agroecosystem sustainability under stress



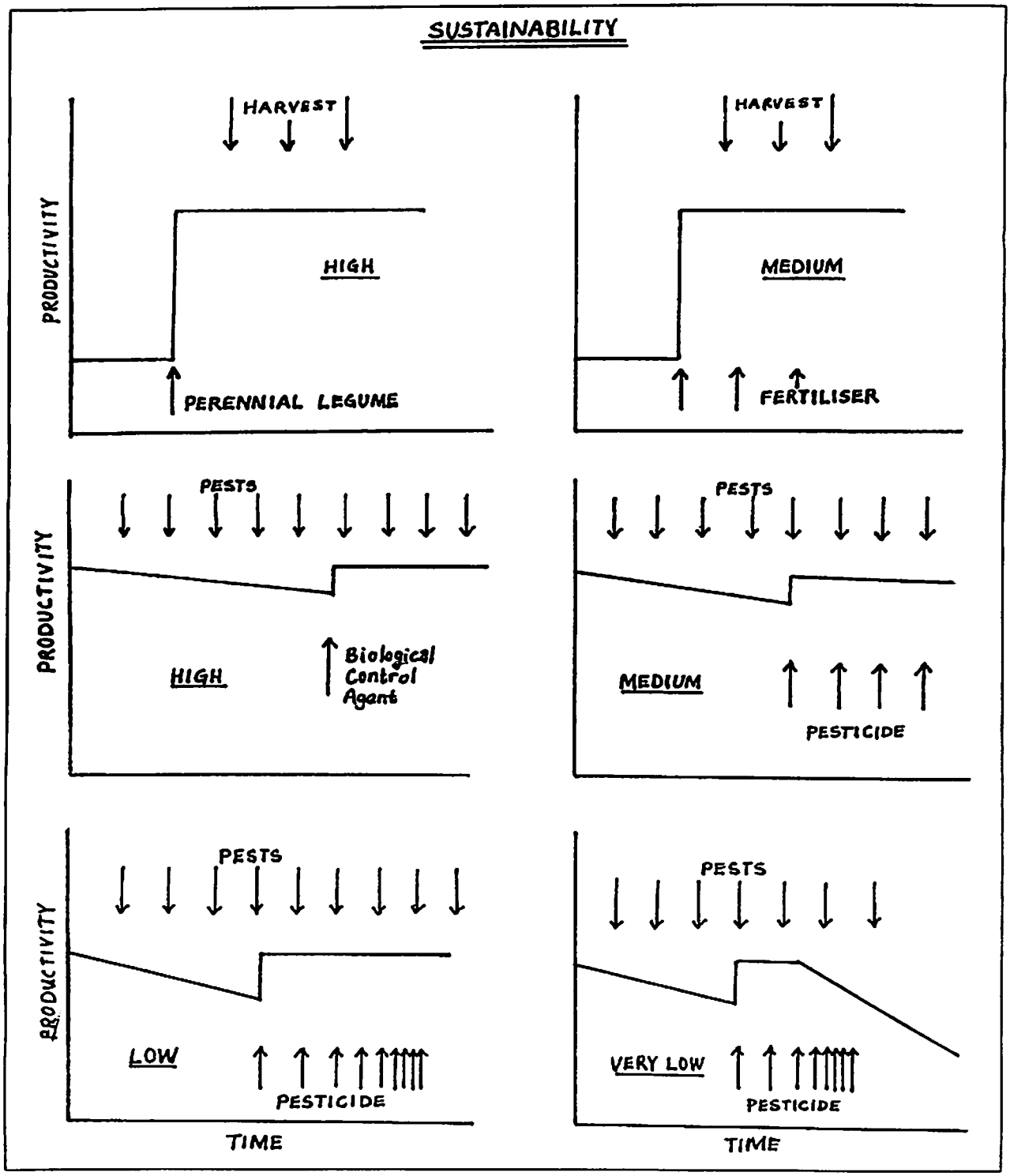
Source: Conway 1987

Figure 18. Agroecosystem sustainability under perturbation



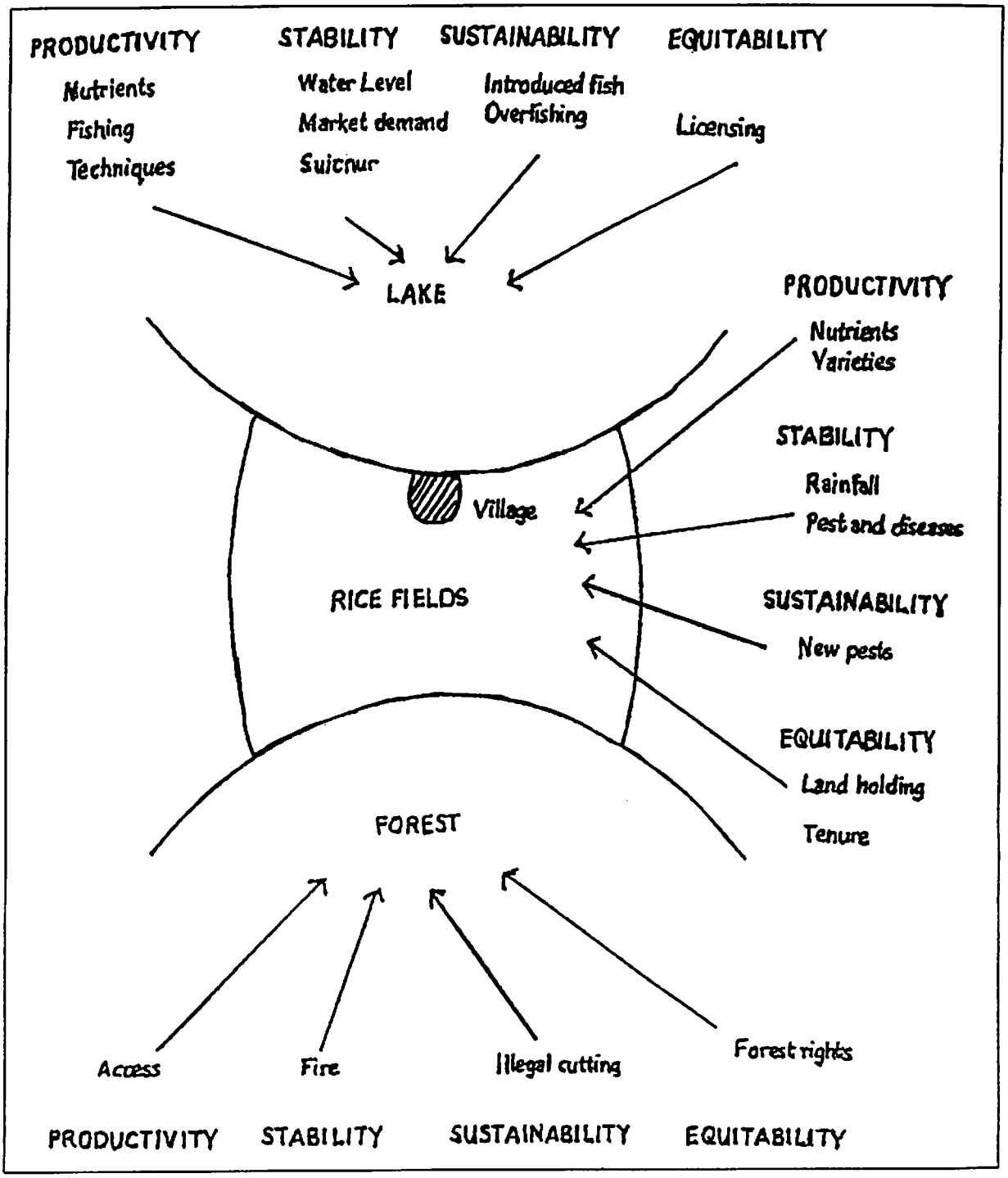
Source: Conway 1987

Figure 19. Agroecosystem sustainability subject to inputs



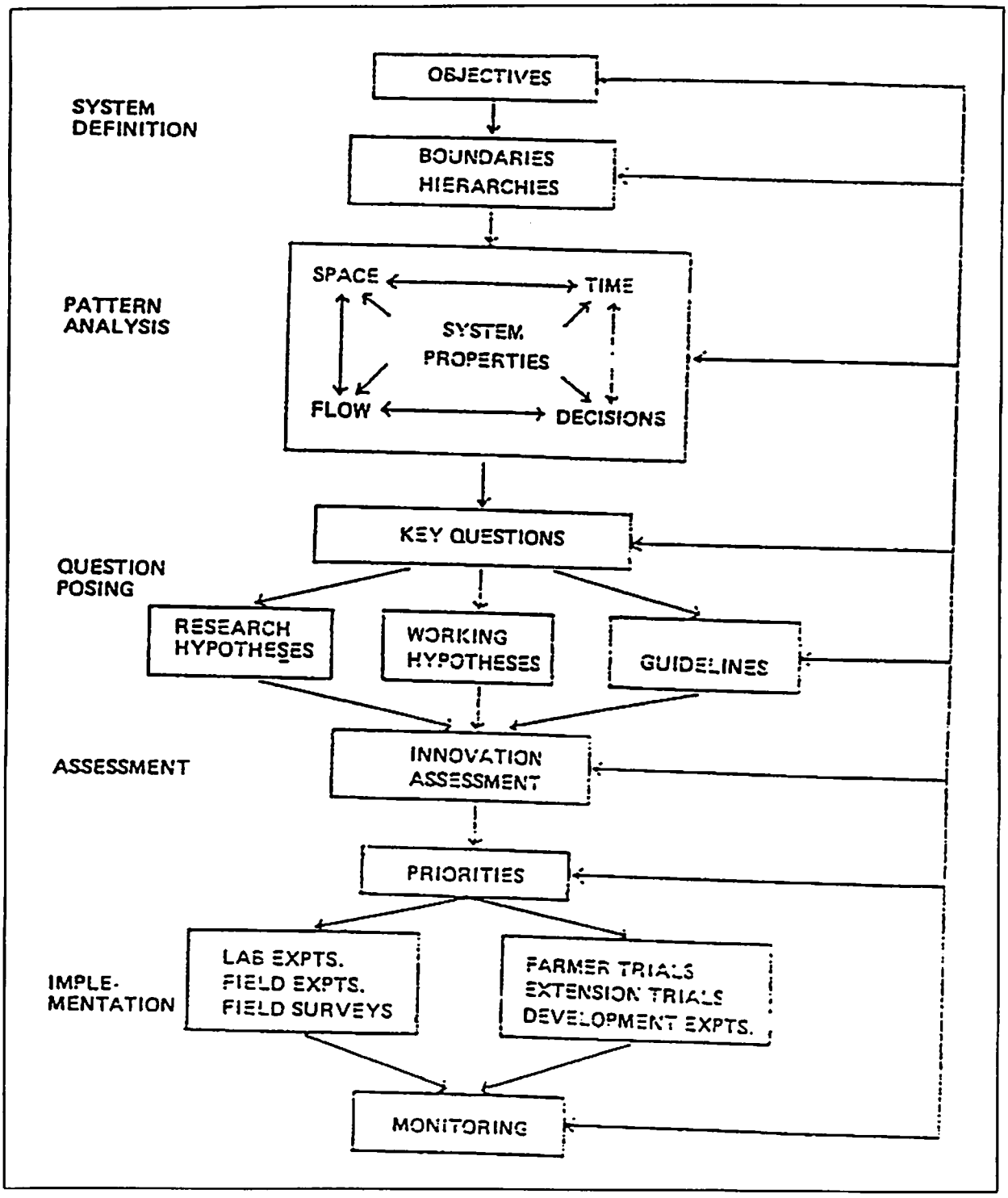
Source: Conway 1987

Figure 20. Factors affecting productivity, stability, sustainability and equitability of a lakeside village agroecosystem



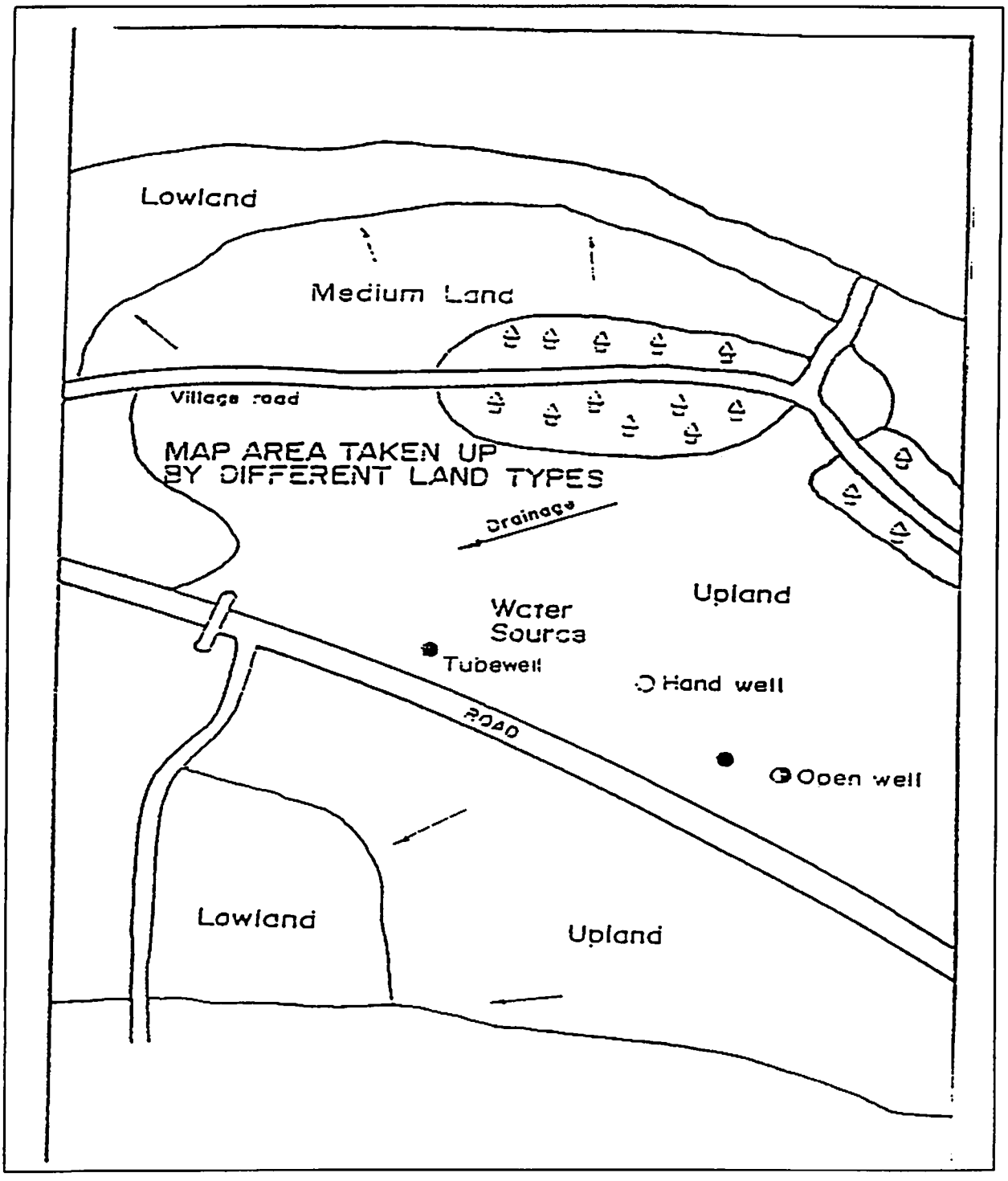
Source: Conway and Sajise 1985

Figure 21. The procedure of agroecosystem analysis for research and development



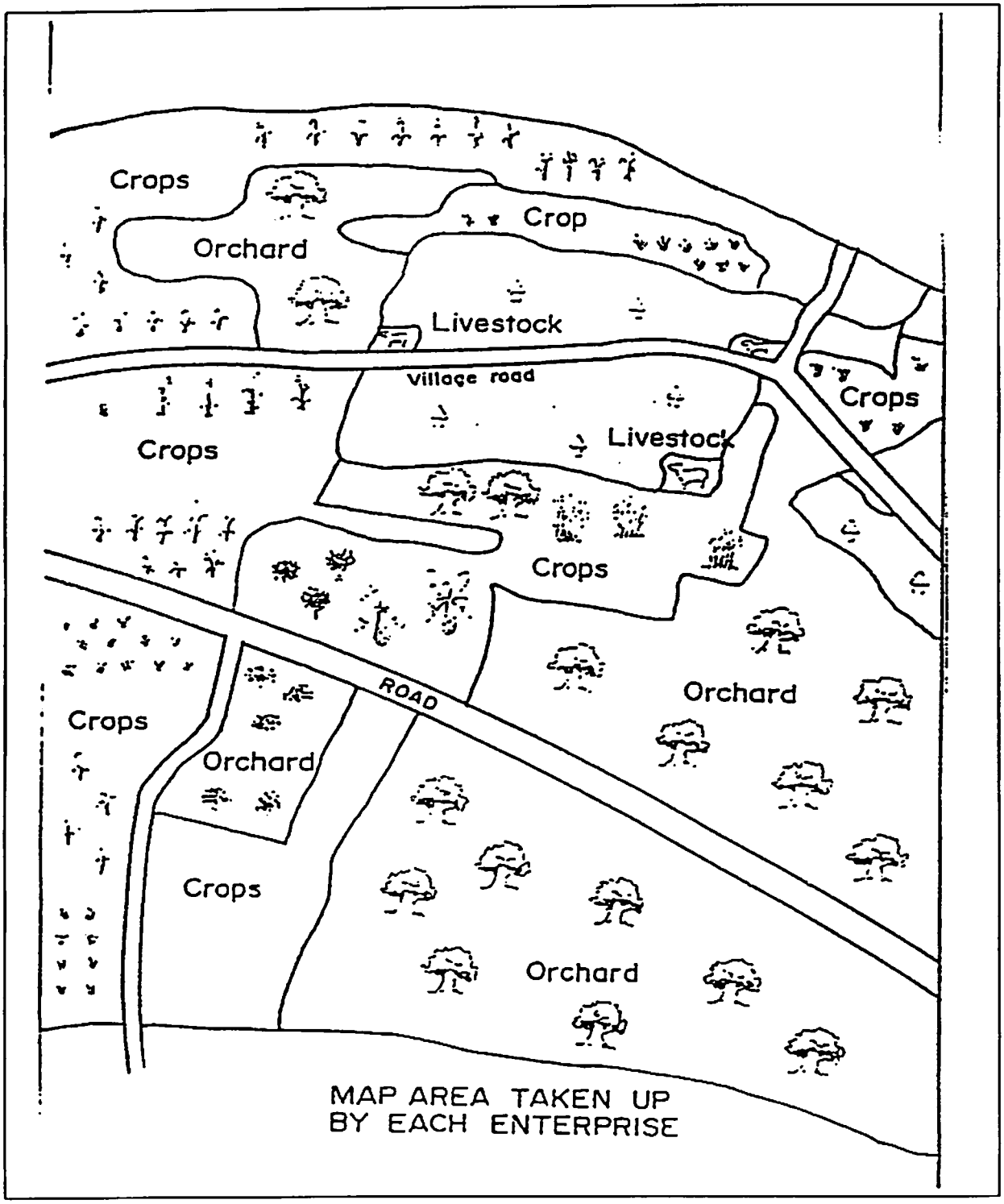
Source: Conway and Sajise 1985

Figure 22. Topography and hydrology map



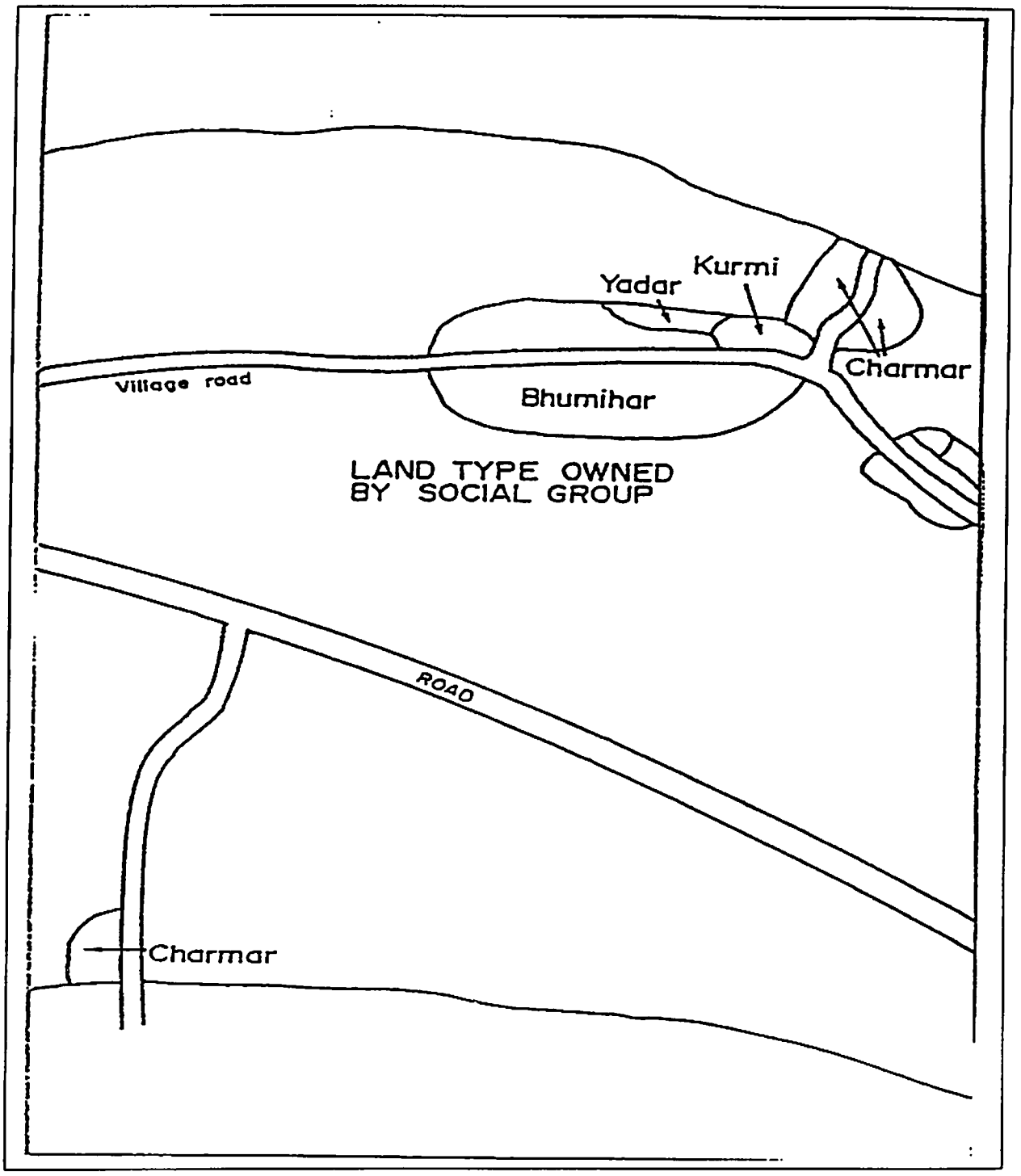
Source: Lightfoot et al 1989

Figure 23. Enterprise map



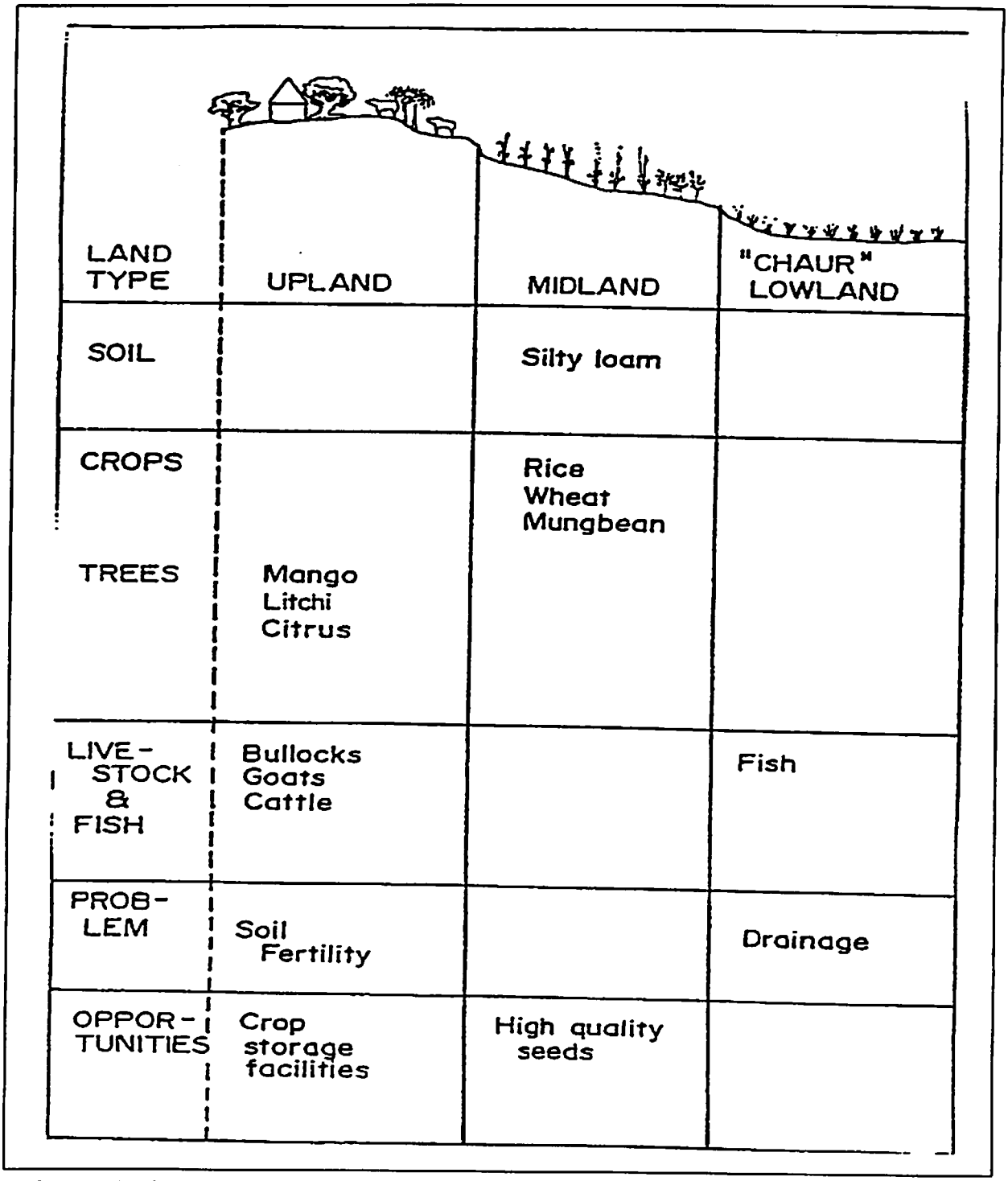
Source: Lightfoot et al 1989

Figure 24. Social map



Source: Lightfoot et al 1989

Figure 25. Transect



Source: Lightfoot et al 1989

Table 1. Can Tho City District Data Statistics, 1996

Population	332 972
Labour Force	203 079
Total Land Area	14 129 has
Agricultural Land Area	9 073 has
Agricultural Production	50 603 tons $year^{-1}$
Rice Production	49 180 tons $year^{-1}$
Population Density	2 357 persons km^{-2}
Population Growth Rate	1.60% (1995-1996)

Source: Can Tho Province Department of Statistics. (Nien Giam Thong Ke, 1997). Cuc Thong Ke Can Tho

Table 2. Chau Phu District Data Statistics, 1996

Population	237 274
Labour Force	113 816
Total Land Area	42 633 has
Agricultural Land Area	36 124 has
Agricultural Production	362 409 tons $year^{-1}$
Rice Production	328 450 tons $year^{-1}$
Population Density	556 persons km^{-2}
Population Growth Rate	1.83% (1995-1996)

Source: An Giang Province Department of Statistics. (Nien Giam Thong Ke, 1994-1996). Huyen Chau Phu

Table 3. Socio-economic characteristics of Loi Du – B Hamlet, 1998.

Population	2 984
Male	1 383
Female	1 601
Labour Force	874
Male (18-45 years old)	696
Female (18-25 years old)	178
Total Land Area	162.38 ha
Agricultural Land Area Rice field Orchard Houses	157.17 ha (92.96 ha) (64.21 ha) 5.21 ha
Agricultural Production	1027 tons $year^{-1}$
Rice Other Crops	(1023 tons $year^{-1}$) (4 tons $year^{-1}$)
Population Density	18.4 persons ha
Population Growth Rate	1.3% (1997-1998)
Natural growth (from birth)	1.1% (1997-1998)
Artificial growth (from migration)	1.6% (1997-1998)
Number of Households Poor households Landless households	629 15 14

Source: Personal communication with Loi Du – B head of hamlet

Table 4. Issues and practices affecting the fisheries sector, Loi Du - B (October 1998)

Issues	Management Intervention	Level of effectiveness	Reason for effectiveness/ineffectiveness
1. Overfishing (3)	education ban overfishing penalty	very effective	administration; self-will
2. Agroecological loading (3)	education; integrated pest management (IPM)	very effective	self-will
3. Inappropriate exploitation patterns (2)	education	very effective (head of hamlet) ineffective (head of women)	administration; self-will poverty
	punishment	very effective	administration; self-will
4. Domestic/sewage pollution (2)			
5. Use of destructive fishing practices	fine plus education	ineffective	poor implementation
6. Flooding	use of net and dike to keep fish	effective	some unusual high floods occur*
7. Poverty	poverty alleviation programs by the government	effective	short term credit **
8. Human population	population education/family planning programs	very effective	community's awareness on population problems
9. Small and large scale fisheries conflicts			
10. Siltation / sedimentation			
11. Soil erosion			
12. Habitat degradation/destruction			
13. Reduced biodiversity			
14. Inadequate technical extension support			
15. Limited institutional funding			
16. Insufficient / ineffective law enforcement			
17. Level of education			
18. Migration			
19. Lack of hamlet coordination and solidarity			
20. Unemployment			

Notes: Figures in parenthesis are frequency of responses; all others have frequency =1

* intervention generally effective except when some unusual high floods occur

Table 5. Management interventions, level of effectiveness, and degree of acceptance in Loi Du – B (October 1998)

Management interventions		Level of effectiveness	Reason	Degree of effectiveness	Reason
Regulation of activities	**Intervention instruments**				
1. Restricted fishing activities	ban on destructive fishing practices	very effective (head of hamlet)	recognized	highly accepted	recognized
		ineffective (head of farmers' union)	not really carried out	low acceptance	poverty
	ban on destructive gears	ineffective	not really carried out	low acceptance	poverty
2. Regulated farming practices	control of toxic chemical applications	effective		highly accepted	
3. Limited entry	fish conservation zone	very effective (head of hamlet)	recognized (hamlet)	highly accepted (hamlet)	recognized (hamlet)
		ineffective (head of farmers' union)	not carried out (farmers' union)	low acceptance (farmers' union)	poverty (farmers' union)
	enforcement of regulations and penalties	ineffective	not really carried out	low acceptance	poverty
Supervision of institution	**Intervention instruments**				
4. Strengthening and upgrading of institutional capacity	training for technical personnel and facilities upgrading				
5. Improvement of marketing and post-harvest facilities	strategic rural road infrastructure	very effective	recognized	highly accepted	recognized
6. Enhancement of research and information	harvestable size of fish	very effective	recognized	highly accepted	recognized
		very effective	recognized	highly accepted	recognized

Table 6. Policies, regulations, ordinances, and laws related to fishery, Loi Du – B (October 1998)

Policies related to fishery	Effectiveness	Factors	Regulations violated	Type of violation	Penalty*	Recommendations for improved enforcement
1. Property rights in terms of access, withdrawal, management, exclusion and transfer	effective	battery trap forbidden; fishing gear net with small mesh size			200,000 – 500,000 VND	education; penalty when the violation is repeated
2. Rules on fishing operations			ban on destructive devices	battery shocking	up to 200,000 VND	stronger enforcement
3. Regulatory mechanisms (e.g. quota, closed season, etc.)				duck fishing		re-education; stronger enforcement
4. Penalties / incentives (e.g. taxation, licensing, fines)						
5. 1 fine	ineffective	poverty; regulations only on paper				

* US $ 1.00 = 13 845 VND

Table 7. Conditions of the fishery resources, Loi Du – B (October 1998)

Changes on the resource	Fish population	Factors affecting fish population	Fishing as a lucrative employment	Need to manage the fisheries sector	Steps to stabilize fish population
Low fish catch	decrease	a. weather b. fish culturing c. pollution		Yes	Strictly enforce fishing regulations on illegal fishing in certain areas Strict enforcement of fishing regulations on agroecological loading
Decline in fish species	decrease	illegal fishing			Strictly enforce fishing regulations on illegal fishing everywhere
Few fish species	decrease	overfishing	No	Yes	a. culture fish b. create jobs c. improve people's livelihood
Few people go fishing	protected	habitat protection		Yes	Modify fishery regulations to fish only in certain times of the year (open vs. closed seasons)
Few fish species	decrease	flooding			Improve fish traps to enclose more species

Table 8. Trend Anlysis for Fishing and Framing Activities in Loi Du – B hamlet

Category	Trend	Indicators	Reasons
Fish Quantity • Before 1968 • From 1970 to present	= ↓	Abundant fish Fewer fish	- Human population was low; few fishermen - Growing population; intensive aquaculture of more pesticides
Fish species • Before 1968	=	Diversity in species	- Different kinds of fish were caught: snakehead, catfish, climbing perch, gourami, common silver
• From 1968-1978		50% reduction	- Land areas were divided; fish resources petered out; snakehead, catfish were disappearing. Mainly left: climbing perch, gourami
• From 1978-1988	↓	70% reduction	- Two rice season / year; many people fished; abandoned lands were used; climbing perch, gourami were disappearing
• From1988-1998	↓	90% reduction	- Lower fish population; three rice seasons / year; pesticides were used too much; fishing gears with very small mesh-size were used
Need for fish in diet - From 1998	↑	Fish is rarely in diet	Farmers like to eat fish; farmers usually buy fish
Number of fishermen • **Before 1968**	=	10% of households	- Some people fished; fish catch per person can either be sold or stored for home consumption for 2-3 days
• **From 1968-1978**	↑	30% of households	- Many people fished; fish catch per person was going down but still enough for home consumption for 1-2 days
• **From 1978-1988**	↑	40% of households	- Much more people fished; fish caught by 2 persons was just enough for 1 day consumption
• **From 1988-1998**	↑	90% of households	- People fished daily; catch by 2 persons was not enough for daily consumption
Fishing gears • Before 1968 • From 1968-1978	= ↑	Handline Handline and bamboo trap	- Fish caught by handline was enough for consumption - Fish caught by handline was not enough for consumption that bamboo trap was used
• From 1978-1988	↑	Handline, bamboo trap, and gill net	- Fish caught by handline and bamboo trap was not enough for consumption that gill net was used
• From 1988-1998	↑	Handline, bamboo trap, gill net, and electric shock fishing gear	- Electric shock fishing gear was used to catch many kinds of fish but this has led fishery resources to be destroyed

Note: = Constant ↑ Increasing ↓ Decreasing

Table 9. Existing organizations, Loi Du – B (October 1998)

Organizations	Formal*	Involved in fisheries	Level	Category
1. Hamlet people's committee	Yes	Yes	Hamlet	government organization
2. Farmer's organization	No	No	Hamlet	non-government organization
3. Women's organization	No	No	Hamlet	non-government organization
4. Youth's club	No	No	Hamlet	non-government organization
5. Police / local military	Yes	Yes	Hamlet	government organization
6. Extension	No	No	Hamlet	non-government organization
7. Veterans	No	No	Hamlet	non-government organization
8. Elders	No	No	Hamlet	non-government organization

*Formal organizations are government organizations that have real authority and power; members become government officials (Mr. Nguyen Hun Thien, CTU).

Table 10. Activities and functions of the organizations, Loi Du – B (October 1998)

Organization	Main objectives of the organization	Activities of the organization	Effectiveness	Contributing factors to effectiveness	Administrative structure	Years of existence	Number of members
1. Hamlet people's committee	administration	assisting community in alternative projects	effective	people are responsive to government authority	village hamlet	23 (1975)	3 elected officials
2. Farmer's organization	extension; help in livelihood projects	assisting community in livelihood projects; extensions			national provincial district village hamlet	23 (1975)	200 in 13 groups
3. Women's organization	Civic work	family planning redcross				4	40 persons in 12 groups
4. Youth's club		assisting community in alternative livelihood projects					

Table 11. Fish production and marketing, Loi Du – B (October 1998)

Fish species	Catch / trip	Consumed	Sold	Price / kg (VND)	
	(kg)	(%)		landing site	market
1. Snakehead	0.5 – 3	20 – 70	30 – 80	11,000 – 20,000	13,000 – 30,000
2. Catfish	0.2 – 0.5	20	80	10,000 – 15,000	14,000 – 18,000
3. Climbing perch	0.2 – 0.5	20	80	7,000 – 10,000	15,000
4. Gourami	0.5	20 –100	80	8,000	10,000
5. Carp				6,000	8,000
6. Sandgoby				8,000	12,000
7. Shrimp				7,000	10,000

Note: US $ 1.00 = 13 845 VND

Table 12. Socio-economic characteristics of Binh An – Thanh Loi Hamlet, 1998

Population	6 799
Male	3 390
Female	3 409
Labour Force	1 674
Male	1 226
Female	448
Total Land Area	765.8 ha
Agricultural Land Area	733 ha
Rice field	(721.4 ha)
Orchard	(11.6 ha)
Houses	32.8 ha
Agricultural Production	8 865 tons $year^{-1}$
Rice	8 657 tons $year^{-1}$
Other Crops	208 tons $year^{-1}$
Population Density	
Population Growth Rate	2.0% (1997-1998)
Natural growth (from birth)	1.5% (1997-1998)
Artificial growth (from migration)	2.5% (1997-1998)
Number of Households	1 151
Poor households	228
Landless households	69

Source: Personal communication with Binh An – Than Loi head of hamlet

Table 13. Issues and practices affecting the fisheries sector, Binh An – Thanh Loi (October 1998)

Issues	Management Intervention	Level of effectiveness	Reason for effectiveness / ineffectiveness
1. Over-fishing	education	effective	people respond to authority
2. Inappropriate exploitation patterns			
3. Use of destructive fishing practices	change gear loan and credit education	effective effective effective	other people respond to authority
4. Flooding			
5. Habitat degradation / destruction			
6. Reduced biodiversity			
7. Agro-ecological loading			
8. Domestic / sewage pollution			
9. Insufficient / ineffective law enforcement			
10. Level of education			
11. Poverty			
12. Migration			

Table 14. Management interventions, level of effectiveness, and degree of acceptance, Binh An – Thanh Loi (October 1998)

Management interventions		Level of effectiveness	Reason	Degree of effectiveness	Reason
Regulation of activities	**Intervention instruments**				
1. Limited entry	fish conservation zone	effective			
	enforcement of regulations and penalties	very effective	appropriate to situation		
2. Restricted fishing activities	ban on destructive fishing practices	effective			
3. Regulated farming activities	control of chemical applications	effective	recognized	moderate	less inputs implies lower yield

Table 15. Policies, regulations, ordinances and laws related to fishery, Binh An Thanh Loi (October 1998)

Policies related to fishery	Effectiveness	Factors	Regulations violated	Type of violation	Penalty	Recommendations for improved enforcement
Rules on fishing operations	ineffective		ban on destructive device	electrical fishing	do not know	hamlet authority doesn't have the right to fine

Table 16. Conditions of the fishery resources, Binh An Thanh Loi (October 1998)

Changes on the resource and its users	Fish population	Number of fishes	Factors affecting fish population	Fishing as a lucrative employment	Need to manage the fisheries sector	Steps to stabilize fish population
	decrease	decreasing	weather illegal fishing pollution overfishing		Yes	Modify fishery to fish only certain species Modify fishery to fish only certain times Strictly enforce fishing regulations on illegal fishing in certain areas
	decrease	increasing	fish culturing / cages illegal fishing overfishing		Yes	Culture fish
Many fishermen	decrease	decreasing			Yes	Culture fish Weather Habitat protection
Water turns greener this year (maybe due to phytoplankton; if brown, more sediment	decrease	increasing	weather number of fishes fish culturing / cages		Maybe	Culture fish Set-up reserves with no fishing of any sort Strictly enforce fishing regulations on illegal fishing everywhere Strictly enforce fishing regulations on illegal fishing in certain areas

Table 17. Existing organizations, Binh An – Thanh Loi (October 1998).

Organizations	Formal*	Involved in fisheries	Level	Category
1. Hamlet people's committee	Yes	Yes	Hamlet	government organization
2. Farmer's organization	No	No	Hamlet	non-government organization
3. Women's organization	No	No	Hamlet	non-government organization
4. Youth's club	No	No	Hamlet	non-government organization
5. Police / local military	Yes	Yes	Hamlet	government organization
6. Extension	No	No	Hamlet	non-government organization
7. Veterans	No	No	Hamlet	non-government organization
8. Elders	No	No	Hamlet	non-government organization

*Formal organizations are government organizations that have real authority and power; members become government officials (Mr. Nguyen Hun Thien, CTU).

Table 18. Activities of the organizations, Binh An Thanh Loi (October 1998)

Organization	Main objectives of the organization	Activities engaged in by the respondents	Effectiveness	Contributing factors to effectiveness	Administrative structure	Years of existence	Number of members
1. Hamlet people's committee		administrative and technical work in the association / organization		extension program e.g. IPM; transfer of technology		13 (1985)	from 500 to 1171
2. Farmer's organization	extension; community organizing	administrative and technical work in the association / organization	effective	willingness of the workers	national provincial district village hamlet	23 (1975)	700 (total household s = 1400)
3. Women's organization	Family planning; community organizing	administrative and technical work in the association / organization	effective	willingness of the workers	national provincial district village hamlet	23 (1975)	1000

Table 19. Fish production and consumption, Binh An-Thanh Loi, October 1998

Fish species	Catch/trip (kg/day)	*Consumed* (%)	Sold	Price/kg (VND)	
				Landing site	Retail market
Snakehead murrel	1 - 7	10	90	10 000 – 15 000	11 000 – 17 000
Yellow catfish	5 - 7			15 000	
Climbing perch	5 - 30	5	95	4 000 – 15 000	
Three-spot gourami	5 - 7			15 000 - 20 000	
Common silver barb/tinfoil barb	3 - 7			10 000 - 20 000	12 000
Freshwater shrimps	5 - 10			6 000 - 10 000	11 000
Common carp	10 - 1 000	0.2 - 5	95 - 99.8	9 - 2 500	12 000
White lady carp	300 - 500	5	95	1 500	1 500
Common silver carp	2 - 15	5	95	10 000	

Note: US$ 1.00 = 13 845 VND

Table 20. Comparison of the bio-physical and socioeconomic profile between Loi Du-B and Binh An-Thanh Loi, Vietnam, October 1998.

CHARACTERISTICS	LOI DU – B (Hamlet)	BINH AN – THANH LOI (Hamlet)
I. Administrative structure		
1. Province	Can Tho	An Giang
2. District	Can Tho	Chau Phu
3. Village	An Binh	Vinh Thanh Trung
II. Bio-physical resources		
1. Total land area (ha)	162.38	765.8
A. Agricultural		
1. Land area (ha)	157.17	733
a. rice area	92.96	721.4
b. orchard	64.21	11.6
2. Total Production (tons/year)	1027	8865
a. Rice	1023 (11 t/ha/3crops)	8657 (12 t/ha/2 crops)
b. Other crops	4	208
3. Type of water regime	Semi-deep	Deep
4. Number of rice cropping seasons	3	2
B. Fisheries		
1. Fishing grounds	River, ricefield, Rau Ram Channel	River, ricefield, canal, Binh An-Thanh Loi Channel
2. Commonly caught fish species	Snakehead (Channidae), catfish , climbing perch (Anabantidae), gourami (Belontiidae), carp (Cyprinidae), sandgoby, shrimp	Snakehead, catfish, climbing perch, gourami, common silver barb, freshwater shrimps, carp, white lady carp, common silver carp
3. Fishing seasons		
a. peak months	September – November	August – January
b. lean months	December – August	February – July
III. Socio-economics		
1. Population	2,984	6,799
a. male	1,383	3,390
b. female	1,601	3,409
2. Population density (persons per ha)	18.4	8.87
3. Growth rate	1.3% (1997-1998)	2.0% (1997-1998)
a. natural (from birth)	1.1% (1997-1998)	1.5% (1997-1998)
b. artificial (from migration)	1.6% (1997-1998)	2.5% (1997-1998)
4. Number of households	629	1,151
a. poor households	15 (2% of total households)	228 (20% of total households)
b. landless households	14	69
5. Main occupation	Farming	Fishing
6. Labour force	874	1,674
a. male	696	1,226
b. female	178	448

Table 21. Common issues affecting fisheries sector and management interventions in Loi Du-B and Binh An-Thanh Loi, October 1998

ISSUES	MANAGEMENT INTERVENTIONS	
	LOI DU-B	BINH AN-THANH LOI
1. Over fishing	• Education • Ban for over fishing • Penalty	• Education
2. Agro-ecological loading	• Education • Integrated pest management (IPM)	
3. Inappropriate exploitation patterns	• Education • Penalty/punishment	
4. Domestic/sewage pollution		
5. Use of destructive fishing practices	• Fine • Education	• Change fishing gear • Education

Appendix 1

Institutional and Management Systems Key Informant Survey Questionnaire

ASSESSMENT OF THE CONTRIBUTION OF AQUATIC RESOURCES IN THE MEKONG RIVER BASIN TO FOOD AND NUTRITIONAL SECURITY OF THE FISHING AND FARMING POPULATION

KEY INFORMANT QUESTIONNAIRE
(INSTITUTIONAL AND MANAGEMENT SYSTEMS)

A. BACKGROUND INFORMATION

A.1 Name of respondent:

_____

A.2 Address:

_____

A.3 Age: _____ A.4 Sex: 1 ___ Male 2 ____ Female

A.5 Civil Status: 1 ___ Single 4 ___ Divorced/separated

2 ___ Married 5 ___ Others, specify _____

3 ___ Widow/widower

A.6 Educational attainment:

0 ___ No schooling

1 ___ Elementary level

2 ___ Elementary graduate

3 ___ High school graduate

4 ___ College level

5 ____ College graduate

6 ____ Vocational level

7 ____ Graduate studies level

8 ____ Finished graduate studies

B. AWARENESS OF FISHERIES-RELATED MANAGEMENT ISSUES AND INTERVENTIONS

B.1 What are the major issues or constraints affecting the fisheries sector in your hamlet? Check multiple responses in the table below. (ENCIRCLE THE APPROPRIATE CODE)

Key issues/constraints			
1. Overfishing	1	2	3
2. Inappropriate exploitation patterns	1	2	3
3. Use of destructive fishing practices	1	2	3
4. Small- and large scale fisheries conflicts	1	2	3
5. Post-harvest losses	1	2	3
6. Siltation/sedimentation	1	2	3
7. Soil Erosion	1	2	3
8. Flooding	1	2	3
9. Habitat degradation/destruction	1	2	3
10. Reduced biodiversity	1	2	3
11. Agrochemical loading (pesticides, herbicides)	1	2	3
12. Domestic/sewage pollution	1	2	3
13. Inadequate technical extension support	1	2	3
14. Limited institutional funding (loans and credits)	1	2	3
15. Insufficient/ineffective law enforcement	1	2	3
16. Level of education	1	2	3
17. Poverty	1	2	3
18. Migration	1	2	3
19. Lack of hamlet coordination and solidarity	1	2	3

Codes:

1 – Identified by respondent (R) without probing

2 – Identified by R with probing

3 – Not identified by R

B.2 What are the management interventions pursued to remedy the above problems cited above. How effective are they being implemented? What are the factors that contribute to the success/failure of implementation?

Issue/management intervention	Source	Level of effectiveness	Reason
Issue 1 _____ Management interventions: _____ _____ _____ _____			
Issue 2_____ Management interventions: _____ _____ _____ _____			
Issue 3_____ Management interventions: _____ _____ _____ _____			

Issue 4_____ Management interventions: _____ _____ _____			
Issue 5_____ Management interventions: _____ _____ _____ _____			

Source of awareness:
0 - Own observation
1 - Hamlet
2 - GO (government) officials
3 - NGO (non-government) officials
4 - Friends
5 - Relatives
6 - Media (radio, TV, print)
7 - Others, specify _____

Codes for level of effectiveness:
1 - Very effective
2 - Effective
3 - Not so effective
4 - Effective at first, but ineffective later
5 - Ineffective

B.3 Do you know if the following management interventions are being implemented in this hamlet? (ENUMERATE ONLY INTERVENTIONS WHICH WERE NOT MENTIONED BY THE RESPONDENT IN B.2)

Issue/management intervention	Level of effectiveness	Reason	Degree of acceptance	Reason
Limited entry and regulated fishing activities - fish conservation zone - enforcement of regulations and penalties - enhancement of alternative livelihood				
Restrictions - ban on destructive fishing practices - ban on destructive gears - seasonal closures				
Improvement of marketing and post-harvest facilities - strategic rural road infrastructure - extension, training and credit Support				
Enhancement of awareness and participation of stakeholders - current participation in the decision-making process - any desire to participate - participation in management of aquatic resources				
Reduction of environmental impacts - control of toxic chemical application - introduction of biological pest control - education/awareness program				
Institutional strengthening and upgrading - technical personnel and facilities upgrading - improvement of financial capability and mandates of the organizations - enhancement of organizational coordination/collaboration				
Enhancement of research and information - harvestable size of fish - set aside areas for fish sanctuaries - resource enhancement and habitat rehabilitation techniques - selective fishing depending on species				

Codes for level of acceptance:

1 - High level of acceptance by hamlet
2 - Moderate level of acceptance by hamlet
3 - Low level of acceptance by hamlet
4 - Rejected by the hamlet
5 - Opposed by the hamlet
6 - Do not know/No opinion

C. ORGANIZATIONAL SYSTEMS

C.1 What are the organizations existing in your hamlet?

1 _____
2 _____
3 _____
4 _____
5 _____
6 _____
7 _____
8 _____
9 _____
10 _____

C.2 Which organizations are engaged in fisheries?

1 - Engaged in fisheries = _____
2 - Not engaged in fisheries = _____
3 - Do not know = _____

C.3 Which are formal (legally organized groups) and which are informal?

1 - Formal = _____
2 - Informal = _____

C.4 To what level do they belong (Hamlet, Provincial, Regional, National, International)

C.5 (FOR FORMAL GROUPS): Which category do they belong?

1 - GOs (government organizations)
2 - NGOs (nongovernment organizations)
3 - POs (People's groups, e.g. farmer's union)
4 - Private interest groups (e.g. farmer's club)
5 - Others, specify _____

C.6 Which organizations are you a member of?

_____

C.7 What activities are you engaged in? (Referring to memberships in C5.)

1 - Administrative and technical work in the association/organization
2 - Building and maintenance of fish sanctuaries
3 - Imposition of laws and ordinances and monitoring of violators
4 - Participation and role in alternative livelihood projects
5 - others, specify _____

C.8 What are the main objectives of these organizations?

C.9 How would you assess the effectiveness/ineffectiveness of each of the above organizations in achieving their objectives?

C.10 What are the factors that contribute to the effectiveness/ineffectiveness of each of the above organizations in achieving their objectives?

C.11 What is the organization's administrative structure?

C.12 How long has the organization been in existence?

C.13 How many members are there in this organization?

C.14 What are the benefits of being a member of this organization?

C.15 Is the membership increasing or decreasing?
1 – Increasing 2 – Decreasing 3 - No change

C.16 What are the organizations' technical, manpower and financial resources?

C.17 How is the organization affiliated with other organizations vertically and horizontally?

Summary of Information for different organizations:

C1. Name of Organization	C2 Fisheries?	C3 Formal?	C4 Level	C5 Category	C6 Membership	C7 Activities	C9 Effectiveness	C10 Factors

FOR ORGANIZATIONS RELATED TO FISHERY:

C18 Policies, programs, regulations, laws and ordinances	C19 Effectiveness (See Codes Below)	C20 Factors
Property rights in terms of access, withdrawal, management, exclusion and transfer 1._____ 2._____ 3._____		
Operational rules that pertain to authority 1._____ 2._____ 3_____		
Regulatory mechanisms (e.g. quota, closed season, etc.): 1._____ 2._____ 3._____ 4._____		
Penalties/Incentives (e.g. taxation, licensing, fines.): 1._____ 2._____ 3._____		

Codes for C19
1 - Very effective
2 - Effective
3 - Not so effective
4 - Effective at first, ineffective later
5 - Ineffective

C21 What regulations are violated?	C22 What is the type of violation?	C23 How much is the Penalty	C24 Recommendations for improved enforcement

D. AWARENESS OF THE CONDITION OF THE FISHERIES RESOURCES

D.1 What changes in immediate aquatic environment of the hamlet and of neighboring hamlets have you observed?

a. Physical appearance: _____
_____
_____

b. Fish productivity:

1 - Increase
2 - Decrease
3 - Remains the same
4 - Seasonal, elaborate: _____
5 - Others, specify: _____

c. Number of fishers

1 - Increase
2 - Decrease
3 - Remains the same
4 - Others, specify: _____

(IF ANSWER TO D1.B IS INCREASE OR DECREASE, ASK :)

D.2 What factors have contributed to the increase/decrease in fish population? (ENCIRCLE ALL THAT APPLIES)

1 - Laws and ordinances : (in what way?) : _____
_____
_____

2 - Fish sanctuaries
3 - Weather
4 - Number of fishers
5 - Fish culturing/cages
6 - Habitat protection
7 - Illegal fishing
8 - Pollution
9 - Overfishing
10 - Others, specify _____

D.3 Do you feel optimistic that fishing will still be a lucrative source of employment?

1 - Yes
2 - No

D.4 Do you see a need to manage the fisheries sector?

1 - Yes
2 - No
3 - Maybe
7 - Do not know
8 - Others, specify

D.5 If No to D.4, why not?

D.6 If Yes to D.4, what practical steps would stabilize the fish population?

1 - Culture fish
2 - Modify fishery to fish only certain species
3 - Modify fishery to fish only certain times
4 - Modify fishery to rotate harvest areas
5 - Set up reserves with no fishing of any sort
6 - Strictly enforce fishing regulations on illegal fishing everywhere
7 - Strictly enforce fishing regulations on illegal fishing in certain areas
8 - No opinion/Do not know
9 - Others, specify _____

Table D. Protected aquatic areas

D7. Are there protected aquatic areas in your hamlet?	D8. Location	D9. Date established	D10. Status (See Codes Below)	D11. Awareness (See Codes Below)
Fish sanctuary				

Codes for D.10
1 - Existing
2 - Non-existing
3 - Abandoned
4 - Partly damaged
5 - Do not know
6 - Others, specify _____

Codes for D.11
1 - Yes
2 - No
3 - Maybe
4 - Do not know

E. AWARENESS OF LIVELIHOOD PROGRAMS

E1. Livelihood Activities supported by Social Credit	E2. Effectiveness (See Codes Below)	E3. Problems
Piggery		
Sari-sari store		
Fish vending		
Rice trading		
Transportation		

Codes for E2
1 - Very effective
2 - Effective
3 - Not so effective
4 - Effective at first, ineffective later
5 - Ineffective

Appendix 2

Market Systems Key Informant Survey Questionnaire

ASSESSMENT OF THE CONTRIBUTION OF AQUATIC RESOURCES IN THE MEKONG RIVER BASIN TO FOOD AND NUTRITIONAL SECURITY OF THE FISHING AND FARMING POPULATION

KEY INFORMANT QUESTIONNAIRE
(MARKET ATTRIBUTES)

A. BACKGROUND INFORMATION

A.1 Name of respondent:

_____

A.2 Address:

_____

_____

A.3 Age: _____ A.4 Sex: 1 ___ Male 2 ____ Female

A.5 Civil Status :

1 ___ Single
2 ___ Married
3 ___ Widow/widower
4 ___ Divorced/separated
5 ___ Others, specify _____

A.6 Educational attainment:

0 ___ No schooling
1 ___ Elementary level
2 ___ Elementary graduate
3 ___ High school graduate
4 ___ College level
5 ___ College graduate
6 ___ Vocational level
7 ___ Graduate studies level
8 ___ Finished graduate studies

B. FISH PRODUCTION AND ALLOCATION OF FISH EFFORT

B1 Species caught in your hamlet	B2 Catch/trip (kg)	B3a % discarded	B3b % consumed	B3c % sold	B4a Price/kg (landing site)	B4b Price/kg (market)

B.5 What are the common fish substitutes in an average household diet in your community?

1. _____
2. _____
3. _____
4. _____

B.6 Are the fish prices affected by the changes in prices of substitutes, such as chicken and pork?

1 - Yes
2 - No
3 - Do not know

B.7 What are the determinants of price?

1 - Quality of fish
2 - Volume landed
3 - Seasonal factors
4 - Price of fish dictated by brokers
5 - Marketing costs
6 - Others, specify _____

B.8 What are the ways of setting prices?

B.9 What are the types of crafts and gears used in fishing in this hamlet?

a. Craft
   1 - Small boat, motorized
   2 - Small boat, non-motorized
   3 - _____
   4 - _____
   5 - _____
   6 - _____
   7 - Do not know
   8 - Others, specify _____

b. Gears
   1 - Drift gillnet
   2 - Handline
   3 - Trawl net
   4 - Clift net
   5 - Cash net
   6 - Barrier net
   7 - Encircling net
   8 - Gill net
   9 - Stow net
   10 - Longline
   11 - Trap net
   12- Sock-electricity gears
   13- Others: _____

B.10 Where do the fishers in your community fish?

B.11 Has there been a shift in fishing areas?

1 - Yes
2 - No

IF YES TO B.11

B12 - Shifting FROM which fishing ground TO which fishing ground	B13 - When did shifting start to happen	B14 - Reasons for shifting

B.15a What months of the year constitute the peak season for fishing? B.15b What about the lean months?

Peak months: _____
Why are these considered the peak months

Lean months: _____
Why are these considered the lean months

Fishing ground	B16a Distance (peak)	B16b Distance (lean)	B17a No. of hours/day (peak)	B17b No. of hours/day (lean)	B18a No. of days/month (peak)	B18b No. of days/mont h (lean)

B.19 Is the per capita demand for fish and other sea foods changing?

1 - Increasing
2 - Decreasing
3 - Remains the same
4 - Others, specify
7 - Do not know

B.20 What are the reasons for the pattern of change in the demand for fish?

C. MARKET FUNCTIONS:

C1. How is the fish catch stored (e.g. fresh, frozen, processed)?

1- _____
2- _____
3- _____
4- _____

C2. How is the fish catch packaged (e.g. iced, salted)?

1 - _____
2 - _____
3 - _____
4 - _____

C3. How is the fish catch transported (e.g. boat, truck)?

1 - _____
2 - _____
3 - _____
4 - _____

C4. Are fish graded/classified? How?

_____
_____
_____

C5. What are the marketing facilities?

1 - Transportation/road networks
2 - Landing sites
3 - Others, specify

D. MARKET STRUCTURE AND ORIENTATION

D.1 What are the types of fishers in the hamlet?

1 - Subsistence
2 - Commercial
3 - Others, specify

D.2 What are the different types of fish traders in the hamlet?

1 - _____
2 - _____
3 - _____
4 - _____

D.3 What are the traditional marketing arrangements?

D.4 Is there a credit-marketing relationship between fisher and fish trader?

IF YES, explain or elaborate.

D.5 What are the problems in marketing fish?

1 - _____
2 - _____
3 - _____

D.6 What are the constraints in marketing processed other fish products?

1 - _____
2 - _____
3 - _____

Appendix 3

In-House Training on Agro-Ecosystem Mapping

INTERNATIONAL CENTER FOR LIVING AQUATIC RESOURCES MANAGEMENT
POLICY RESEARCH AND IMPACT ASSESSMENT PROGRAM
28 July – 1 August 1998
Can Tho University

In-house Training on Agroecosystem Mapping

Schedule

28 July AM Lectures I – IV; PM Lectures V - VI

29 July - Can Tho

30 July - An Giang

31 July - visit to government agencies to retrieve relevant data/information in Can Tho

1 August - data compilation and analysis

OUTLINE IN AGROECOSYSTEM ANALYSIS AND MAPPING

I. Objectives of the training
II. Define Agroecosystem
III. System properties
IV. Factors affecting system properties
V. Agroecosystem methodologies and mapping
VI. Exercises (questionnaires)
VII. References

TRAINING LECTURE ON AGROECOSYSEM ANALYSIS AND MAPPING*

Can Tho University

28 July – 1 August 1998

I. Objectives of the Training

1. To learn the basic concepts in agroecosystem analysis.
2. To practice agroecosystem mapping and gain enough skill to perform this at the project sites.
3. To appreciate multidisciplinary approach/team work in agroecosystem mapping.
4. To identify problems and opportunities that future research efforts could address as a result of the compilation of a village transect.

II. Overview and definition of agroecosystem

Agriculture and the environment are linked together to provide the basic needs of the people. Resources of land, water, sunlight and the biological organisms are factors we depend on for agricultural production. In the process of agricultural development, we introduce improved varieties of plants and animals, pesticides, fertilisers and agricultural machinery's. Interaction of these elements with the environment may cause adverse effects such that the natural resources essential to agricultural production are harmed or destroyed (e.g. excess pesticide application hitting non-target organisms or seepage to groundwater).

Interaction of man on the environment also creates conflicts in terms of resource use and allocation. Natural resources are not evenly distributed and most of the time they are not present in large quantities and good quality where human population is densest. Thus development does not only entail maximizing the productivity of natural resources but sharing of the resources and their productivity should also be taken into consideration.

Development requires a multidisciplinary approach since this is an integration of a wide range of skills and knowledge. For example, introduction of high-yielding rice varieties

* Main reference: Conway, G.R. and P.E. Sajise. 1985. The Agroecosystems of Buhi: Problems and Opportunities. Proceedings of the Buhi Agroecosystems Analysis Workshop, 14 – 18 November 1985, Naga City, Philippines.

requires scientists with genetics, plant pathology, agronomy and entomology background among others. Likewise, the concept of agroecosystem is a marriage between the agricultural sector and the environment (physical and social), i.e. it deals with all levels in the hierarchy of agroecosystems, from field through farm, village and watershed, to region and nation. Agroecosystem also provides a technique of analysis and packages of technology that focus not only on productivity, but also, explicitly on other indicators of performance – stability, sustainability and equitability – and on the trade-offs between them (Conway 1986).

Agroecosystem is a part of the rapid rural appraisal and environmental mapping. Agroecosystems are ecological systems modified by human beings to produce food, fibre or other agricultural products. It is a complex of agro – socio – economic – ecological systems. The main goal of agroecosystem is to increase social value. Social value is a function of the amounts of goods and services produced by the agroecosystem, their relationship to human needs (or happiness) and their allocation among the human population (Conway 1987).

B. Definition of a system

System is an assemblage of elements contained within a boundary such that the elements within the boundary have a strong functional relationships with each other, but limited, weak or non-existent relationships with elements in other assemblages; the combined outcome of the strong functional relationships within the boundary is to produce a distinctive behaviour of the assemblage such that it responds to many stimuli as a whole, even if the stimulus is only applied to one part.

Figure 11 – example of a system – Mekong River Basin in Vietnam.

Systems higher in the hierarchy tend to control those beneath them and, most important for the task of analysis, the behaviour of higher systems is not readily discerned simply from a study of the behaviour of lower systems. **Figure 12** illustrates the hierarchy of agroecosystem.

Natural ecological systems are transformed into hybrid agroecosystems for the purpose of food or fibre production. Examples are ricefield ecosystem (**Fig. 13**) and lake ecosystem (**Fig. 14**).

III. System Properties

1. **Productivity** - the net output of valued product per unit of resource input. Common measures are yield or net income per hectare. Three basic resources are land, labour and capital, and to these may be added energy and technological inputs such as fertilisers and pesticides.

   Productivity may be measured as the mean or total over a period of time and may be static, increasing or declining. It may be high, equal or low with respect to similarly measured productivity's of other agroecosystems (**Fig. 15**).

2. **Stability** - is the constancy of productivity in the face of small disturbances caused by the normal fluctuations of the surrounding environment. The environment is regarded as the physical, biological, social, and economic variables lying outside the agroecosystem (**Fig. 16**).

   Measures of stability are yields or net incomes per ha or yields per man hour or yields per kg fertilizer, on a weekly, monthly or annual basis.

3. **Sustainability** - its ability to maintain productivity inspite of a major disturbance. Disturbance may be an intensive stress where stress is defined as a regular, sometimes continuous, relatively small and predictable that has a cumulative effect. A stress may be caused by acidity, toxicity or indebtedness (**Fig. 17**).

   A perturbation is an infrequent, relatively large, and unpredictable disturbance that has an immediate impact. A rare drought, flood, a new pest or the sudden collapse of a market are examples of perturbation (**Fig. 18**).

Stresses and perturbations may be natural or man made. E.g. pruning is a stress to an individual tree while the process of repeated harvesting is a stress to the field agroecosystem.

Sustainability, described in this way, is very similar to the resilience of an ecological systems. Agroecosystems, however, differ significantly from natural ecological systems in that they are all subject to a level of man-made inputs designed to produce a particular set of outputs. This significantly alters the way we look at their resilience properties. Thus sustainability is the resilience of a man manipulated ecological system, i.e., one subject to man-made inputs, and refers specifically to the resilience of the desired outputs, i.e., the productivity of the system (**Fig. 19**).

The most ubiquitous form of input to an agroecosystem is the subsidy, usually in the form of the application of fertilizer. A stress of perturbation to the system may then follow and the question is whether the productivity produced by the original input is maintained. If the disturbance is the process of harvesting then the productivity may only be regained by a further input, for example a renewed application of fertilizer. In this case the sustainability is only maintained by repeated inputs. However the input may be the introduction of a new kind of plant to the system, for example a nitrogen fixing, perennial legume. Then the productivity of the agroecosystem may be maintained without any further input (**Fig. 19**).

Another common form of input is of a control agent. For example an agroecosystem may be subject to stress from pests, which without intervention, will result in a drop in productivity. Use of a pesticide may restore the level of productivity but in the fact of further pest attack this will only be maintained by further pesticide applications. However, the introduction of a biological control agent, for example a parasitic wasp which attacks the pest population, may result in permanent control and hence a maintained productivity without further intervention. In both biological control and introduced perennial legume situations the agroecosystem may be regarded as intrinsically highly sustainable, at least with respect to pest control and nitrogen levels, respectively.

4. **Equitability** – is the evenness of distribution of the productivity among the human beneficiaries. Once again the productivity may be defined in any of the ways described above, but will be most commonly measured as the total yield or net income for the agroecosystem under consideration, i. e, the farm, the village or the nation. The human beneficiaries may be the members of the farm household or the villagers or the population of a nation. The productivity may be evenly shared among beneficiaries producing high equitability or may be unevenly shared, with some receiving more than others, and perhaps some receiving very little or none.

Figure 20 shows the factors affecting productivity, stability, sustainability, and equitability of a lakeside village agroecosystem.

IV. Factors Affecting System Properties

In general the main causes of low productivity are lack of inputs or resources, while the main causes of low stability are climatic and market fluctuations and the variable effects of pests and diseases. The factors affecting sustainability range from over-fishing and illegal logging to new pests and diseases. The equitability of the system is affected by the rights to cultivate land or to harvest trees or fish.

V. Agroecosystem Analysis and Methodologies

The steps of the procedure for agroecosystem analysis for research and development was described in **Fig. 21.**

Objective setting

Objective setting is where the result of the study will depend. Its aim is to define a very fine subclassification of the area that will reflect the dynamics of each agroecosystem based on various criteria. The objectives must be simple, precise and is acceptable to the whole team. As in our case, objective may be:

1. to map out aquatic resources and biological diversity and their characteristics; and
2. to provide extensive and in-depth baseline information which will aid in assessing the contributions of aquatic resources to food security and livelihood of the farming and fishing populations.

System Definition

This involves identification of systems, system boundaries and system hierarchies. This is subjective and tentative, i.e., the biological and physico-chemical boundaries are often clear (e.g lake – shoreline, river valley – extent of watershed; ricefield – bund) but the cultural and socioeconomic boundaries are more elusive (e.g. farm house – farm itself like cultivated land, the farm household member who derives his income from another place, or the sale of the produce may depend on distant markets). To address this, translate these factors into physical or geographic terms and elaborate the system hierarchies that link or combine systems whose boundaries are defined in different terms. The boundary can be revised as the activity proceeds and more information become available. This is so because all these things determine the key functional relationship of the system thus also determining the properties of the system.

Pattern Analysis

1. **Space** - Spatial patterns are most readily revealed by simple maps, transects and participatory mapping. Overlays are particularly useful in determining the different zones within an agroecosystem. A transect line is an imaginary line laid down cutting across different segments of the village/farm. Transects are useful in identifying the location of important problems and spatial relationships both between and within farms. Participatory mapping on the other hand, is the method by which villagers indicate relevant information on a map based on their knowledge of physical, biological, social and economic conditions/resources of their village.

2. **Time** - patterns in time are best expressed by simple graphs. Three patterns are important:
   a) Seasonal change and can be analysed by calendars in which cropping sequences, livestock and fishery cycles, labour, credit peaks, prices, etc. are graphed against various agrometeorological variables. This helps, in particular, identify those periods in the year where timing of operations and the availability of resources are critical for productivity and stability.
   b) Longer term changes, in prices, production, climate, demographic parameters, etc. can be graphed in a conventional manner (e.g. 10 years of data requirement). These reveal trends in productivity and a measure of stability,

possible time lags in the system and other causes of instability, and any signs of lack of sustainability.

c) The final pattern in time is of the response of important variables to stress and perturbation. Stresses, as defined earlier, include soil deficiencies and toxicities, pests, diseases and weeds, indebtedness, etc. Perturbations include major floods or droughts or a sudden outbreak of a pest or disease.

3. **Flow** - patterns of flows and transformations of energy, materials, money, information etc. in the agroecosystem. The sources of income and the nature of expenditure for each household are particularly important and these can be summarized by bar diagrams. Production and marketing patterns are also important and may be described by conventional flow diagrams that can also be used to trace out impacts of particular changes or innovations in an agroecosystem. The aim of producing flow diagrams, however, should not be trace out all the detailed relationships. Flows should be principally analyzed for the major causes and effects and for the presence of stabilizing and destabilizing feedback loops.

4. **Decisions** - Decisions, ranging from those of national agricultural policy to the individual farmer's day-to-day choices, occur at all levels in the hierarchy of agroecosystems. Two patterns are important:

   a) Choices of different livelihood systems made in a given agroecosystem under differing conditions and is best described by means of a decision tree. Construction of the tree helps to reveal both the goals of the farmer and the constraints on choice that are present in the agroecosystem.

   b) The second pattern is of the spheres of influence of individuals and institutions in decision making. Here the aim is to identify the critical decisionmakers and the extent to which they interact with one another. The degree of contact and overlap that occurs can be portrayed readily by Venn diagrams.

System Properties

This guides the form of pattern analysis and indicate the key relationships and decisions. This summarizes the relationships within the agroecosystem and the most important factors contributing to a relationship.

Table 1. Key variables and processes affecting the system properties of an agroecosystem.

POSITIVE		NEGATIVE
PRODUCTIVITY		
Factors increasing productivity		Constraints, limiting factors
STABILITY		
Stabilizing factors		Destabilizing factors
SUSTAINABILITY		
Processes preventing collapse		Stresses and perturbations
EQUITABILITY		
Factors increasing equitability		Factors producing inequity

Key Questions

Key questions which arise throughout the procedure must be noted down as they emerge and then collectively revised and reviewed by the team in the light of all the information available. It should be multidisciplinary in nature but at the same time highly focused.

Research Design and Implementation

As in any research hypotheses are tested by either a laboratory experiments or field exercises. In our case, field exercises or ground validation will be used to verify the result of each activity/procedure.

Agroecosystem Mapping Tasks **(Lightfoot et al, 1989)**

1. *Map of Topography and Hydrology* **(Fig. 22)**

- This map is made by eliciting from farmers every land type that they can distinguish and ascertain their spatial distribution on a base map of roads, homes, orchards and other landmarks (temples, tanks, etc.).
- Establishing land-type boundaries requires a considerable amount of walking around.
- Farmers are then requested to indicate flood and drainage directions and main water sources.

a. Materials and Requirements:
   1. base map – a map showing the extent/boundary of the village
   2. writing materials

Method:
- Participatory mapping

2. *Enterprise map* (Fig. 23)
- This map is made by asking farmers what enterprises they conduct on each land type.
- Major enterprises are typically crops, animals, fish and orchards. Special attention should be given to agricultural and non-agricultural enterprises in the busy housing areas.
- One must also be sensitive to gender differentiation in enterprises.

a. Materials and Requirements:
   1. base map
   2. relevant socioeconomic data

b. Methods:
   1. participatory mapping
   2. transect mapping

1. *Social groups* (Fig. 24)
- This map is made by asking farmers to name the castes or social groups living in the village.
- The spatial distribution of houses by caste is then sketched.
- Caste access to land areas and other important resources should then be demarcated.

a. Materials and Requirements:
   1. base map
   2. relevant socioeconomic data

b. Methods:

4. *Transect of village* **(Fig. 25)**

- This agroecological zones transect is constructed from a composite section through
  every land type. (They are not "true" walk-through transects.)
- For each land type the local name, soil type, crops, trees, livestock, fish, problems
  and opportunities are listed from information provided by the farmers.

a. Materials and Requirements:

1. base map

b. Methods:

1. transect mapping
2. field validation

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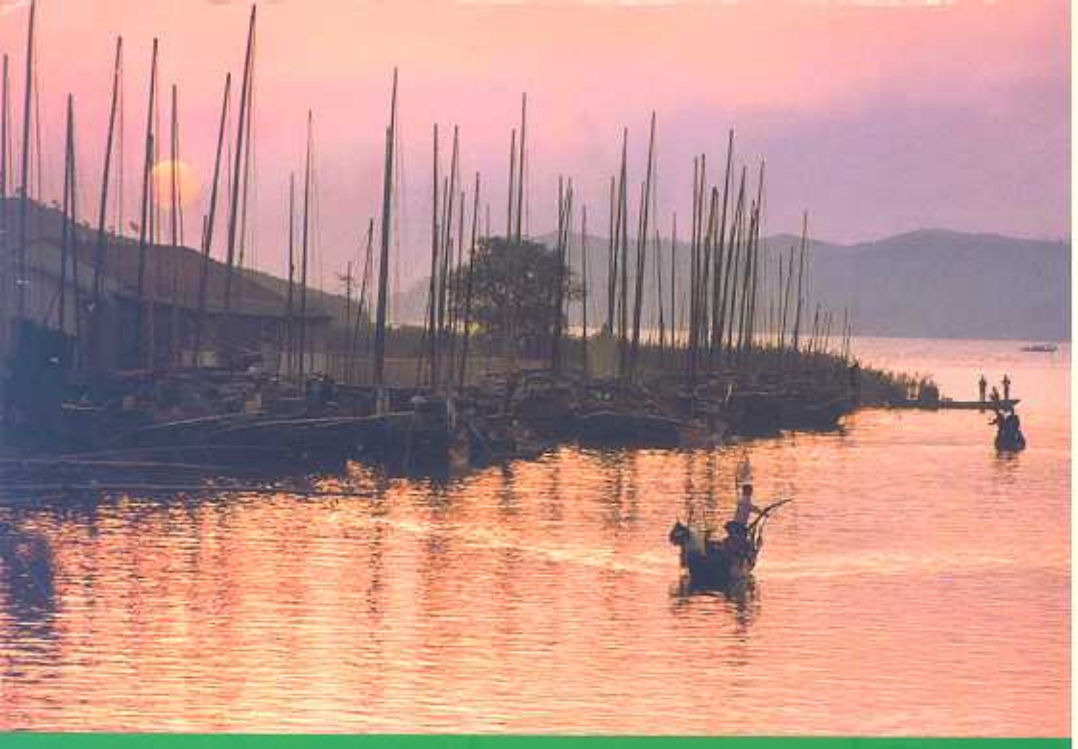

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