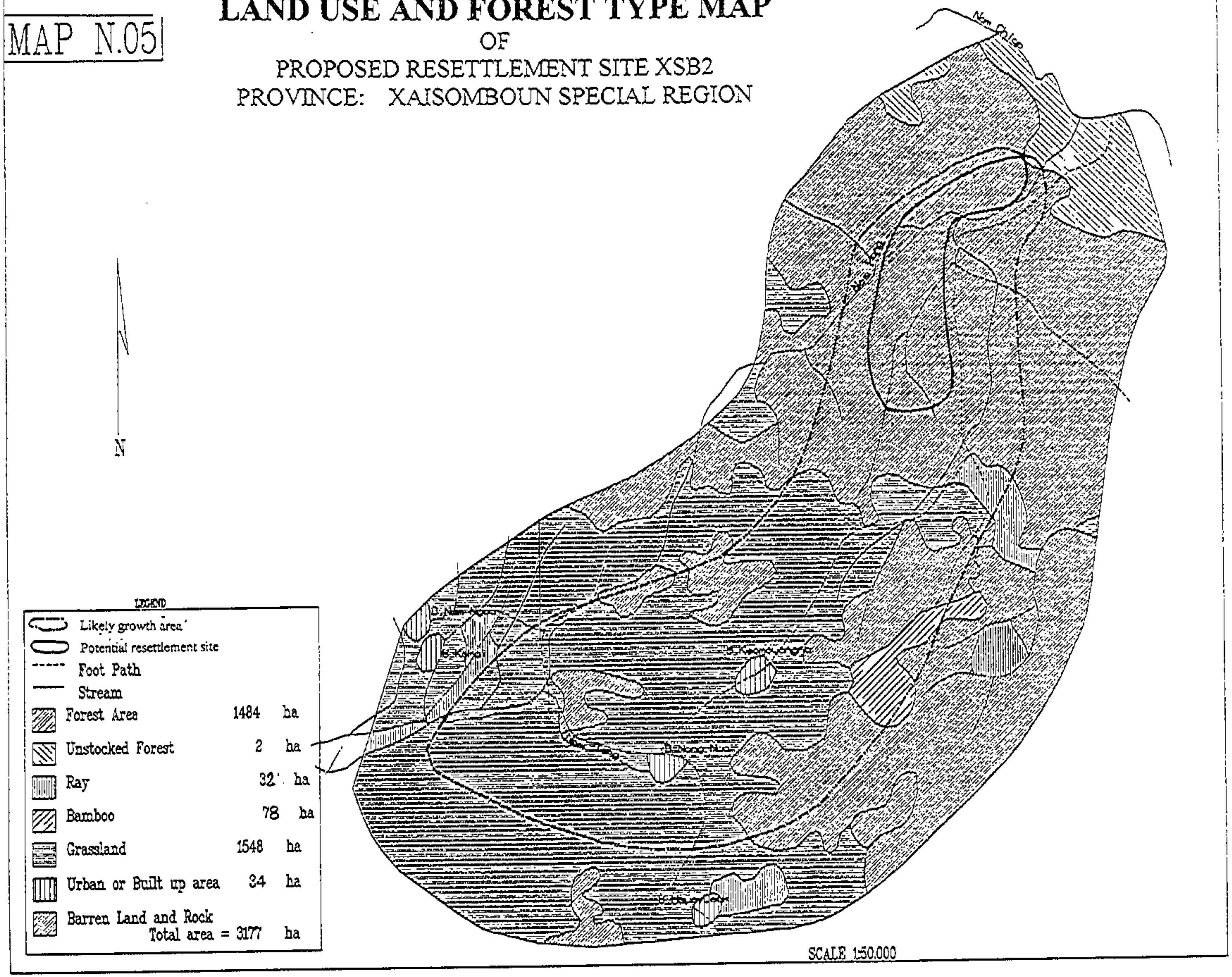
MAP N.05

LAND USE AND FOREST TYPE MAP

OF

PROPOSED RESETTLEMENT SITE XSB2

PROVINCE: XAISOMBOUN SPECIAL REGION



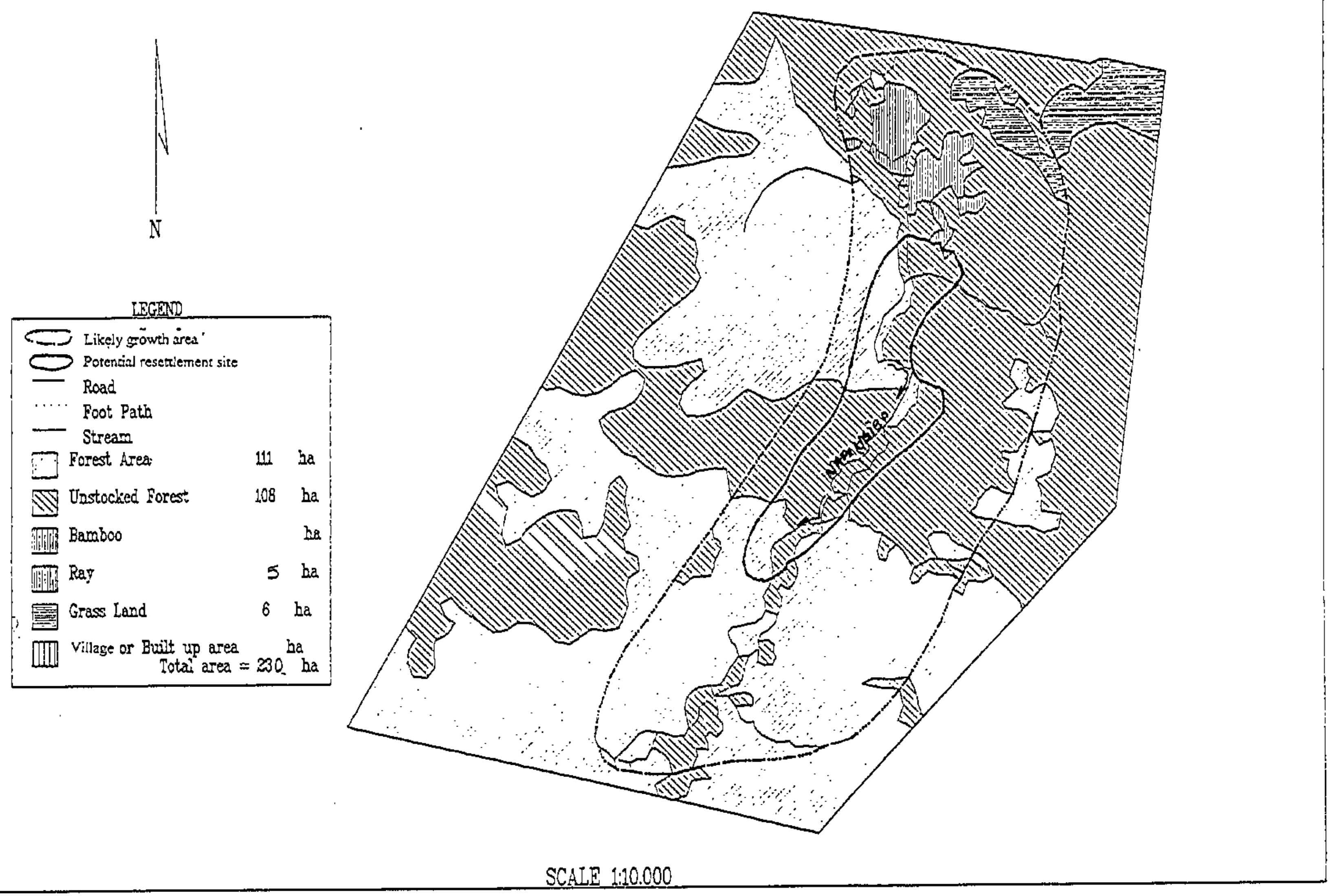
MAP N.06

LAND USE AND FOREST TYPE MAP
OF
PROPOSED RESETTLEMENT SITE XSB3
PROVINCE: XAISOMBOUN SPECIAL REGION

SCALE 1:25.000

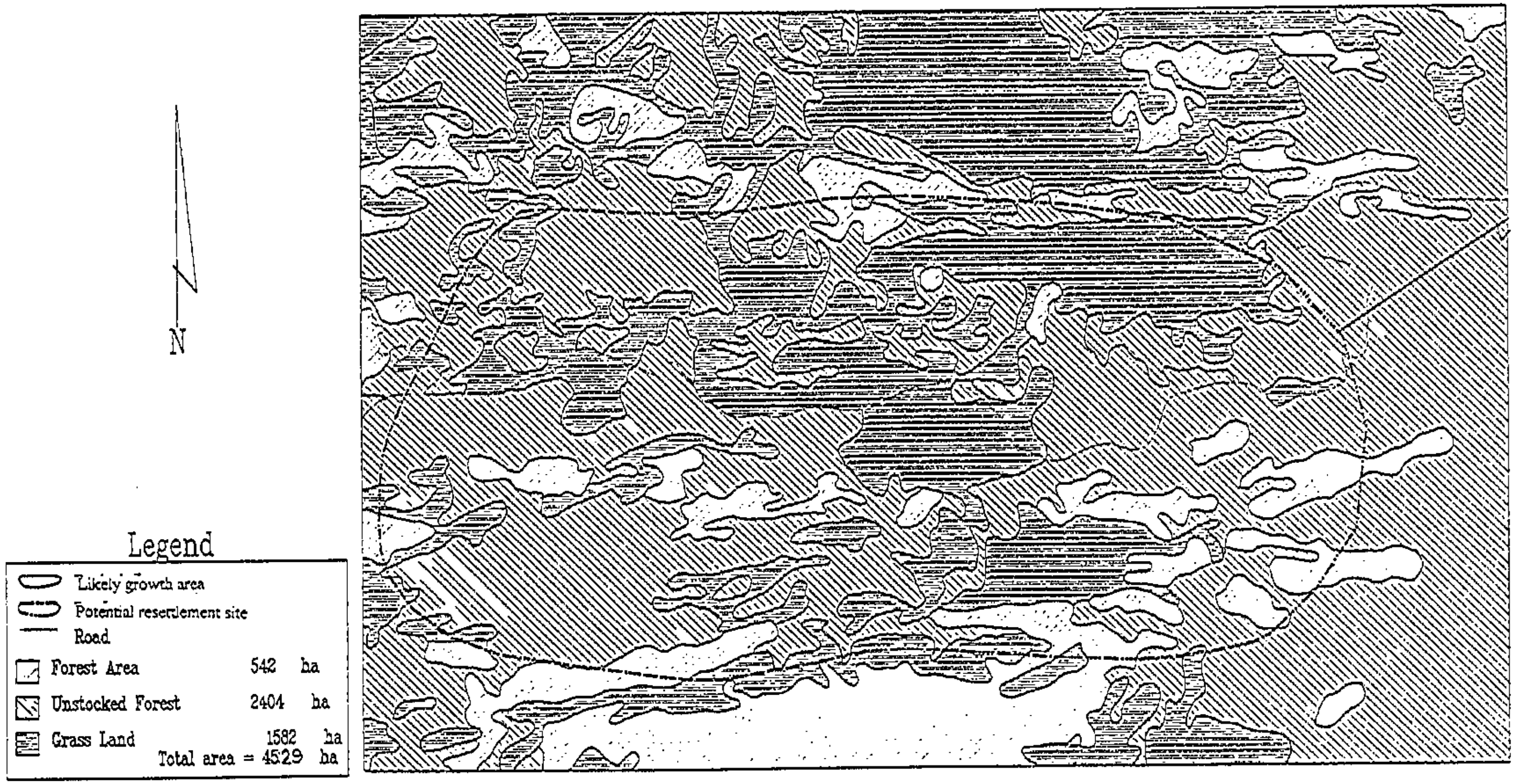
MAP N.07

LAND USE AND FOREST TYPE MAP
OF
PROPOSED RESETTLEMENT SITE XSB4
PROVINCE: XAISOMBOUN SPECIAL REGION



MAP N.08

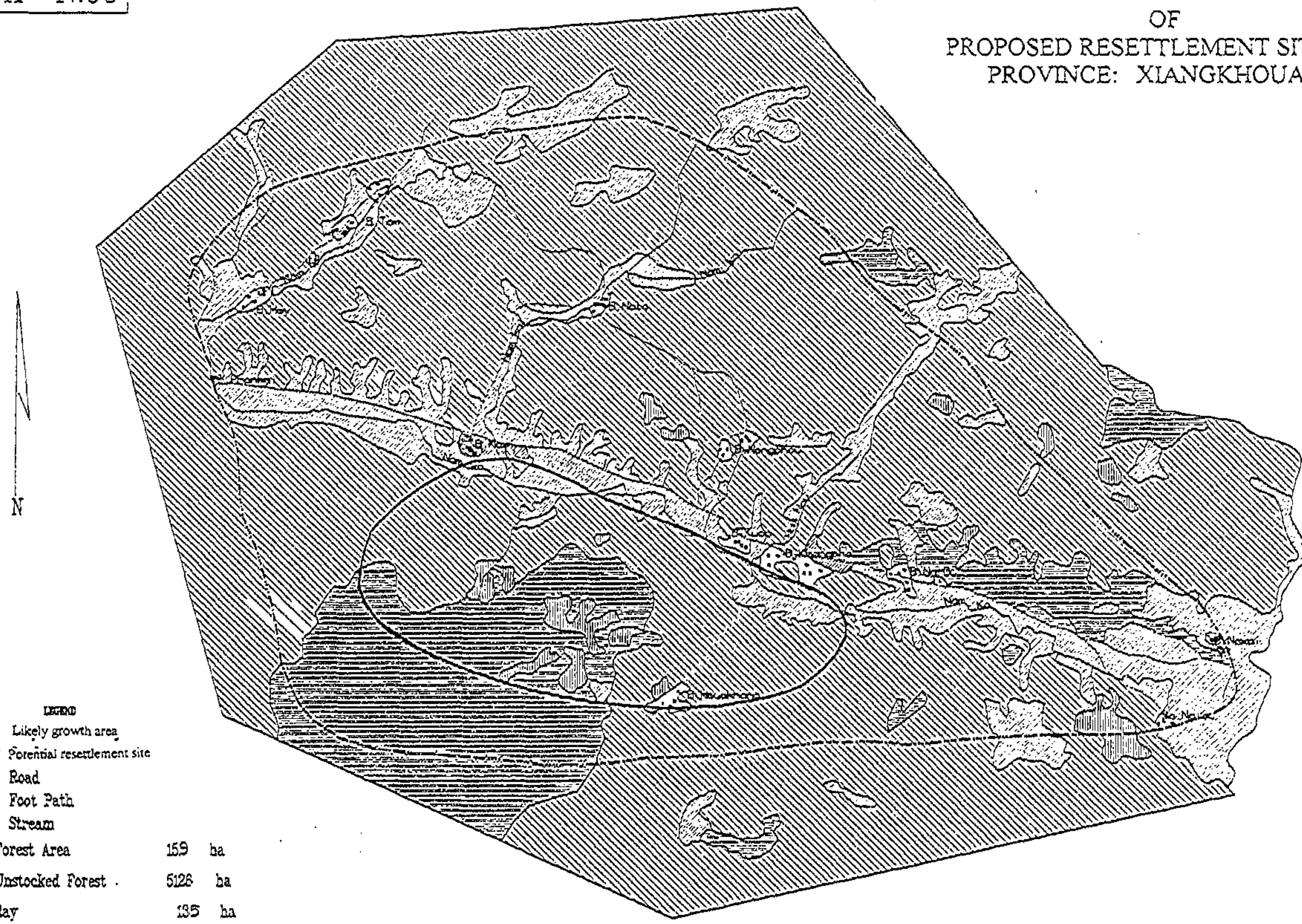
LAND USE AND FOREST TYPE MAP
OF
PROPOSED RESETTLEMENT SITE XSB5
PROVINCE: XAISOMBOUN SPECIAL REGION



Scale 1:50000

MAP N.09

LAND USE AND FOREST TYPE MAP
OF
PROPOSED RESETTLEMENT SITE XK1
PROVINCE: XIANGKHOUANG



LEGEND

- Likely growth area
- Potential resettlement site
- Road
- Foot Path
- Stream

Forest Area	159	ha
Unstocked Forest	5126	ha
Ray	135	ha
Rice Paddy	1153	ha
Grass Land	1115	ha
Water	13	ha
Village or Built up area	87	ha
Total area =	7789	ha

SCALE 1:50.000

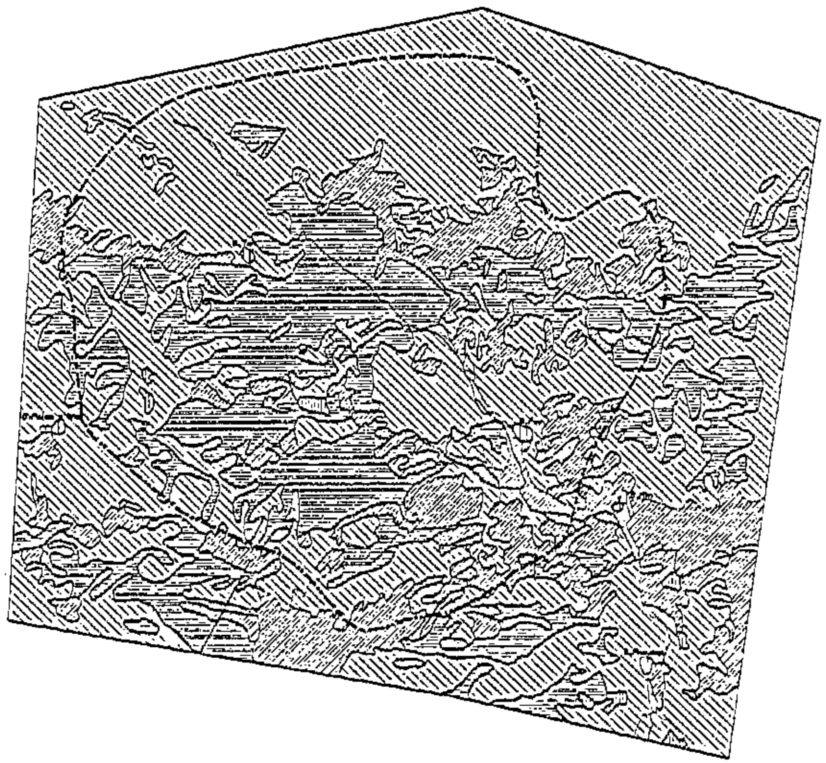
MAP N.10

LAND USE AND FOREST TYPE MAP
OF
PROPOSED RESETTLEMENT SITE XK2
PROVINCE: XIANGKHOUANG

LEGEND

Likely growth area		
Potential resettlement site		
Road		
Stream		
Forest Area	421	ha
Unstocked Forest	1177	ha
Ray	12	ha
Rice Paddy	38	ha
Grassland	690	ha
Village or Biult up area	4	ha

Total area = 2342 ha



SCALE 1:50,000

MAP. N.11

LAND USE AND FOREST TYPE MAP
OF
PROPOSED RESETTLEMENT SITE XK3
PROVINCE: XIANGKHOUANG

LEGEND

Likely growth area			
Potential resettlement site			
Foot Path			
Stream			
Forest Area	4003	ha	
Unstocked Forest	8274	ha	
Rice paddy	1986	ha	
Ray	1181	ha	
Swamp	71	ha	
Village or Built up area	226	ha	
Total area =	15742	ha	

N

SCALE 1:100.000

MAP N.11

LAND USE AND FOREST TYPE MAP
OF
PROPOSED RESETTLEMENT SITE XK3
PROVINCE: XIANGKHOUANG

N

LEGEND

Likely growth area		
Potential resettlement site		
Foot Path		
Stream		
Forest Area	4003	ha
Unstocked Forest	8274	ha
Rice paddy	1986	ha
Ray	1181	ha
Swamp	71	ha
Village or Built up area	225	ha
Total area =	15742	ha

SCALE 1:100,000

ANNEX - 5

CASE STUDY OF RESERVOIR FLOATING CAGE NET FISHERIES

A Case Study
on
The Saguling and Cirata Hydropower Reservoirs Model
for
Floating Net Cage Reservoir Fisheries in Resettlement

1. INTRODUCTION

From 1985-88 the Saguling and Cirata hydropower reservoirs in the densely populated highlands of West Java, Indonesia displaced over 40,000 families. As part of a comprehensive resettlement plan, the projects attempted to resettle 3,000 families in water-based, floating fish cage aquaculture. In addition, they attempted related land-based aquaculture (1,500 families in each reservoir). The projects carried out a four-year program of aquaculture research, demonstration, extension, and training programs with over 4,000 displaced farming families. This program included:

- Organization of traditional courses (adoption/diffusion methods);
- Formation of fish farmers associations;
- Hands on, participatory research with farmers;
- Establishment of community schools in villages having the highest numbers of displaced residents;
- Farmer-to-farmer visits;
- Publishing farmer workbooks in the local language; and
- Arranging study tours to other Asian nations with relevant experiences.

By end 1992, fish cage aquaculture and other aquaculture support systems in and around the Saguling and Cirata reservoirs employed 7,527 persons. At the end of 1996, total aquaculture production was 24,496 metric tons (approximately 95% common carp, Cyprinus carpio and 5% hybrid red tilapia, Oreochromis spp.). This amount of fish was over 20% of the total amount of fish estimated to be entering the Bandung District (population and estimated 3 million persons). Total 1996 gross revenue from fish was over US$24 million, over twice the estimated annual revenue ($10.4 million adjusted for inflation to 1996) from the 5,783ha of ricelands lost to the reservoirs by the dams.[1]

The World Bank funded Saguling-Cirata Reservoir Project was the first to demonstrate the potential of a planned, "ecosystems" approach to resettlement fisheries. This environmentally oriented resettlement effort fully utilized the new water surface for aquaculture and captures fisheries and captures fisheries and developed supporting production, economic, and marketing infrastructure. More new jobs were created in the support industries for reservoir fisheries than

[1] Costa-Pierce, Barry A. 1998. *Constraints to the Sustainability of Cage Aquaculture for Resettlement from Hydropower Dams in Asia: An Indonesian Case Study*. Posted on the Internet: http://darwin.bio.uci.edu/~sustain/indo.html. Irvine, CA: University of California, Department of Environmental Analysis and Design.

in the fisheries themselves.[2]

As pointed out in a World Bank technical paper on developing reservoir aquaculture for people displaced by dams, the view of reservoirs as ecological resources with far more value than as mere water storage units has received little attention. This is despite reports from a growing number of projects showing unexpectedly high returns from fisheries.[3]

The formation of a reservoir "is a dramatic reordering of nature that creates a suite of complex, dynamic aquatic ecosystems." With proper planning, these new ecosystems can make potentially much more valuable contributions than those to national energy or to agricultural production. Indeed, they offer to the people who can adapt to living and working with them new opportunities for employment, and they can dramatically increase the production of aquatic protein. In some years the total income from fisheries in reservoirs has exceeded the income generated from electricity sales.[4]

It has been estimated that annual inland fish production in Asia is 5.5 million tons, comprising 57% of the world's inland fish production. However, fish yields from Asian reservoirs comprises just 0.5 million tons of this 5.5 million. Fish production from Asian reservoirs is estimated at only 20kg/ha/year, with a wide variability in production that was not always related to the size of the reservoir. An average percentage increase in reservoir area in 15 Asian nations from 1987 to 2000 is calculated to be 511%, ranging from 50% (Singapore) to 9,900% (Lao PDR). By 2000 it is predicted that the collective water surface in reservoirs (20.3 million ha) will exceed the surface area of Asia's natural waters (18.5 million ha).[5]

Clearly, if the huge expanse of underutilized water areas locked behind Asia's dams could be utilized for increased fish production, thousands of tons of new aquatic protein could enter Asian markets. Production of new aquatic protein is especially urgent in Asia, a region where fish is the most important source of animal protein. In addition, there is a need to create thousands of new rural jobs due to population growth is evident and to find innovative ways to stem the rapid rural to urban migration. It is argued that expansion of aquatic food production in Asian reservoirs could assist in mitigating Asia's growing food and population crises.[6]

There are vast areas of new inland waters "locked up" in hydropower and irrigation reservoirs in Asia. The surface waters of these hydropower reservoirs are almost completely vacant of any significant productive enterprise, other than being used for water storage, and subsistence level fishing that provides little other than part-time incomes.

Nearly all Asian reservoirs outside of China and Thailand have little or no water-based aquaculture systems such as fish cages, and have underdeveloped capture fisheries management programs. Development of aquaculture in and around Asia's hydropower and irrigation reservoirs to enhance fish production, and as a management tool to enhance capture fisheries, may be one means to provide thousands of new jobs in rural areas. Fisheries development may also be the only means left for creating new sources of freshwater aquatic protein for many densely populated Asian nations. An expert long involved with the Indonesian experience in floating net cage fisheries suggests that hydropower and irrigation reservoirs may be Asia's final "aquatic frontier".[7]

[2] Costa-Pierce, B.A. 1997. *From Farmers to Fishes: Developing Reservoir Aquaculture for People Displaced by Dams.* Washington, DC: The World Bank Technical Paper, No. 369.
[3] Costa-Pierce, 1997, p. x.
[4] Costa-Pierce, 1997, p. x.
[5] Costa-Pierce, 1998.
[6] Costa-Pierce, 1998.
[7] Costa-Pierce, 1998.

2. THE CASE STUDY

The Case Study presented here is a greatly simplified and abbreviated version of Costa-Pierce, Barry A. 1998. Constraints to the Sustainability of Cage Aquaculture for Resettlement from Hydropower Dams in Asia: An Indonesian Case Study, which was posted on the Internet at: http://darwin.bio.uci.edu/~sustain/indo.html. It has left out Dr. Costa-Pierce's many references, which are, however, available in the original paper.[8] Dr. Costa-Pierce discusses some of the problems recently found in the model and suggests mitigative measures. However, this discussion focuses on the experience as a model that could be applied, as practical, to the Nam Ngiep 1 HEP Resettlement Action Plan.

Institutional Framework and Planning Process: Funding for the resettlement aquaculture efforts on the Saguling and Cirata reservoirs was obtained from the World Bank as a small portion of a larger loan package to the Indonesian Electric Company (PT.PLN) for dam construction at Cirata.

The Project provided Technical Support in the form of applied ecological, capture fisheries, aquaculture research, extension, training, and other support services to the West Java Provincial Fisheries Agency (Bandung, Indonesia) in order to facilitate rapid resettlement of the reservoir families. And it provided these families either full or part-time jobs in reservoir aquaculture, capture fisheries, or related support industries in the two hydropower reservoir areas through a comprehensive Reservoir Fisheries And Aquaculture Development And Management Plan For Population Resettlement.

While there was a relatively large information base available in freshwater aquaculture development and capture fisheries management in Asia, there were no previous experiences anywhere involving the resettlement of such a large number of persons through a planned development program of reservoir cage aquaculture.[9] For this reason, the World Bank suggested that the local lead organization, the Institute of Ecology (IOE) at Padjadjaran University associate with an international fisheries research organization to assist with technical advice in fisheries and project implementation. This was the International Center for Living Aquatic Resources Management (ICLARM) in Manila, Philippines.

A new Institutional Framework was formulated for project implementation to define an overall administrative structure for the project and to delegate individual institutional responsibilities.

The IOE was chosen as the lead agency to coordinate a multidisciplinary applied research and training program that involved agricultural economists, sociologists, demographers, anthropologists, agronomists, forestry, animal husbandry, capture fisheries, and aquaculture professionals. To assist IOE's applied research program, ICLARM provided the services of a full time resident consultant fisheries scientist. ICLARM also provided specific short-term scientific expertise in capture fisheries, aquaculture, and fisheries marketing and economics.

The Indonesian government's West Java Provincial Fisheries Agency created a special Reservoir Fisheries Technical Implementation Unit that established offices at both the Saguling and Cirata dam sites to lead the local extension and training efforts. IOE also hired fisheries

[8] Contact information, from his webpage, is: Barry A. Costa-Pierce, Director, Mississippi-Alabama Sea Grant Consortium, 703 East Beach Drive, Ocean Springs, MS 39566-7000, Tel: 228-875-9368, Cell: 228-209-5643, Fax: 228-875-0528, E-mail: b.costapierce@usm.edu. Web page: http://www.masgc.org

[9] And the allied land-based aquaculture support systems such as hatcheries and nurseries.

extension personnel on three year contracts to facilitate more rapid transfer of applied research results to villagers and to coordinate extension activities with the government's technical implementation unit. The Indonesian Electric Company (PT.PLN) provided funding, institutional coordination and unlimited access to the reservoir areas for research and development activities, since, after compensation monies were paid, the reservoirs and their draw-down areas were PLN's "private property".

Applied research was done in a participatory manner with villagers in capture fisheries, aquaculture, draw-down agriculture, sociology, fisheries economics and marketing. A number of different types of low cost, water-based, cage aquaculture systems were developed and tested. Fish cage capital costs ranged from US$299 for cages having recycled oil drums and wood frames for flotation, to US$108-$167 for cages having bamboo or banana logs for flotation. Low cost "mini" cages (17.3m^3) were also developed that cost between US$20-$70 to construct. In addition, a suite of low cost land-based hatchery and nursery aquaculture systems were developed. These aquaculture systems were simple and not elaborate and were well within the financial means of the majority of the displaced people.[10]

Technological interventions in land-based aquaculture were based upon existing models of traditional knowledge systems in integrated agriculture-aquaculture farming ecosystems present for over a hundred years in West Java. Cage aquaculture technologies were based upon previous Indonesian and overseas experiences. Development of the land-based and water-based aquaculture systems was integrated in an attempt to integrate the new, water-based reservoir cage systems into an existing social ecological system of traditional pond hatchery and rice-fish nursery systems. This was done to create as many new jobs as possible by using aquaculture's "multiplier effects."

Farming Systems Extension and Training Programs: Two (2) extension approaches were used to disseminate to displaced persons aquaculture technologies. For new "water farmers" totally unfamiliar with traditional aquaculture technologies in West Java, adoption/diffusion techniques were chosen. For farmers who knew about traditional cage aquaculture, or land-based aquaculture techniques, a farming systems research and extension approach was used. This division of extension efforts was not a hard and fast categorization, however. It was left up to farmers themselves to choose which training sessions they wanted to attend. Many farmers attended sessions using both extension techniques.

Traditional Training Methods: In 1982, three years before the first reservoir was to be flooded, formal classroom and hands-on training in cage aquaculture was conducted with a small group of selected residents (mostly village leaders) that were to be displaced. Hands-on practical training in cage aquaculture was conducted in a small, shallow lake and in an existing, downstream reservoir. In addition, PLN created a special "fisheries dike area" in the Saguling Reservoir for cage aquaculture experiments before the flooding of the main part of the reservoir. Aquaculture training was conducted for 24 displaced persons in this diked area. Two (2) displaced farmers from this latter group subsequently received loans from the Bank of Indonesia to develop cage aquaculture businesses after initial experimental results showed the potentials for high yields and profits.

The two (2) pioneer farmers successfully paid back loans from the Bank of Indonesia by just the second year of operation. Their positive results attracted a great deal of community interest. At the same time, PLN facilitated a highly publicized visit by the Governor of West Java to these two farmers. These pre-inundation events created a widespread awareness of the potential of cage aquaculture among Saguling's displaced people, and the two successful farmers later became fish farmer facilitators.

[10] Costa-Pierce, 1998.

Further experimental work from 1986 to 1990 developed a "basket" of low cost technologies in cage aquaculture, small scale ("backyard") fish hatcheries, water-based hatcheries, and integrated rice-fish nursery systems appropriate to the rural expertise, availability of capital and construction materials, and management complexity of displaced farmers.

All research employed displaced villagers (the beneficiaries for whom the technologies were intended) who worked with scientists from the outset. Simultaneously the West Java Provincial Fisheries Agency and IOE/ICLARM collaborated to offer a number of short courses of one (1) week to three (3) months duration for villagers at offices of village headmen. These courses were held in over 20 districts in the Cirata region and were attended by over 500 persons. Courses covered operations of numerous types of land and water-based aquaculture systems having high and low capital costs (e.g. intensive raceway systems, hatcheries, small and large cages, pen systems, rice-fish culture), plus instruction to villagers on how to formulate fish feeds, and process and market fish.

Fish Farmers' Association (FFAs). A Saguling Fish Farmers' Association (SFFA) was formed in late 1985, and by end 1989 had over 700 members. Leadership of the SFFA was by the two (2) pioneers who successfully repaid their loans (subsequently, these two and their families became the most powerful members of the fish farming community). The Technical Implementation Unit of the West Java Provincial Fisheries Agency who also assisted farmers with obtaining bank loans and marketing fish formed the SFFA. In Cirata, a government Village Cooperative Unit (KUD) took the lead in cage aquaculture development with assistance from the government's Technical Implementation Unit. In 1989, the cooperative obtained a government loan package to develop cage aquaculture in Cirata.

Farmer Participatory Training Methods: A farming systems research and extension approach was chosen since it was known that West Java had a unique cultural heritage and a large bank of traditional knowledge in many areas of land and water-based aquaculture and integrated farming systems. Many traditional aquaculture systems and much of the existing farmers' knowledge could be used directly, or modified and adapted for use.

Villagers were employed from the outset and were involved throughout the success or failures of the aquaculture research, development, and adaptation processes. Using this approach, farmer recipients were made active, valued participants in both the process and evaluation of the suitability of chosen technologies for their needs.

There was a high level of indigenous, aquaculture farming knowledge in the rural society where the development project was undertaken. Surveys before the project began documented a wide diversity of aquaculture systems already existed; that farmers in the surrounding region had an impressive management capability; and farmers were already doing detailed practical experiments. Project scientists realized that it was best if they recognized these farmers and their indigenous knowledge for the value of their innovations, since this approach would speed the choice of more promising and more relevant research topics of direct value to the intended beneficiaries.

Three Cage Aquaculture Research Stations were constructed to test a variety of low cost technologies ("the basket") under three different but prevailing limnological and social/cultural conditions in Saguling in the years just after reservoir filling (the "on-station" experimentation phase).

Establishment of Community Integrated Aquaculture Schools: While development of the aquaculture resettlement option was the main concern of the project, it was clear from the outset that a more holistic approach to applied research, extension and environmental restoration would be necessary. To accomplish this, community schools were created in three villages surrounding the Saguling reservoir with the largest percentage of displaced residents.

The project rented village houses for a 3-year period in two villages in Saguling's northern region and one in the southern region in areas having excellent technical capabilities for cage aquaculture, and having boat and road access to markets. Another house was rented to coordinate applied research and community training activities in Cirata.

Village schools had a permanent IOE/ICLARM staff member stationed at the houses who coordinated all applied research projects, hands-on training, and community relationships. Villagers were employed to carry out all aquaculture construction, labor and routine tasks at the schools. Village schools were the center of all collaborative research activities with villagers and between the various outside institutions and other outside villagers visiting the schools. IOE, ICLARM, Provincial and Technical Unit personnel visited village schools regularly on overnight stays to mentor progress, to discuss results internally, and to meet and discuss progress with villagers.

Village schools were replete with displays, photographs and extension aquaculture books written in both the local and national languages. Programs at the village schools focused not only on aquaculture but also had working demonstrations in animal husbandry, composting, soil conservation, capture fisheries, fish feed formulation, and fish processing technologies. The village schools also promoted an environmental rehabilitation system, which took a system ecology approach to small farm development. Many ecological principles were intuitively familiar to the sophisticated rural farmers. But scientific staff also introduced them to a wide range of new technologies (cage aquaculture, land-based aquaculture systems such as hatcheries and new rice-fish systems), rabbit husbandry, earthworm culture and composting, insect culture, fish and animal processing and marketing, and agroforestry and erosion control. It was estimated from records kept at the schools that over 4,000 villagers visited the four village schools from 1986-1990.

Farmer-to-Farmer Visits: Once the Saguling cage culture industry began its remarkable expansion, the task of attracting new entrants was of little concern for the project. Indeed control of the number of cages became an issue as early as 1989, since cages became concentrated in one of the southern sectors of Saguling reservoir in the Bongas Region. By the end 1989, over 80% of the cage aquaculturists in Saguling were concentrated in this region. The Bongas Region had an excellent technical capability for cage aquaculture (a long, deep, sheltered bay with good flushing), a good economic infrastructure, and had excellent market access to fish fingerling and feed suppliers. Given the obvious success of development of cage aquaculture in Saguling, by mid-1988, project extension efforts shifted to the new Cirata reservoir.

Since, in familiar cultural settings, diffusion of innovations can occur as rapidly with informal farmer contacts as in formal courses, a "hands-off extension approach" was used to develop aquaculture in Cirata. Simple farmer-to-farmer visits were sponsored for displaced residents from the new Cirata reservoir. In structured visits, prospective water farmers from the Cirata reservoir region were sponsored to visit the "aquaculturally developed" regions of the Saguling reservoir. Extension personnel were present to answer questions, to distribute free aquaculture workbooks in the local language, to provide "social lubrication", and to take care of personal needs. These visits were a tremendous success. By end 1989, 94 cages (40 families) were operating in Cirata with no formal course work or extension programs having been conducted. By end 1992, fish production in Cirata was estimated at 3,880 tons.

Information Resources: It was found that Saguling's cage fish farmers were well educated, with 94% having completed elementary school. Almost all of the people could read extension workbooks if they were in the local Sundanese language. Far fewer villagers could read extension materials in the national language (Bahasa Indonesia), and almost no one could read English. As a result, simple "comic book" type workbooks on floating net cage, pen, small-scale hatchery, and small cages were published in the local Sundanese dialect and distributed widely.

Workbooks were made available free at all IOE/ICLARM community schools, and at the offices of the government's Technical Implementation Unit at the reservoir dam sites. Books were used widely by extension officers and trainers in formal courses in villages. Workbooks were also available free to all members of the Saguling Fish Farmers' Association and Village Cooperative Units in Cirata.

During visits to cage culture operators in Saguling and Cirata in 1989-1990, it was frequently observed that these workbooks were among the only reading materials available in village residences. Children seemed to particularly value the "comic book nature" of the materials; to the point that, cage culture "toys" appeared in one village.

Study Tours to Nations with Relevant Experiences: Many aquaculture technologies successful in one developing nation can be transferred to other nations with similar development circumstances after adaptive research is undertaken. However, West Java has a unique aquaculture history, a wealth of experience, and capable fisheries institutions and scientists involved in aquaculture of common carp and other species. However, it was noted that:

Saguling and Cirata were very eutrophic reservoirs with a large potential for "no feed", or extensive cage aquaculture, and

Much of the specific technology to diversify the reservoir cage culture industry and assist the poorest of displaced residents [e.g., by evolving a low cost or extensive cage aquaculture, particularly for Nile tilapia (Oreochromis niloticus) and Chinese silver (Hypophthalmichthys molitrix) and bighead (Aristichthys nobilis) carps] was lacking;

Project scientists felt that transfer of modern methods and management practices in extensive aquaculture to the Indonesian reservoirs would not be a prolonged proposition or expensive exercise. The Philippines has a wide diversity of successful tilapia cage and pen aquaculture, and extensive cage aquaculture for the Chinese carps has been successful in lakes in China, Nepal, and Singapore.

It was decided to arrange two study tours in 1987-88 for selected scientists from the Indonesian State Electric Company, IOE, and the Technical Implementation Unit to transfer technology rapidly from Asian nations with relevant experiences in low-cost cage aquaculture to Indonesia.

This transfer of technology by sponsoring overseas study tours was very successful. By end 1989, 26 small-scale cage hatcheries for an Indonesian variety of red tilapia (hybrids of Oreochromis spp.) were being operated by resource poor farmers in Saguling. Two tilapia growout operations started in 1989-1990. In addition, in 1990, a number of cage operators started doing polycultures of common carp and red tilapia in cages. Active research in tilapia aquaculture was started by the Provincial Fisheries Agency, at the local University (Department of Fisheries, Padjadjaran University), and at IOE.

Short-Term Analysis of Successes and Failures (1986-1993): The Reservoir Aquaculture Resettlement Project was successful in developing numerous new land and water-based aquaculture systems and associated aquaculture support industries in villages surrounding the two new hydropower reservoirs. The project trained a documented 2,081 persons and recorded over 4,000 visits to village schools; by 1992, an estimated 7,527 persons were directly or indirectly involved in fish production; and at the end of 1996 total annual fish production from cages from the two reservoirs was an amazing 24,496 tons.

Costa-Pierce cautions the reader "to reflect a little on the magnitude of this production." The reported range of capture fisheries production in Southeast Asian reservoirs is just 5 to 675 kg/ha/year. In 1996, cage aquaculture in the Saguling and Cirata reservoirs produced 2,130 kg/ha/year (24,496/11,500 ha). And expansion of production is possible with existing technology and better siting. Each cage could produce fish at 3 tons/year if adequate supplies of fingerlings were available. Applied across the 16,400 cages (at carrying capacity) would yield 49,200 tons of fish and generate an estimated $49.2 million/year ($1 /kg) at capacity. And the production potential of simple cage systems doesn't stop there.

By 1997 there had been a proliferation of a new type of "condominium" cage aquaculture systems in the Bongas area of the Saguling reservoir that had a production potential of 10 tons/cage/year. Clearly, the cage aquaculture systems in the Saguling and Cirata reservoirs present a exciting new model of large scale protein food production for a protein-hungry Asia, that could, if sustainable, represent a new, globally-important food resource ecosystem.[11]

The most important factors contributing to the initial technical success of the development efforts in the first seven years were:

1. *Presence of A Defined, Educated Target Group:* Lists of names with addresses of displaced persons from reservoir inundation were obtained from the Electric Company along with how much compensation money these people obtained. While in many cases the electric company lists were found to be outdated or wrong, the fact that some information did exist helped to identify:
   a. The exact geographic scope of the project (new and old villages with largest numbers of displaced families),
   b. Families who had backyard fish ponds before the reservoir, and therefore had a traditional knowledge of aquaculture ecosystems;
2. *Ready Availability of Investment Capital:* Lack of the ready availability of start-up capital often constrains aquaculture development among the rural poor (the target group of many development assistance projects). All villagers in Saguling obtained compensation money from the electric company; 92% received less than Rp 6 million, and 8% over Rp 6 million. Having a large amount of cash available allowed immediate investment in new aquaculture businesses. However, for the poorest residents, compensation monies were not enough to replace homes and lands lost due to increased land prices, speculation, and inflation;
3. *Lack Of Alternative Employment Opportunities in Both Rural Agricultural and Human Ecosystems:* Rural population densities increased 2-3 times due to the reservoirs, from a range of 237-1,691 persons/km^2 before the reservoir to 476-4,292 persons/km^2 after. These are among the highest "rural" population densities anywhere in the world. According to Collier et al. (1977), by the late 1970's the rice agroecosystem in Java could not absorb more rural labor. They predicted massive migration to coastal Javanese cities if a solution was not found (and one wasn't: Jakarta boomed from 11.9 to 17.1 million in the 1980's);
4. *Local Traditional Knowledge of Aquaculture and Cage Culture:* The success of development assistance has been described in terms of the "technological mastery" of a system, defined as "the autonomous ability to identify, select, and generate technological improvements and changes". Rapid adoption of the fish cage systems in the reservoirs was influenced by the inherent innovativeness of farmers in West Java. Farmers operating

[11] Dr. Donald Graybill, on the Nam Ngiep 1 HEP Feasibility Study's Environmental Assessment Committee, has been associated with the Reservoir Aquaculture Resettlement Project over many years and has provided the Study Team a valuable video on the project: Larry L. Brown, Director, Photographer, Editor; Barry Costa-Pierce, Producer and Writer. 1994. *Farming the Waters, Java's Blue Revolution*. Washington, DC: The World Bank.

existing agro-and aquaecosystems in the province had an impressive amount of indigenous knowledge and vibrant on-farm "trial and error research" systems that were characterized by a great deal of individual innovation. The adoption of change has also been viewed as directly influenced by the basal level of innovativeness present in a society.

5. *Large Market Demands and Relatively High Prices for Freshwater Fish:* Price fluctuations for freshwater fish observed in Jakarta were small even though strong seasonal fluctuations in fish supplies occurred. Given the increasing population density and increasing incomes of Jakarta residents (who eat about 14kg of fish per capita per year), market demands for freshwater fish were large;

6. *Ready Access To Large Urban Markets On Paved Roads:*

7. *Suitable Environment:* Saguling had many deep, sheltered bays very suitable for cage aquaculture.

8. *Institutional Cooperation:* Although difficult to coordinate, and necessitating a larger than anticipated administrative load, the cooperation and technical assistance of government, electric company, ecology, and fisheries organizations was critical;

9. *Accessibility of Rural Extension Services:* Some 90% of Saguling's cage culturists with a single fish cage participated in extension and training programs, and that 44% of all cage farmers got information from training or extension programs.

Costa-Pierce, in his paper, notes that the main problems have been insufficient attention to realistic economic appraisals, a lack of social concerns, especially social impacts on equity, a lack of expertise, and a lack of appropriate technologies incorporating traditional knowledge.

Floating net cage aquaculture can be used as a sustainable and important new means of large-scale population resettlement from hydropower dam construction in developing countries if:

(i) Adequate government planning for fisheries is included before dam construction (too often fisheries are viewed as another "simple engineering problem");

(ii) Adequate financial compensation for lost assets is given;

(iii) Rigid enforcement of institutional regulations guaranteeing the long-term benefits of the new lakes are for the exclusive use of the displaced people;

(iv) Enforcement of regulations on cage numbers so as to prevent environmental degradation; and

(v) Provision of adequate government subsidies for aquaculture job creation, training, long-term extension support, and active monitoring.

3. REFERENCE

3.1 DRAWDOWN AGRICULTURE, AGROFORESTRY, AND EROSION CONTROL

Moreover, drawdown agriculture is unsuitable for hydropower reservoirs where there is little predictability of the magnitude of draw-down. Saguling, farmers attempted to grow rice and vegetables. Crops drowned. Converted to grazing land. Costa-Pierce, 1997. P. 32

Land above draw-down area intensively cultivated with multiple crops. Farmers report easy access to water ensures a crop even when drought. Advantage of highly fertile soil in draw-down area, moving to land when cultivate above draw-down area. Costa-Pierce, 1997. P. 32.

Bamboo forests above high water mark, expanding to meet demand for bamboo created by the new cage aquaculture industry. Costa-Pierce, 1997. P. 32. Forests helping control erosion and sedimentation in watershed. Costa-Pierce, 1997. P. 32.

Draw-down of Lake Kariba, Zambia and Zimbabwe, grass (*Panicum repens*) planted that has remarkable ability to remain alive even when submerged for many months. At reemergence, grass recovers and flourishes, covering wide swaths of draw-down zone in rich, green carpet and helping reduce wave erosion. Tons of manure. For grass and productive littoral zone. Herbivorous tilapia (*tilapia rendalli*) introduced to utilize new feeding area. Costa-Pierce, 1997. P.32.

Urban people get cheaper power, rural people get displaced. Costa-Pierce, 1997. P. 33. Conflicts arise when goals of a dam are articulated only in economic terms, and in a way that implies that the dam and reservoir project will involve only sacrifice for the communities affected. Costa-Pierce, 1997. P. 35

Dams need to be explained within the broader context of the future development needs of these communities and the needs for rehabilitating and enhancing ecosystems. Local resettlement plans should be a part of overall government plans for regional and rural rehabilitation and development. Resettlement needs to be explained to those affected not as a win-lose situation that can be addressed through simple compensation, and not solely in terms of the benefits to the nation as a while, but also in terms of local benefits, local development, and local jobs. Costa-Pierce, 1997. P. 35

Developing integrated reservoir fisheries ecosystems requires establishing a process for preparing plans that detail the range and complexity of the problems. The key is to formulate new links and establish a consultative process that Costa-Pierce, 1997. P. 35:

- *Recognizes all parties involved in The River Basin Development*: the people affected, their institutions, arbitrators, non-governmental organizations, and local, provincial, and national governments. Every effort must be made to establish an inclusive setting. Existing institutions need to be evaluated before hand to see whether they need strengthening to carry out a comprehensive, participatory planning process, or whether a special agency needs to be created, such as a River Basin Commission.

- Recognizes the equal importance of the engineering, social, and environmental aspects of the project, and establishes a Commission that incorporates the dam and reservoir project and its impacts into a Regional Development and Management Plan for the local society and environment.

- Establishes trust in a process of participatory consultation before any engineering works or other actions are initiated, and establishes written working agreements for the parties involved that detail the process, the requirements from the different parties, the reporting structure, and the processes for resolving conflicts and reporting their resolution. Such a consultative process is not a one time event, but a continual, evolving activity.
- Determines project objectives holistically, taking into consideration engineering, management, social, resettlement, and environmental aspects.
- Develops cost-benefit analyses of development programs and social and environmental restoration and rehabilitation programs.
- Considers new opportunities, tradeoffs, and constraints, then produces strategies for optimizing and mitigating the outcomes of decisions.
- Determines priorities.
- Reexamines its decisions and priorities in the light of the original project objectives and revises them – and the objectives – as agreed to be necessary.

3.2 A FIVE PHASE PLANNING PROCESS

A five phase planning process is envisaged for incorporating fisheries ecosystems into a long-term Regional Development Plan for Resettlement from river basin projects. *Costa Pierce 1997 pp 35-37*:

Phase 1: Preparing background studies, feasibility studies, reports on the social and political status of the affected communities, and preliminary recommendations. Phase 1 studies should document the society's organization, community traditions and practices, government structures, and relevant laws, regulations, policies, and responsibilities. The studies should use rapid appraisal techniques to evaluate major natural agricultural and economic systems and their forms and functions in society. The goal is to come up with a preliminary set of recommendations addressing the major issues and priorities for action. The work in this phase is crucial in determining the possible impacts of the project.

Phase 2. Formulating an integrated development and management plan for land and water ecosystems to support local resettlement. This phase occurs after the decision has been made at appropriate government levels to proceed with the project. During this phase an implementation plan for integrated reservoir fisheries ecosystems is developed, as the same time as plans for dam engineering and construction. Formulating a local resettlement plan that develops alternative livelihoods —such as integrated fisheries ecosystems – is a lengthy process that should begin before planning for engineering works. Delaying planning for local resettlement and for integrated reservoir ecosystems until dam construction begins leaves too little time for the planning process and for creating the web of essential connections to the communities affected.

Phase 3. Involving community leaders and groups in formulating and assessing plans and contracting with or forming non-governmental organizations (NGOs) to assist in the project. This phase is often the missing link in resettlement, especially where governments tend to shroud projects in technical details. Cernea 1991 'forced population displacement, even by size alone, is the most significant variable in river basin development. Yet current thinking and planning patterns do not recognize it adequately, either in terms of its magnitude and real costs, or in terms of its social consequences.' Too often, active community participation in planning for the livelihoods of the displaced people, and for rural roads, electrification, potable water, sanitation systems, and food production, is given only lip service. Little attention is paid to setting aside adequate funding to create new community structures that can regularly evaluate and, if necessary, redirect resettlement efforts. Forming NGOs that include community leaders can be an important part of this interactive process. But these new organizations must consider the community relationships with the new ecosystems created. They must also be adequately funded and supported in their attempts to establish new processes for discussion and compromise.

Phase 4. *Preparing progress reports, including reassessing plans and charting progress through the stage in which the reservoir fills and the ecosystem is unstable.* This phase focuses on monitoring the society and the new ecosystems during what is for both the most critical stage of the project. In this phase the best-laid plans can go seriously awry unless a system of rapid assessment, reporting, and communication is established. The agreed on process for resolving conflicts must be in place before this phase.

Phase 5. Reevaluating and, if necessary, reformulating the Resettlement Plan after a period of monitoring and of drawing lessons during the stabilization of the reservoir and from operational experience with the new ecosystems and the dam and other major structures. During this operational phase the integrated reservoir fisheries ecosystems are developing rapidly and institutional structures are adapting or need to adapt to cope with the changes.

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