SECTION 4.2

PROBLEMS AND ISSUES IN COMPENSATORY MEASURES RELATED TO WATER RESOURCE DEVELOPMENTS

Saburo Matsui

4.2.1. PROBLEMS AND ISSUES

Among the various types of water resource development projects, dam and reservoir construction have perhaps the most significant social and environmental effects. These projects often create problems of involuntary resettlement due to the inundation of houses as well as land. People dislocated by a large project may lose a variety of assets such as properties, employment opportunities, fishing waters, irrigation works, standing crops, and trees. In the case of the very poor, even the loss of assets or opportunities that are not normally evaluated as an economic value may be disastrous. Such opportunities include the collection of roots, berries or leaves for dietary supplement or sale.

The adverse consequences of displacement can be summarized into the key dimensions of the improverishment risk model: 1) landlessness, 2) joblessness, 3) homelessness, 4) marginalization, 5) food insecurity, 6) morbidity, and 7) social disarticulation (Cernea, 1990). The key dimensions often interact with each other and even tend to reinforce each other. It is therefore necessary to find solutions which avoid the unnecessary displacement of people or reduce the number of people who are displaced to a minimum. In cases where displacement is unavoidable, it is necessary to find ways of mitigating the adverse effects on the displaced people.

Government laws and regulations relating to expropriation of property by the state are generally used to define the procedures for valuation of, and compensation for, the property lost in cases of forced resettlement. However, such national laws and regulations governing compensation are sometimes outdated, or lacking in precision or appropriate mechanisms, and therefore very often do not prevent serious hardship and suffering of the dislocated people.

The World Bank guidelines point out that "experiences with the resettlement of

large populations tend to show that payment of cash compensation alone is often a very inadequate strategy for dealing with the dislocated; in some instances, the entire compensation has been used for immediate consumption purposes, leaving the dislocated with nothing to replace their lost income-generating assets and opportunities." The World Bank concluded that the "land for land" approaches are to be firmly supported instead of "cash compensation" (Cernea, 1988; Cernea, 1987).

In resettlement planning, housing at new sites, sanitary facilities, drinking water supply systems, schools, health care facilities, etc. are another major component in addition to compensation for private assets. When the population of the dislocated group is large, the compensatory measures to the group as a whole become complex. Depending on the situation, a variety of measures to provide infrastructure are needed to support reconstruction of a new social organization in the new place.

Another essential component of the resettlement planning process is the need to provide support program for the host community. In the situation where the ratio between the incoming resettled population and the host population of the receiving areas is high, the host population may face increased pressures on its society as well as on the area's natural resources. Compensatory measures to the host population are also necessary in this case.

4.2.2 JAPANESE EXPERIENCE OF COMPENSATORY MEASURES FOR SOCIAL AND ENVIRONMENTAL EFFECTS OF WATER RESOURCE DEVELOPMENTS

It may be worthwhile to begin by briefly reviewing the history of Japanese water resource development in terms of compensatory measures and to try to analyze the problems.

First of all, historically the New Constitution and the Imperial Constitution established the rights of private property which are at the foundation of the compensation system. In water developments projects there have always been conflicts between new and existing water rights. Thus the construction of a new inevitably creates new conflicts and the new for conflict resolution. This conflict resolution in relation to water rights is usually a long and protracted process involving a number of bureaucratic systems of central and local governments, and various water users. Only after the settlement of these conflicts can the water development project be initiated.

In parallel with the history of the development of water resources in Japan,

institutional and organizational compensatory measures began with irrigation projects and gradually expanded to water supply and hydroelectricity projects in the period from about 1870 to 1920s. The industrialization of Japan increased the demands for electricity, which in turn fostered the development of water resources projects. The need to coordinate the competition among various water demands led to comprehensive planning of water resource developments, including compensatory measures for social and environmental effects, in many river basins.

At the end of World War II, Japan implemented programs to try to restore its infrastructure, farm lands and for flood control and afforestation. The ensuing water resource development projects followed the example of the Tennessee Valley Authority (TVA) development projects, introducing multi-purpose dams. During the 1960s and 70s, rapid industrialization and urbanization in many cities created new large-scale demands for water resources. However, many cities faced water shortages due to the delay of water resource development projects. Utilization of groundwater for industry induced subsidence of ground levels in many cities which still continues to date.

Japanese society has developed in a number of complex stages which in part explains the present complexity of laws and regulations. The organisation responsible for undertaking a particular water development project, in addition to its efforts to deal with the conflict resolution process, must clear many hurdles related to these laws and regulations before construction can begin. Furthermore, the project undertaker must negotiate a compensation deal with those people who may lose their property of livelihood as a direct consequence of the development project. In the past, the negotiation period was normally less than 20 years. But more recently, 20 years or more is the norm with further delays expected in future.

Table 4.2.1 shows the number of dams constructed during different periods by different organizations for water resource development. Suitable catchment areas for the construction of new dams have recently become very difficult to find.

Table 4.2.1
Number of Dams Constructed under Water Resource Development Projects in Japan (Takebayashi, 1981)

Organization	pre-1950	51-60	61-70	71-80	Total
National Government	1	19	16	16	52
Water Resources Development Public Corporation	0	0	4	9	13
Local Governments and others (multi-purpose dam)	8	29	34	49	120
Local Governments and others (flood control dam)	0	2	7	35	44

4.2.3 NEED FOR SOCIAL AND ENVIRONMENTAL MEASURES FOR THE DEVELOPMENT OF RESERVOIR AREAS IN JAPAN

Construction of new reservoirs created the following problems in Japan:

1. Development of large-scale reservoirs often involved the involuntary resettlement of people, and the loss of their property as well as their community structure, which in turn affected various socio-economic conditions of neighbouring communities.

2. The communities which are involuntarily resettled are usually mountain or farming villages which suffer from depopulation and an aging population. It was difficult to find new land and employment opportunities for the relocated people.

3. Benefits from the construction of new reservoirs usually accrued to the people who live downstream, while those who lived in the catchment area bore most of the costs. Those upstream people called for more reasonable compensation measures to offset their sacrifices.

The Ministry of Construction in Japan has developed the following approach to measures related to reservoir development:

1. prevention of the depopulation of the communities in reservoir areas;

2. financial aid for the local governments which care for the resettled and host populations;

3. coordination between the costs on upstream and the benefits for downstream populations; and

4. special compensatory measures for re-establishing dislocated people by national and local governments (Takebayashi, 1988).

4.2.4 CLASSIFICATION OF VARIOUS COMPENSATORY MEASURES PRACTICED IN JAPAN

Various compensatory measures for reservoir areas practiced in Japan can be classified into three major categories as follows:

1. re-establishing dislocated people;
2. provision of infrastructure around reservoir areas; and
3. aid to local governments.

Each category can be further sub-divided into different levels.

1. Re-establishing dislocated individuals is supported at three different levels:

- Dam enterprises are required to directly support those affected individuals through compensation, as defined in the General Compensation Order (1962), and/or by special funds, depending on the situation.

- Local governments in the reservoir's catchment area and the downstream organizations which obtain benefits from the construction of the reservoir should support those individuals by various direct and indirect methods, including the provision of new land, new jobs, attracting enterprises to areas downstream of the reservoir, and providing low interest loans to assist those individuals to obtain new land. The "Fund for Special Measures for Reservoir Area Development" has been

established recently.

- Reduced taxes on the compensation money.

2. Provision of infrastructure around reservoir areas is conducted at four different levels:

- Dam enterprises should compensate for infrastructure destroyed by the construction of the reservoir as defined by the Infrastructure Compensation Order (1967), and/or should conduct direct replacement construction, and provide necessary infrastructure around reservoir areas.

- Provision of infrastructure defined by the Act for Special Measures for Reservoir Areas Development, and the Act for Provision of Infrastructure Around Regions of Power Generation Facilities.

- Local governments in the catchment area and the downstream organizations which obtain benefits should also provide various types of infrastructure, if necessary. They can use the "Fund for Measures for Reservoir Areas Development" for necessary infrastructure construction.

- Local governments can support various undertakings initiated by the dislocated people based on, for instance, the Act to Promote Mountain Villages Development, the Act for Special Measures to Promote the Development of Depopulated Areas, and various other acts related to the development of local areas and exploitation of forest resources owned by the national government.

3. Financial and taxation aids for local governments are conducted by the following two levels:

- Local governments (cities and towns) in the reservoir areas can put a fixed assets tax on a dam enterprise.

- Prefectural governments can charge an electric enterprise for utilization of stream water.

The above-stated measures can be grouped and compared based on the amount

of money used, as shown in Figure 4.2.1.

Key to Figure 4.2.1

1. Money supported by dam enterprises
2. Money supported by national government, local governments, and downstream organizations
3. Money calculated according to the General Compensation Order
4. Money calculated according to the Infrastructure Compensation Order
5. Money prepared according to the Act of Special Measures for Reservoir Areas Development, and the so-called "Three Acts for the Development of Power Resources"
6. Money provided according to various acts relating to local development and exploitation
7. Money supported by the Fund of Measures for Reservoir Areas development and various taxation systems

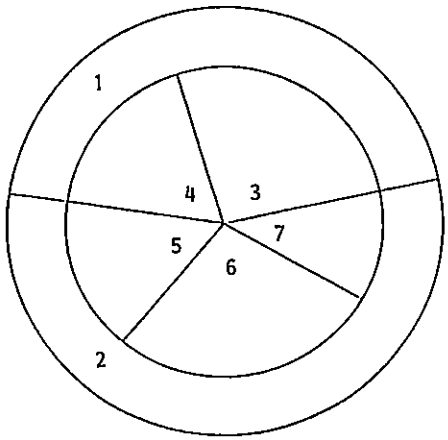

Figure 4.2.1 Classification of Money used for Social and Environmental Measures for Reservoir Areas Development in Japan, according to sources and responsible organizations (from Cernea, 1987).

Key to Figure 4.2.1

1. Money supported by dam enterprises
2. Money supported by national government, local governments, and downstream organizations
3. Money calculated according to the General Compensation Order
4. Money calculated according to the Infrastructure Compensation Order
5. Money prepared according to the Act of Special Measures for Reservoir Areas Development, and the so-called "Three Acts for the Development of Power Resources"
6. Money provided according to various acts relating to local development and exploitation
7. Money supported by the Fund of Measures for Reservoir Areas development and various taxation systems

4.2.5 THE ACT FOR SPECIAL MEASURES FOR RESERVOIR AREAS DEVELOPMENT

The Act for Special Measures for Reservoir Areas Development (ASMRAD) was enacted in 1973. It was the first act in Japan with which effective measures could be provided to cover various problems arising from water resource development projects, such as the construction of dams and the regulation of lakes and marsh water levels.

The aim of ASMRAD is to promote special measures to stabilize the life and promote the welfare of people affected by the construction of dams and water level regulation facilities, through the preparation of infrastructure around the reservoir areas and with a plan for the protection of the reservoir's water quality.

The application of ASMRAD involves the designation of reservoir construction projects or regulation facilities according to conditions described by ASMRAD. Any reservoir construction project which will cause the inundation of more than 30 houses or 30 ha of farmland (in Hokkaido Prefecture, 60 ha farmland) can be designated. Any project to construct a facility for regulating water levels which will benefit more than two prefectural governments by creating large reservoir surface areas can also be designated.

Since enaction, 65 projects have been designated under the law, including the Lake Kasumigaura Comprehensive Development Project and the Lake Biwa

Comprehensive Development Project. The designated reservoir areas are located in more than 33 prefectures. The development undertakers include the Ministry of Construction; Ministry of Agriculture, Forestry and Fisheries; prefectural governments; Water Resources Development Public Corporations and Power Resources Development Corporations.

Various types of infrastructure were constructed with the support of ASMRAD, including forestry conservancy, flood control, land improvement, road construction, water supply, sewerage systems, night soil treatment facilities, solid waste treatment facilities, land creation, public housing health centers, nursery schools, elementary schools, junior high schools, civic centers, fire stations, sport facilities, public gardens, and cable broadcasting facilities.

Of these infrastructure provision investments, the largest amount of money was allocated for road construction (about 50%), followed by afforestation and flood control (about 12%), land amelioration, afforestation and forest roads (about 19%).

It was argued that ASMRAD's coverage needs to be expanded to include joint management facilities for the modernization of farming, afforestation and fisheries, museums of folklore and archaeology, homes for the elderly, children's homes, children's gardens, recreation facilities, and radiotelephone facilities. ASMRAD was amended to expand its coverage to meet the above points in 1978.

ASMRAD was also amended in 1979 to increase the amount of subsidies for the construction of infrastructure when the size of a project becomes larger than the following limits. When the construction of a reservoir or a water level regulation facility is expected to cause more than 150 houses or 150 ha to be inundated, the subsidy must be increased. Likewise, when more than two prefectural governments downstream obtain benefits from a project, and more than 75 houses or 75 ha of land are inundated, the subsidy by ASMRAD is also increased.

Thus ASMRAD has been amended to meet new problems arising from projects of construction of reservoir areas.

4.2.6 THE ACT OF TAXATION FOR THE DEVELOPMENT OF POWER RESOURCES,THE SPECIAL ACCOUNT ACT OF MEASURES FOR THE DEVELOPMENT OF POWER RESOURCES, AND THE ACT OF PROVISION OF INFRASTRUCTURE AROUND REGIONS OF POWER GENERATION FACILITIES

"Three Acts for the Development of Power Resources" were established to promote the development of electric power generation in Japan. These are the Act of Taxation for the Development of Power Resources (ATDPR), the Special Account Act of Measures for the Development of Power Resources (SAAMDPR), and the Act of Provision of Infrastructure around Regions of Power Generation Facilities (APIRPGF).

ATDPR authorizes spending of a portion of electric power rates for the promotion of projects for power resource developments so that the national government can charge consumers a tax on power rates for the development of power resources (500 Yen / 1000 kWH). Based on the tax, the national government can set up special accounts within the national budget for measures to develop power resources authorized by the SAAMDPR.

A portion of the accounts is allotted for local governments which receive power resource development projects related grant support. Local governments can use the grant support to set up infrastructure in the regions of power generation facilities authorized by APIRPGF. Local governments which have power generation facilities inside their administrative boundary providing excess electric power beyond the boundary, can also accept additional grants which can be used to create jobs for the people around the power generating facilities Local governments which have hydro-power generating facilities within their administrative boundary in operation for more than 15 years, can accept grant support when conditions meet the requirements set by the Ministry of International Trade and Industry. The grant-in-aid can be used to mitigate social and environmental effects arising from the hydro-power facilities.

It is obvious that good coordination must be arranged between the measures supported by the ASMRAD and the APIRPGF. The arrangement of the acts obviously needs the following considerations:

1. The area in which ASMRAD-supported infrastructure is built should be as small as a group of several lot numbers, which can meet various small demands of infrastructure by local residents. Instead, APIRPGF supports rather large infrastructure construction conducted by local governments.

2. The projects supported by ASMRAD must be decided prior to any decision on the projects by APIRPGF.

3. When projects supported by ASMRAD are planned, a combination of other national grant support can be introduced, depending on the type of infrastructure. APIRPGF projects cannot be combined with other national grant support for the construction of

infrastructure.

4.2.7 THE FUNDING OF MEASURES FOR RESERVOIR DEVELOPMENT AREAS

Water resource development projects create, to a greater or lesser degree, so-called "upstream and downstream problems". In order to resolve these problems, financial devices need to be created in addition to the measures supported by the national government. Coordination of benefits and costs between upstream and downstream areas has been practiced in the past for water resource development projects with the introduction of various financial systems.

For example, in 1965 the Shiga Prefectural Afforestation Public Corporation was founded with the support of the Shiga Prefectural Government and other neighbouring local governments in the lower reaches of the Yodo River, to conserve forests in the mountains around Lake Biwa, upstream of the Yodo River. In 1973, relating to the Lake Biwa Comprehensive Development Plan, the System of Financing of Lower Reaches, and the Shiga Fund of the Management and Adjustment of Lake Biwa were founded. Furthermore, in 1974 the System of Bearing Costs of Lower Reaches was set up. These systems of funds and cooperation pioneered the development of water resource projects in river basins in Japan. Later, another 15 funding systems were founded for other water resource development projects, including the Fund for Yahagi River Water Resources (1978).

4.2.8 OTHER MEASURES AND NECESSITY FOR FURTHER IMPROVEMENT

People who live in the catchment areas affected by water resource development projects tend to experience the negative costs and need the understanding of the people of the lower reaches of the stream. The "upstream and downstream" problem should be resolved through a combination of various measures, including central government aid and financial aid by local governments from the lower reaches. Another important way is to organize communication between the people from upstream and downstream, to promote a sense of solidarity amongst the residents of the river basin.

The following activities are practiced in Japan:

1. People from the lower reaches go to the reservoirs and clean up the water and the shorelines.

2. Marine products and souvenirs from the lower reaches are distributed to the people in the reservoir areas free or at discounted prices.

3. Agricultural products from the reservoir areas are periodically purchased by the people of the lower reaches.

4. Recuperation and recreation facilities in both the reservoir areas and the lower reaches can be opened for both the upstream and downstream residents.

5. In compulsory education, water resources problems are taught with relevant materials and children are encouraged to visit the facilities of the water resources project.

6. People downstream are informed of festivals and events held by the people upstream and are encouraged to actively participate in them.

7. Public education on the importance of water resource development projects is promoted.

Although both the General Compensation Order and the Act for Special Measures for Reservoir Areas Development can cover many necessary measures for re-establishing the life of dislocated people, compensation is usually made in cash. Substitute land for resettlement has been provided with the aid of local governments. However, it has been difficult to provide substitute land for continuing agriculture and afforestation. There are still improvements needed in the operation of the projects.

It has been more and more difficult to find new reservoir areas in Japan due to many natural, economic and social conditions. It is now more important than ever for the responsible project organizers to collaborate with concerned local governments and organizations which represent the people downstream who benefit from the water resource development project.

4.2.9 CONCLUSION

The construction of reservoirs creates many problems, including the resettlement of dislocated people. In developing countries, institutional and organizational systems for the problems of involuntary resettlement have not been well established. The World Bank's experiences in financing water resource development projects for developing countries can give us important insights into resettlement operations. Japanese experiences of institutional and organizational systems to respond to socio-economic problems arising from reservoir construction are also important. Japanese compensatory measures were developed in a context of rapid industrialization and urbanization on the one hand, and rapid depopulation of mountain villages on the other hand. Similarly rapid industrialization and urbanization is taking place in many developing countries today. Japan's experiences may be a good example for those developing countries which are following a similar course of socio-economic development.

REFERENCES

Cernea, M.M. 1990. Population Displacement and Water Resources Development: current practice, issues and policy responses. Third Expert Group Workshop on River/Lake Basin Approaches to Environmentally Sound Management of Water Resources. Otsu.

Cernea, M.M. 1988. Involuntary Resettlement and Development: Finance and Development. The World Bank. September.

Cernea, M.M. 1987. Social Issues in Involuntary Resettlement Process -- policy guidelines and operational procedures in World Bank-financed projects. The World Bank.

Takebayashi, S. 1981. The Present State of Measures for Reservoir Areas and its Problems. Gekkan Yochi (in Japanese). March.

PROFILE F:

AMAZONIAN RESERVOIRS - BRAZIL

J. G. Tundisi

1. INTRODUCTION

The Brazilian Amazonia covers 60.44% of the territory of Brazil and is the largest hydrographic basin in the world. The region is covered largely with tropical rain forest, and about 5% of it is occupied by floodplains along the Amazon River and some of its tributaries. Theoretically, the Amazon region has an enormous economic hydropower potential with unique environmental conditions, and a disperse, very limited economic development with a population of only 3.12 inhabitants/km^2 (Juras, 1990). Recently, the Amazon region has been subjected to intensive exploitation of its forest and mineral resources, with considerable environmental disruption.

The exploitation of the hydroelectric potential of the Amazon region started as far back as 1968. There are now four power plants in operation (Tuevrni, Samuel, Balbina and Coaracy Numes) and nine planned. Fig. F1 shows the existing and planned reservoirs. The four installed reservoirs were located in areas mainly consisting of tropical rain forest (not removed prior to construction).

The reservoirs in the Amazon region present many problems of environmental disruption of the biogeophysical system, but can also produce many changes in the economic and social systems. Therefore, this is an important case study because of the uniqueness of the region, its main mechanisms of ecological functioning, and the need to balance economic and social development with the exploitation of natural resources. On the other hand, the construction of reservoirs in the Amazon region can be an important agent for regional development, removing pressure from areas to be preserved to maintain the traditional low-scale economic activity.

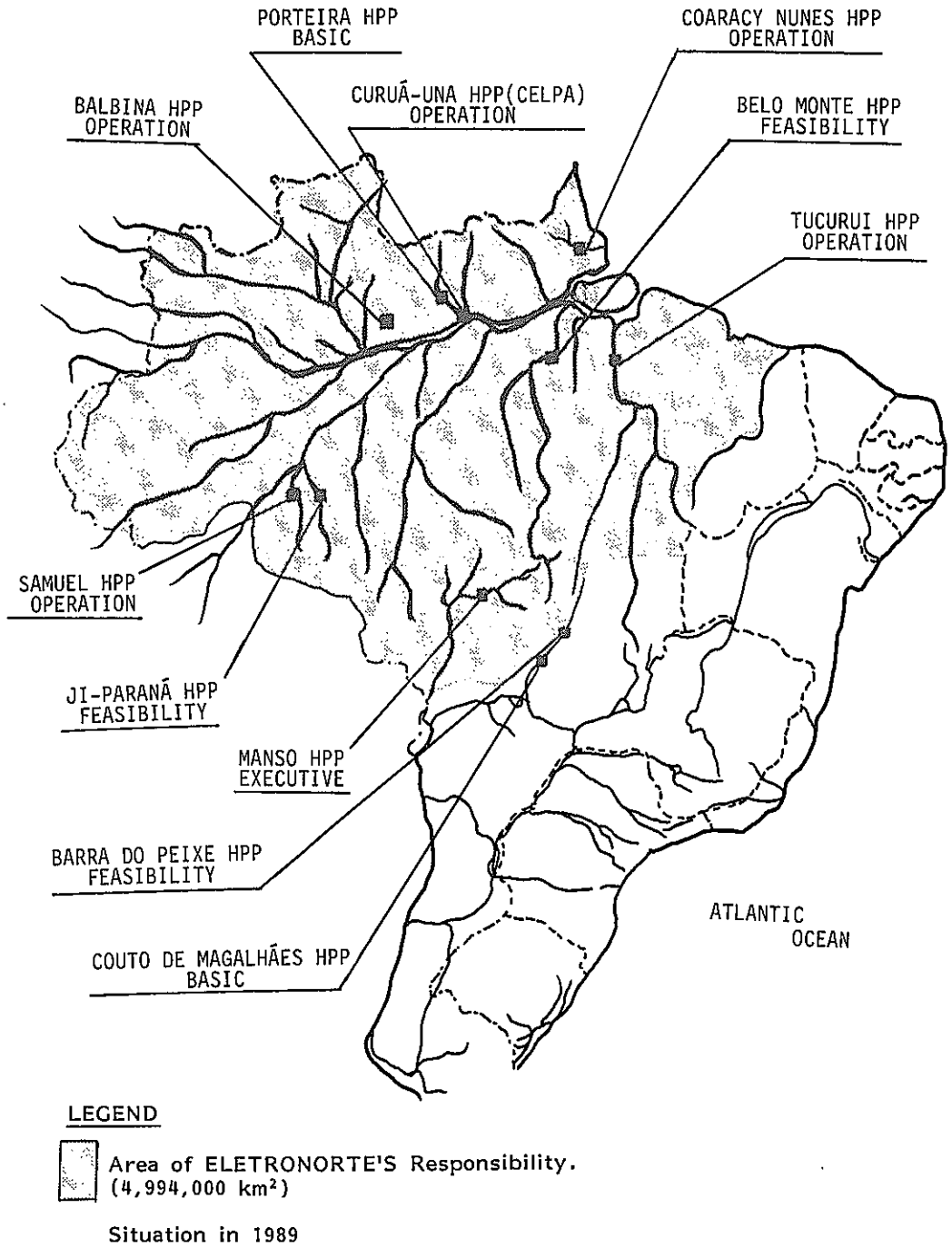

Figure F1. Map of the Amazonian Region with Existing and Projected Reservoirs (from Juras, 1990)

2. THE GENERAL ENVIRONMENTAL EFFECTS OF AMAZONIAN RESERVOIRS

Due to the special characteristics of the Amazonian region, the construction of reservoirs which occupy enormous areas (owing to the low declivity of the rivers) produce several problems in the biogeophysical, economic and social systems. These problems have been addressed by, for instance, Goodland (1977) and Tundisi et al. (1990).:

Chemical effects:
Aerobic decomposition, anaerobic decomposition, oxygen reduction, chemical precipitation, eutrophication, production of hydrogen sulphide, increased acidity.

Physical effects:
Reduction of vertical circulation, mechanical interference with dam, mechanical interference with multiple use.

Biological and human effects:
Loss of environmental "services", loss of valuable timber, loss of wildlife habitats, impaired water quality, proliferation of water needs, increased disease vectors.

Economic and social effects:
Disruption of low-scale economic activities and introduction of new types of economic activities, relocation of populations and increased urbanization of the dam site, relocation of Indian population (Amerindians), increase of tropical waterborne diseases such as malaria, loss of cultural identity of indigenous population and native non-indigenous population, loss of valuable archaeological information.

Generally, after the construction and filling up of the dam, a relatively large migrating human population arrives at the dam site, in the hope of obtaining employment or for the possible further exploitation of the aquatic environment (fisheries, navigation, exploitation of submerged timber). This aggravates the social conflicts and the public health problems. The exploitation of fish biomass is very intensive after filling up (some species of fish, such as the Cicchla ocelaris, grow very quickly after the dam is closed).

Another problem of chemical origin which has a biological and social effect is the discharge of bottom hypolimmetric water which causes extensive fish kills and produces a water of poor quality which cannot be used for any purpose.

Thus the downstream effects can be very severe as regards the river dwelling population.

3. PERSPECTIVES

The exploitation of the Amazonian hydropower is a complex problem. The export of energy outside the Amazonian reservoir is very high, at around 80%, due to the extraregional dependency of the Northeast and Southeast systems. Thus, on top of the above-listed problems, the region exports its hydroelectric potential to the other more developed regions. To solve this problem, recently a system of royalties was devised so that part of the generated hydroelectricity is returned to the original region in the form of investments and correction measures.

Solutions to the problems related to the construction of future Amazonian reservoirs reside in revisions to plans for hydroelectric power and the siting of reservoirs in selected hydrographic basins. On the other hand, the complex social conflicts generated by dam construction have to be solved by extensive negotiations which include upstream/downstream communities, Amerindians, and general users and inhabitants. This is a long process. The revision of the 2020 Brazilian plan for hydroelectric generation has already started. Public pressure, international pressure, and the active participation of the scientific community generated this revision.

As for the existing reservoirs, measures to mitigate the general effects on the ecosystem have been taken. Although not completely satisfactory, these measures show a disposition to work in the direction of large-scale mitigation activities. These include a public health policy to provide health care and preventive measures against endemic diseases, and a relocation policy to provide possible resettlement with extensive social studies of the area before dam construction. Preservation of social interrelationships and the cultural identity of populations is a very important and fundamental problem in this region. Another complex problem is the Indian community which needs special types of compensation which have to be established through negotiations.

The exploitation of the Amazonian hydropower depends on a great deal of skilled capabilities in several sectors involved in the planning, construction and operation of the dam. There also remains a strong need to improve the environmental awareness of the specialists and the general public to solve these conflicts through mutual understanding.

REFERENCES

Balon, E.K. and Coche, A.G., eds. 1974. Lake Kariba, a man-made tropical ecosystem in Central Africa. Junk. The Hague 12: 767.

Barrow, C.J. 1983. The environmental consequences of water resource development in the tropics. In Doi Juni Bee, ed. Natural Resources in Tropical Countries. Singapore University Press. Singapore. pp. 439-476.

Barrow, C.J. 1987. The environmental impacts of the Tucurui Dam of the middle and lower Tocantins River Basin, Brazil. Regulated Rivers. Research and Management 1(1): 49-60.

Baxter, R.M. 1977. Environmental effects of dams and impoundments. Ann. Rev. Ecol. Syst.: 255-283.

Branski, J.M., De Avila, J.P., Lopes, R.L.L., Goncalves, A.J.T. and Tundisi, J.G. 1988. Environmental impact assessment for the Porteira hydroelectric project. Presented at the 2nd Workshop on River/Reservoir Basin Ecosystem Approaches to Environmentally Sound Management of Inland Waters. Bangkok, Thailand.

Garzon, C.E. 1983. Water quality management strategies for the Alto Sinu hydroproject. Preliminary proposal (for) CORELCA, Colombia. Dartmouth College. Hanover, New Hampshire.

Goodland, R.J.A. 1977. Environmental Optimization in Hydrodevelopment of Tropical Foresets. In Panday, R.D., ed. Man-made Lakes and Human Health. University of Suriname. Suriname, Parmmibo.

Goodland, R.J.A. 1980. Environmental ranking of Amazonian Development Projects in Brazil. Environmental Conservation 7(1): 9-26.

Juras, A.A. 1990. Environmental Policies as Applied to Eletrumorte. In The Brazilian Northern Electrical Authority: Enterprises in the Amazon Region. Training Seminar on River/Lake Basin Management. Nagoya, Japan. p. 106.

Junk, W.J. and Nunes de Mello, J.A.S. 1987. Impactos ecologicos das represas hidreletricas na bacia amazonica brasileira. Tubinger Geographische Studien 95: 367-387.

Petr, T. 1978. Tropical Man-made Lakes: their ecological impact. Arch. Hydrobiol. 81(3): 368-385.

Tundisi, J.G. 1986. Ambiente, represas e barragens. Revista Ciencia Hoje 5(27), SBPC: 48-54.

Tundisi, T.G. and Matsumura-Tundisi, T. 1988. Limnology and eutrophication of Barra Bonita Reservoir, S. Paulo State, Southern Brazil. Proceedings of Reservoir Conference. Ceske Budejovice Tchecoslovaquia.

Tundisi, J.G., Matsumura-Tundisi, T., Hino, K., and Calijuri, M.C. 1988. The Lobo (Broa) Ecosystem and Reservoirs in Brazil. Expert Group Workshop on River/Lake Basin Approach to Environmentally Sound Management of Water Resources. UNEP/ILEC/UNCRD. Nagoya, Japan.

Van der Heide, J. 1976. Hydrobiology of the Man-made Brokopondo Lake. In collaboration with Leentvaar, P. and Meyer, J. Brokopondo Research Report 2, Suriname. p. 95.

Van der Heide, J. 1982. Lake Brokopondo - filling phase limnology of a man-made lake in the humid tropics. Amsterdam. p. 428.