

**D3.7 Reconnaissance Surveys of Water Abstraction Downstream of the Planned Dong Nai No.4 Powerhouse to the Tri An Reservoir**

The Irrigation and Land Departments of the Lam Dong and Dak Lak Provincial Authorities were consulted on aspects of Dong Nai River water use downstream of the planned Dong Nai No.4 powerhouse to the existing Tri An reservoir. The Departments confirmed that due to the steep slope of the land, which forms a continuous gorge extending from the powerhouse to the southwestern boundary of Nam Cat Loc, communes do not readily inhabit this area. Furthermore the Departments advised that the Dong Nai River has no significance to agricultural production in the buffer zones. The Lam Dong Provincial authority stated that it knows of only two locations, just north of Nam Cat Tien, where water is occasionally pumped from the River to irrigate paddies during the wet season. The Departments added that at present there are no significant amounts of water abstracted from the Dong Nai River, between the Dong Nai No.4 powerhouse and the Tri An reservoir, for the purposes of irrigation, industrial manufacture and drinking. Paddy and vegetable fields are common in the area between the north of Nam Cat Tien and south of Cat Loc, and to the east of Nam Cat Tien towards Tri An reservoir. Within the latter area there are about 6,200 hectares of paddy and vegetable fields. The fields are at a much higher elevation than the mean level of water in the Dong Nai River. Water is rarely pumped from the Dong Nai River to supply irrigation needs for these fields. Tributaries that eventually drain into the Dong Nai River supply the irrigation needs for these fields. Commonly, the tributaries are banded with earthen embankments to impound water in the wet season. Consequently the bunds form shallow reservoirs, from which irrigation channels are connected to supply the fields in the dry season. Thus the development of Dong Nai No.3 and 4 would not severely impact these agricultural fields. Likewise the Dong Nai River is not a significant source for drinking water, and there are no industrial concerns in this area that rely on a constant supply of water from the Dong Nai River.

**D3.8 Reconnaissance Surveys of Commune Households within the Planned Dong Nai No.3 Reservoir Impoundment Area**

The reconnaissance surveys found that households from only three communes occupy land and farm land within the proposed impoundment area of the planned Dong Nai No.3 reservoir. The three communes are the Dak Plao and Dak Som (which belong to the Dak Lak Province and Dak Nong District); and the Dinh Trang Thuong (which belongs to the Lam Dong Province and the Di Ling District). A visit in February 1999 to these commune areas confirmed that the households are essentially poor, with an economy based on agriculture (coffee, rice, vegetables and fruit). The standard of hygiene and sanitation was of a poor standard, and malaria was common among the population. Drinking water was abstracted from dug and tube wells. The majority of the houses were constructed from bamboo and wood, with thatched roofs. Almost all the households (over 90%) belonged to the Ma minority tribe. The households are recent immigrants into the planned Dong Nai No.3 reservoir area. They are not indigenous people. They originate from the south central plateau area, and migrated into the planned Dong Nai No. 3 area after the cessation of hostilities at the end of 1975.

A Rapid Rural Appraisal (RRA) based on sampling 10% of the households living in the Dak Plao/Dak Som and Dinh Tranh Thuong communes, which would loose land and homes from

flooding the reservoir, was undertaken in February 1999. The poll also aimed to gather opinions of the affected households on resettlement. A total of 17 households were interviewed (10 from Dak Plao and 7 from Dinh Trang Thuong). The total number of persons in the 17 families was 119 (namely 51 from Dinh Trang Thuong and 68 from Dak Plao). The format of the RRA and the results of its analyses are presented in Table D3.1. Over 93% of the persons interviewed belonged to the Ma minority tribe. This tribe is historically semi-nomadic. The number of persons in a household varied from 6 to 8. The major cause of illness was malaria and diarrhea. Measles, mumps and whooping cough are common in children. Typically each family has 6 to 12 hectares of cultivated land, mainly comprising coffee, rain-fed rice and fruit. Livestock is common in the commune households. Arable land is derived from recently felled forest. Fishing has no significance to the communes' livelihood. The affected households (those that would be flooded) wish to remain as agricultural workers. Medical facilities are very basic, and medicines are not readily available to treat the common illnesses in the communes. Public transport is seasonal and reliable services run in the dry season only. Roads that are flooded in the wet season are impassable. Most children attend primary school up to the age of about 14 and then they work in the fields. The households are not connected to the national electricity grid. Diesel generators supply electricity to some threshing machines. Tube wells and dug wells are the main source for drinking and irrigation water. Ground water is not polluted and the quality is considered to be good by government standards. There are no archeological, historical or cultural assets in the communes. The annual average income per household is about 12 million Vietnamese Dong (equivalent to about 850 US\$, at an exchange rate of 14,000 Dong to 1 US\$).

The format of the baseline RRA developed for this reconnaissance phase (i.e. sampling from 5% to 10% of the affected households and determining their opinions about resettlement) was adopted and extended to sample 20% of the affected household during the detailed investigation field studies (June to September 1999). The results of the detailed RRA are described in Chapter D4 below.

The results of the households' opinions on resettlement are summarized in Section 3.9 below.

### **D3.9 Reconnaissance Survey of the Households' Perception about Resettlement**

The survey found that the affected households understand and appreciate the meaning of resettlement. The communes living in the planned Dong Nai No.3 reservoir area are fully aware of Government current resettlement programs through the related experiences of neighboring communes. In particular, the Ministry of Agriculture and Rural Development (MoARD) actively pursues policies to resettle nomadic minority tribes into more stable and sustainable agricultural and manufacturing livelihoods. Additionally, the MoARD achieves some of its aims in protecting sensitive forests by resettling the communes away from these habitats.

The commune households that would be affected by the development of Dong Nai No.3 reservoir are aware of their entitlement to cash allowances (generally made on a monthly basis) for purchasing food and fuel, whilst the new agricultural fields and homes are prepared. The communes realize that forced resettlement into new locations is generally accompanied with better provisions for homes, healthcare, education, agricultural extension, and other infrastructure.

#### **D3.9.1 The Households' Main Concerns about the Resettlement Area**

The communes commented that all households should move at the same time, and this point is particularly important for extended family members. Thus, for example, grandparents, parents and children and adult brothers and sisters, as well as their children, should move at the same time. The commune wish to safeguard against extended separation of the family members.

The communes desire good homes made with better construction materials than the former homes (i.e. homes made from brick or concrete rather than from bamboo, wood and thatch). They asked for guarantees on their obtaining new fields, and a subsistence allowance that would cover the period between ploughing/sowing the new fields and gathering the first two harvests. They want better education and health, transport and market facilities as described in the next Section below.

#### **D3.9.2 Opinions Concerning Replacement Communal Facilities**

The communes expressed they wanted good education facilities (both primary and secondary) for their children; good roads for transporting goods into and out of the new communes; good provisions of transport; good health facilities (medical center and staff); and, *inter alia*, markets for trading and selling food and other produce.

#### **D3.9.3 The Households' Appreciation of Compensation**

The communes understand that lost fields and homes would be compensated on a like-for-like basis. Thus flooded fields would be replaced with new fields of the same size or larger. Homes would be replaced with the same construction materials, or better. Some households believe they would get lump sum cash compensations. Many also realize that expenditure of any cash payments would be closely regulated and monitored so as to prevent their wasting money on unnecessary goods.

#### **D3.9.4 The Households' Views on Farming Fish**

The communes objected to a livelihood, whether fully or partially, based on fish aquaculture. The households prefer to retain their existing agricultural livelihoods and lifestyles, which are based on growing coffee, fruit, vegetables and rice. This lifestyle is central to their ethnic origins and culture. The communes are aware of problems existing in fish farms at Tri An reservoir, which has experienced significant recent losses in stocks from disease and poor water quality.

#### **D3.10 Reconnaissance Surveys of National Parks and their Buffer Zones**

The reconnaissance surveys revealed that the planned Dong Nai No.3 and No.4 reservoirs, dams and powerhouses would not occupy any land designated as a National Park, Nature Reserve, Special Scenic Area or Protection Forest. The Cat Tien National Park lies from 50 to 130 km distant from the proposed Dong Nai No. 4 dam and reservoir. However, it was noted that the powerhouse of Dong Nai No.4 would be constructed on the very northern perimeter edge of the Lam Dong Province buffer zone where the zone's boundary meets with the Dong Nai River. This aspect was considered comprehensively during the Detailed Field Investigations carried out between June and September 1999 and is reported below in Section D6.7 of Chapter D6. There are no Protection Forests within the proposed locations of the dams, reservoirs and the powerhouses. The nearest Protection Forest lies about 40 km

west of the proposed Dong Nai No.4 powerhouse.

### **D3.11 Preparation of Tender Documents for the Detailed Field Investigation**

Review of the reconnaissance survey observations indicated that the most important aspects for the detailed field investigations and development of the EIA and RAP, which would be prepared by EVN and submitted to MoSTE and MoARD for gaining consent and planning application for the project were:

- the detailed analyses, by RRA, of the socio-economic condition within the planned reservoir areas;
- the resettlement of households out of the Dong Nai No. 3 reservoir and provision of appropriate compensation measures to replace the lost assets;
- the provision of better homes and education, health, transport, market, and agricultural facilities for the resettled households;
- the survey of the natural wildlife and vegetation occupying the proposed inundated areas of the Dong Nai No.3 and 4 reservoirs;
- the protection of wildlife habitat in virgin forest bordering the planned Dong Nai No.4 reservoir;
- the requirements (if any) for water downstream of the Dong Nai No.4 powerhouse to meet the needs for irrigation, drinking, and sustaining sensitive ecosystems;
- the analyses of environmental impacts and corresponding mitigation measures;
- the requirements for further ecological and socio-economic surveys; and
- the analyses of an environmental monitoring program that would be undertaken during the planning, construction and operational phases of the Project.

Discussions were also held with the MoSTE, MoARD and the Provincial Lam Dong and Dak Lak Provinces concerning their views for environmental protection and resettlement action planning. Mindful of the comments made by these agencies, the Tender Specifications for the detailed environmental surveys were prepared. Subsequently the contracts were awarded to PECC2, who, as required by legislation, and on the basis of the collected field data, also prepared the Vietnamese detailed EIA and RAP reports that would be submitted to the MoSTE and the MoARD to gain consent for the Project.

#### **D4 RESERVOIR POPULATION AND RESETTLEMENT PLAN**

##### **D4.1 Communes in the Dong Nai No.3 and No.4 Areas**

###### **D4.1.1 Communes with Boundaries Occupying the Planned Dong Nai No.3 Reservoir Area**

The planned impounded area for Dong Nai No.3 reservoir contains the boundaries of 7 communes (Table D4.1 and Figure D3.1). However not all of the households belonging to these communes own homes or other fixed assets within the planned Dong Nai No.3 reservoir area. Thus, although the boundary of a commune occupies land within the planned reservoir area, its household members and landowners might not be affected by flooding the reservoir.

During 1997/1998 the Dak Plao commune was split into the Dak Plao and Dak Som communes, and the Loc Lam commune was subdivided into the Loc Lam and Loc Phu communities. The subdivision was necessary for administrative purposes owing to an increase of the population size due to immigration from outlying locations. Within the communes the annual growth rate of the population is about 2.5%, but growth due to immigration is much higher at about 6%. The immigrants comprise shifting agriculturists (practising slash and burn agriculture).

The Dak Plao and Dak Som communes are the largest public group that would be affected by the Dong Nai No.3 reservoir impoundment, as their lands, fields, homes and communal facilities lie below the 550 m elevation contour. Crops grow best below the 550 m elevation contour, and thus settlements are preferred below this altitude. The Dinh Trang Thuong hamlets comprise a small splinter semi-nomadic group, which seasonally migrates away from the main commune location laying about 12 km upstream of the planned reservoir area. This splinter group seasonally migrates into the Dong Nai No.3 planned reservoir area in the dry season to plant and harvest cash crops such as coffee and groundnuts, and to grow rice and vegetables as the staple crop. The pattern of their agricultural regime is described as shifting. The homes of this splinter group are made from bamboo wood and thatch, and are essentially only temporary accommodation for the duration of the dry season.

The Phoc Tho commune, which is generally upstream of the planned Dong Nai No.3 reservoir, has a boundary that slightly penetrates the reservoir area. This commune's boundary occupies only 1.5 km<sup>2</sup> of the planned reservoir area, and this land is forested and owned by the government. No individual from this commune would lose any asset due to impounding the Dong Nai No.3 reservoir. Likewise, no individual from the Quang Khe commune would lose any land due to impounding the Dong Nai No.3 reservoir. Only 17.7 ha of the commune's area, comprising mostly government owned forest, would be impounded by the Dong Nai No.3 reservoir. No individual from the Loc Lam and Loc Phu communes owns homes or land within the planned area of the Dong Nai No.3 reservoir.

It might be noted that the Quang Khe commune boundary straddles both the planned Dong Nai No.3 and No.4 reservoir areas (see Figure D3.1).

###### **D4.1.2 Communes with Boundaries Occupying the Planned Dong Nai No.4 Reservoir Area**

Households do not inhabit the planned impoundment area of the Dong Nai No.4 reservoir. All of the land destined for this reservoir is government owned. Owing to the dense forest and very steep slope of the land inhabitants have not settled within the proposed reservoir area. Therefore no communes and no private individual would be affected by land taken to

develop the Dong Nai No.4 reservoir.

The Dong Nai No.4 reservoir would occupy about 4.0 km<sup>2</sup> of land, contained in a gorge, which lies within the boundaries of the Quang Khe and the Loc Bao communes.

#### **D4.2 Demographic Characteristics of the Communes**

The demographic characteristics of the communes occupying land within the planned Dong Nai No.3 and No.4 reservoir areas is shown in Tables D4.2 to D4.5.

##### **D4.2.1 Demographic and Ethnic Characteristics**

Population statistics of the provinces, the districts and the communes are shown in Tables D4.2 and D4.3. The ethnic (tribal) composition within the overall Districts and in the communes is shown in Tables D4.4 and D4.5. Population density is generally much higher at the commune level as compared to the district and provincial levels. The Kinh tribe is the main ethnic group within the overall Districts (Table D4.4), whereas the Ma ethnic minority tribe predominates within the communes bordering the planned reservoir impoundment areas. The Ma minority tribe comprises about 85% of the inhabitants in the communes that would be affected by impounding the Dong Nai No.3 reservoir. The Kinh (which is a majority tribe) are town-dwellers, with jobs in the service and industry sectors. Very few Kinh live among the rural impoverished communes. Thus the Kinh tribe is represented by about 12% of the population in the rural communes, and by over 60% of the population at the level of the District (Tables D4.4 and D4.5).

The Ma tribe is historically nomadic, and practised slash and burn agriculture on the western plateau area. Traditionally they relied on harvesting timber from forests to build homes and prepare fields for growing rice and other staple foods. In 1975, after the cessation of war hostilities, the tribe migrated into the central highlands and gradually moved southwards into the southern central highlands. Members of the tribe colonized the Dong Nai No.3 reservoir area after 1975, and the population has increased steadily since the 1980s. They are not indigenous to the Dong Nai No.3 reservoir area.

From the demographic data available for the 7 communes (see Table D4.5), apparently 9,444 persons live within the close proximity of the Dong Nai 3 proposed reservoir, and 3,530 live within close proximity of the planned Dong Nai No.4 reservoir.

##### **D4.2.2 Agricultural Production and Forest Cover**

Agricultural production throughout the three relevant Districts and the 7 communes is based on rice, sweet potato, yams and maize as the staple food item, and coffee and tea as the cash crop (Tables D4.6 and D4.7). About 10% of the land use is under agricultural management.

The areas of forest (chiefly bamboo) covering the 7 communes are given in Table D4.8. This forest is mainly low value bamboo and it occupies about 90% of the communes' land within the proposed Dong Nai No.3 reservoir area. Bamboo is an indicator of disturbed forest, and it develops as a direct result of logging and land clearance. The large population living close to the Dong Nai No.3 planned reservoir has a significant impact on the forests. However, within the Dong Nai No.4 commune areas, the forest has a very much higher representation of hardwood species owing to the small human population living alongside the forest.

#### D4.3 Socio-economic Characteristics of the Communes

The District and Provincial Statistical Yearbooks provide only basic qualitative and quantitative estimations of the socio-economic conditions within the communes. The data are not substantive. A summary of the 1998 District Yearbook statistical data for the Dak Plao/Dak Som and Dinh Trang Thuong communes is given in the Table D4.9. It might be noted that families from these 3 communes would lose land and/or homes due to the construction of the planned Dong Nai No.3 reservoir. Compensation and resettlement policies apply only to these communes. A detailed socio-economic survey, based on the RRA carried out during the reconnaissance first field investigations (see Section D3.8 of Chapter D3), comprising sampling 20% of the population in the affected communes (namely, Dak Plao/Dak Som and Dinh Trang Thuong) was made between June and September 1999. The results of the RRA socio-economic census survey are shown in Table D4.10.

The data obtained in the RRA census (20% sampling; Table D4.10) are broadly consistent with the data available from the District 1998 Statistical Yearbook (Table D4.9).

The data show that the number of persons per household ranges from 6 to 8 persons. The average home is built of wood or thatch, and has an average floor space of 30 m<sup>2</sup>.

Typically each family has 2 to 10 ha of cultivated land, commonly comprising coffee, rain-fed rice, vegetable tubers, maize, nuts, beans and fruit. Livestock rearing is also practised (chickens, cattle, goats and pigs). Arable land is prepared from cleared forests. Fishing has no importance to the livelihood of the communes, and they wish to remain as agricultural workers.

The major cause of illness and death is malaria and diarrhea. Malaria, dengue fever, diarrhea, measles, mumps and whooping cough are common diseases in children. Medical facilities are very basic, and medicines are not readily available in the communes. Dak Plao has a health center, which serves the entire community. Three paramedics staff the center and a doctor visits the commune on a monthly basis. The closest medical center to Dak Plao and Dinh Trang Thuong is at Gia Nghia, but this too can only provide basic health care. The Dak Lak province has only one general hospital with 500 beds, and the Lam Dong Province has a general hospital in the provincial center at Da Lat. These general hospitals are about 100 km distant from the communes, and transport to the hospitals is not readily available and is not reliable. The Loc Phu/Loc Lam commune is served by 3 paramedics.

The availability of public transport is seasonal, that is mainly in the dry season. In the rainy season the poor state of the flooded non-tarred roads prevents buses operating in and out of the communes.

Most children attend primary school up to the age of about 14, whilst older children help the parents in the fields. The existing primary school facilities are close to the commune. Each commune has at least one primary school. Secondary schools are restricted to areas having a Kinh majority as for example in the larger towns such as Gia Nghia. Almost all children receive an elementary (primary) school education up to the age of 12 or 14. Subsequently children follow their parents into the family labor market (mainly agricultural production).

The communes are not connected to the electricity grid. Diesel generators supply electricity to some homes and to agricultural threshing machines.

Tube wells and dug wells are the main source of water for drinking and irrigation. Ground water is not polluted and the quality is considered good.

There are no archaeological, historical and cultural assets in the commune. Furthermore, the planned Dong Nai No.3 and No.4 reservoir areas do not have any archaeological or historical cultural assets.

The annual average income per household is about 12 million Vietnamese Dong (equivalent to about 850 US\$ at an exchange rate of 14,000 Vietnamese Dong to 1US\$). In summary, the communes are essentially subsistence farmers, and they are able to accumulate some annual surplus income.

#### **D4.4 Numbers of Households and Land Impacted by Impounding the Dong Nai No.3 Reservoir**

Section D4.1 above noted that some households from the Dak Plao/Dak Som commune (Dak Lak Province) and the Dinh Trang Thuong commune (Lam Dong Province) would lose homes and land as a consequence of impounding the planned Dong Nai No.3 reservoir. It was also noted that impoundment of Dong Nai No.4 reservoir would not lead to the loss of any homes, privately owned land or other privately owned asset. The number of households that would lose homes and land, and the magnitude of these losses, were estimated from the District 1998 Yearbook and from a detailed census carried out by PECC2 in 1998. The latter were complemented by the detailed field investigations, primarily land acquisition surveys, undertaken between June 1999 and September 1999. Tables D4.11 and D4.12 provide a summary of the number of households that would lose land and homes by impounding the Dong Nai No.3 reservoir to the FSL of 590 m. Table D4.13 provides an estimate of the land-use area of each of the 7 communes that would be impounded by the Dong Nai No.3 reservoir. It should be noted that almost all of the impacted households and their agricultural fields lie below the 550 m elevation contour. This is perhaps not surprising, as agricultural crops grow best at and below this altitude.

Table D4.13 clearly indicates the area of land in each of the communes that would be lost by impounding the planned Dong Nai No.3 reservoir. The communes that would lose homes and agricultural fields are mentioned above. Besides these directly affected households, the Phoc Tho commune, which is generally upstream of the planned reservoir, has a boundary that slightly penetrates the reservoir area. This commune's boundary would occupy only 1.5 km<sup>2</sup> of the planned reservoir area. The flooded land would comprise only bamboo forest, which is owned by the Government. In view of the small area of land that this commune would lose, it is not considered in detail in this assessment. Likewise the Quang Khe commune would lose a small area of land amounting to 17.7 hectares. It would also lose land from impounding the Dong Nai No.4 reservoir as reported in the next Section. The Loc Lam/Phu commune would lose about 1,395 hectares of land.

#### **D4.5 Area of Land Flooded by Impounding Dong Nai Reservoir No.4**

The planned Dong Nai No.4 reservoir would occupy about 490 hectares of land belonging to the Quang Khe and Loc Bao communes. As reported above, no households would lose any land or homes through impounding this reservoir. As well as losing 17.7 hectares due to the planned Dong Nai No.3 reservoir, Quang Khe would lose a further 256.35 hectares of government owned land from impounding the Dong Nai No.4 reservoir. The remaining 233.65



hectares of land taken by impounding the reservoir belongs to the Loc Bao commune, and this land is mostly forest and entirely owned by the State.

#### **D4.6 The Affected Households' Perception and Concerns about Resettlement**

Section D4.4 above noted that some households from the Dak Plao/Dak Som commune (Dak Lak Province) and from the Dinh Trang Thuong commune (Lam Dong Province) would lose homes and land from impounding the planned Dong Nai No.3 reservoir. In February 1999, during the first field investigation, a short poll was undertaken within the affected communes to measure their responses concerning resettlement. The results of that poll are described in Chapter D3 above (Section D3.9). During the more comprehensive sampling of the population undertaken during the detailed field investigation stage (June to September 1999), the same questions, as reported in Chapter D3 above (Section D3.8), were raised within the Dak Som/Dak Plao and Dinh Trang Thuong communes. This opportunistic survey was made so as to verify the responses noted in the earlier February 1999 survey. The households' responses were unchanged from the earlier poll, as described in the next paragraph.

The affected households are not opposed to resettlement, as long as the families are compensated for the loss of fields and homes on a like-for-like basis. They desire good homes, adequate education and health facilities, good roads, reliable transport means, and sustainable agricultural capability in the resettlement areas. They also desire guarantees on obtaining new fields and subsistence (cash subsidy) whilst the new homes are built. They also require guarantees on subsidies to ensure sustenance during the period between preparing the new fields and the first two harvests. They wish to safeguard against families becoming disintegrated due to the resettlement; that is the extended family (brothers, sisters, parents and grandparents) should relocate at the same time.

The affected households commented that extended family members living above the FSL should also be offered resettlement, so as to preserve the integrated family unit. The community appreciates from existing government relocation programs, involving neighboring communes, that resettlement into new locations is often accompanied with prospects for better homes and better living and livelihood conditions. The Resettlement Action Plan (RAP) recognizes these aspirations, and it is sympathetic to reasonable wishes expressed by the affected households (see Section 4.8 below).

#### **D4.7 Proposed Resettlement Areas**

The principal legislation governing resettlement, and resettlement action planning, is the Decree 22/1989/ND-CP of 24 April 1998, as reported in Chapter D2 above (Subsection D2.2.2). The Decree 22/1989/ND-CP applies conditions for selecting and preparing resettlement areas. The Decree provides that the area should be selected according to existing programs for land planning (taking account of any needs for environmental protection). Additionally the Decree provides that the resettlement area must have adequate infrastructure to sustain the new households. Mindful of the existing legislation requirements, the locations of the currently considered resettlement areas are shown in Figure D3.1. Overall the resettlement areas were selected on the basis of the following criteria:

- the land shall be suitable for agricultural development (good soil quality, topography,

irrigation, etc.) and animal husbandry;

- there shall be easy access to road transport;
- there shall be easy access to and provisions for medical and educational services;
- uninterrupted water supply shall be available throughout the year;
- protected natural resources shall not be impacted from the choice of the resettlement areas; and
- the areas selected for resettlement shall be in close proximity to the former location.

Initial deliberation is given to resettling the affected Dinh Trang Thuong commune households (89 households as of 1999) at hamlet 9 location. Hamlet 9 is within the boundaries of the commune and 14 km upstream of the existing location of the affected households. It has an area of about 835 hectares and lies alongside the Dong Nai River. Its area lies about 2 to 12 km upstream of the planned reservoir. The present commune center is about 4 km westwards of this proposed resettlement area. The total area of land occupied and farmed by the households, which would be impounded by the reservoir, amounts to 120 hectares (Table D4.13). In comparison to this 120 hectares, which must be compensated, the resettlement area offers 835 hectares for use by the relocated households. A 4.5 km road is required to connect the hamlet to the main National Highway Road No.28. The soil conditions in the area are comparable to the type existing at the households' present location. As part of the National Highway Road No.28 would be flooded, it should be possible to realign the new road through the relocation area. From there it would cross the Dong Nai River and head towards the resettlement area of the Dak Plao/Dak Som commune.

Consideration is given to relocating the affected Dak Plao and Dak Som commune households at Buon Bang Ra (Yuk Dampout). It has an area of about 1,285 hectares. The National Highway Road No.28 passes alongside the southwestern portion of this proposed resettlement area. Buon Bang Ra belongs to the Dak Plao commune and it lies about 6 km northwards from the existing main commune center. The total area of land occupied and farmed by households, which would be impounded, amounts to about 350 hectares (Table D4.13). In comparison to this 350 hectares, which would be compensated, the resettlement area offers 1,285 hectares of land for use by the affected households. A new road is required to connect the resettlement center to the National Highway Road No.28.

Overall these resettlement areas provide the resettled households with more than three times the area of land formerly available to them in the proposed impounded Dong Nai No.3 reservoir. Furthermore, there are no sensitive natural resources within or very close to the proposed resettlement areas.

Irrigation water would be from the Dong Nai River in the dry season, with rain-fed supply in the wet season. The existing resettlement plan considers boring 73 water wells for the resettled Dinh Trang Thuong commune and 168 for the resettled Dak Plao/Dak Som commune.

Consideration is given to providing solid waste management infrastructure. About 12 km of the National Highway Road No.28 would be submerged, and the replacement would require about 50 km of new road that would also be used for transporting construction materials to the site. The resettlement areas would be designed so as to connect homes with the national

electricity grid. Other planned infrastructure comprise, schools, health centers, markets, improved transport routes and so on. These aspects are discussed in more detail below.

#### **D4.8 The Baseline Resettlement Action Plan (RAP)**

The ultimate purpose of the RAP is to report guarantees that private households would be resettled within new living areas, which would provide a sustainable and improved standard of living. In the initial stage a baseline inventory is made of the households and private and public institutions that would lose assets due to the construction and operations of the Project. On the basis of this inventory a baseline RAP is prepared. Subsequently at a later stage, an official and final detailed RAP is made in conjunction with the Provincial Authorities. This final plan would list and define in more detail the measures agreed with the Provincial Authorities to compensate the households and institutions.

The main legislation, rules and regulations governing the content of the RAP are as follows:

1. Central Government's Decree No.22/1998-ND-CP dated 22 April 1998 (Compensation for damage when the State recovers land for national defense, security, national and public interests).
2. Ministry of Finance Circular 145/1998/TT-BTC dated 4 November 1998 (Guidance on the implementation of the Government Decree No.22/1998-ND-CP).
3. Central Government Decree 54/1999/ND-CP dated 8 July 1999 (Safety protection from high voltage transmission lines).
4. Lam Dong Province Compensation Policy Decision No. 2034/QD-UB dated September 1998; and its Guideline No. 627 dated 8 October 1998 (Rules and methods for calculating compensation for land compulsorily taken by the State under Decree No.22/1998-ND-CP).
5. Dak Lak Province Compensation Policy Decision No. 3079/1998/QD-UB dated December 1998 (Compensation rates for crops and assets for land compulsorily taken by the State under Decree No.22/1998-ND-CP).

Under the existing legislation, the Project proponent is required to submit a base-line RAP to the Provincial Authorities (namely the Lam Dong and Dak Plak) for evaluation and for gaining consent to prepare the official detailed report. In fulfillment of the regulations, PECC2 finalized the baseline Resettlement Action Plan in September 1999. Essentially, this baseline report is a policy document, or document of intent. It contains the results of a baseline survey of the households and institutions that would lose assets due to impounding the reservoir. It refers to a tentative scale of compensation measures, as required under the existing national legislation and by rules and regulations issued by the relevant Provincial Authorities. This baseline RAP was prepared in consultation with the Provincial Authorities of Lam Dong and Dak Lak. After approval of the baseline RAP by the Provincial Authority of Lam Dong and Dak Lak, an official detailed confirmation survey, as required by Provincial Authority regulations, would be carried out to finalize the scope of compensation measures and the applicable modes and schedules of compensation. The exact date on which this official detailed survey commences is also the cut-off date after which settlers entering the proposed impoundment areas would not qualify for compensation under the terms of the RAP. The official final detailed survey and preparation of the RAP that would be undertaken in conjunction with the Provincial Authorities is reported in Section D4.10

below. The following discussion reported here, therefore, refers only to the baseline RAP information, which was finalized in September 1999 after completion of the initial inventory of affected households, institutions and property. This initial RAP is required by the Provincial Authorities to evaluate whether to allow the RAP to progress into the official detailed compensation and resettlement surveys in preparation for the actual resettlement phase.

The current baseline RAP contains the results of a census taken on the number of households that would be affected by flooding the Dong Nai No.3 reservoir to its FSL of 590 m. An inventory of impacted assets that would need to be compensated is shown in Table D4.14. The costs for compensating the losses would be based on the Provincial rules and regulations listed above, as required under the Central Government Decree No.22/1998-ND-CP. The inventory of impacted assets and their compensation costs would need to be re-evaluated during the official detailed confirmation surveys, which would be carried out in conjunction with and as directed by the Provincial Authorities (see Section D4.10 below). Compensation measures are discussed in Section D4.9 below.

The overall objective of the RAP is to ensure that all the affected households and other affected person and institutions would be compensated satisfactorily for their losses. Additionally it aims to provide better living conditions in the resettlement areas and to avoid a fall in the living standard. As well as evaluating compensation items and their cost, the RAP aims to:

- provide assistance in resettling households within the relocation areas;
- achieve goals that minimize impacts on the households;
- achieve a better living standard among the resettled households;
- achieve improved education, health, transport and market facilities within the resettlement areas;
- achieve improved supplies of water, electrification, waste treatment and other utilities within the resettlement areas; and
- introduce educational programs on improving farming methods, agricultural production, and family health and welfare.

The realization of these aims would require the close partnership between the communes (notably the Commune representatives, such as the People's Committee of the Commune) and the Resettlement Action Committee (RAC) before resettlement begins. The composition of the RAC, which would direct and enforce the RAP, is discussed in Section D4.11 below. Public consultation is an important part of the RAP, to ensure that the public fully understands the nature and reason for the Project and their rights to compensation measures. The public consultation would be undertaken with the assistance of the People's Commune Committee to explain the RAP, and it would also address mechanisms for hearing and addressing grievances. The public consultation would be undertaken during the official compensation and resettlement detailed surveys and the re-evaluation of the baseline RAP's compensation measures (see Section D4.9 below). The affected household would have representation on the RAC and within the People's Commune Committee so that their opinions and comments can be taken into decisions and policies made before, during and

after resettlement.

After completion of the official detailed confirmation surveys and analyses of the results, the RAC, through the people's representative on the committee, would provide the households with information on the selected resettlement area(s). The information would contain details of the resettlement action plans for optimizing education, health and transport facilities as well as communal centers, including markets within the resettlement locations. This information would include the location of water resources, and any plans for installing water and electricity supplies, and waste treatment facilities.

The finalized official RAP would be implemented and coordinated through the RAC and the Project Management Board (PMB). It would be evaluated and monitored by an external ("watchdog") Independent Monitoring Organization (IMO). These Institutional arrangements would ensure the effective and timely design, planning and implementation of the RAP and provision of the compensation measures. The RAC would inform the affected households, through their representatives on the Committee and in the communes, of the timetable and schedule for the resettlement processes. Namely, the allocation of subsistence allowances; provisions of transport to move transferable assets; provision of allowances to construct new homes and prepare the new living quarters and agricultural fields; relocation of graves, etc.

#### **D4.9 Entitlement to Compensation Measures**

All certificated owners of land and homes (including those with agricultural fields, whether cropped or laying fallow) and owners of other fixed properties, have guaranteed rights to compensation under the provisions of Decree 22/1998-ND-CP. Similarly any rules and regulations notified by the Provincial Authorities would correspondingly apply to these owners. The cut-off date for right to compensation is taken to be the date of the "official compensation and resettlement detailed survey", as agreed between the Project proponent and the Provincial Authorities. The "official compensation and resettlement detailed survey" would be undertaken only after the baseline RAP is approved by the Provincial Authorities and after the planning permission to construct that Project is granted. Stringent regulatory conditions apply to granting compensation measures. Only those persons possessing rightful ownership certificates, as prescribed by the land legislation, or rights for using the land, as prescribed in Decree 22/1998-ND-CP, can make a claim for compensation. The Provincial Authorities, under the provisions of Decree 22/1998-ND-CP, issue rules and guidance for calculating compensation measures and resettlement allowances. In setting the limits on compensation, the Provincial Authorities would consult with the Ministry of Finance and take account of any ruling or guidance issued by this Ministry. Generally compensation would be granted at the market value of the lost asset or in terms of the reasonable cost for replacing that asset. Qualitative compensation measures are shown in Table D4.15

Many of the households living and cultivating land or owning land within the Dong Nai No.3 reservoir area are recent immigrants. Very few of these would have certificates of rightful ownership or rights to use the land. Also, these households are often classified as very poor by Vietnamese standards. However, under Decree 22/1998-ND-CP these households would be considered for compensation on a case-by-case basis under the direction of the People's Commune Committee and the Provincial Authorities. The

magnitude of the compensation measures would be defined and advised by the Provincial Authorities, through its Provincial People's Committee and Provincial Resettlement Committee. These Committees have powers to decide upon the scales of the compensation measures and the allocation of any subsidies. However after publication of the cut-off date for undertaking the detailed resettlement and compensation survey (see Section D4.10 below), compensation would not be granted to any new immigrant entering the commune. Such persons would be forcefully removed from the commune.

Allowances would be provided to all resettled households to assist its members to resettle quickly in the new area and develop a sustainable livelihood.

Compensation measures would comprise replacing or relocating homes and other fixed assets, and/or providing the cash equivalent value of the lost asset. In the latter case, spending of the cash equivalent would be strictly controlled and monitored by the Provincial Authorities so as to prevent the households from wasting the money on unnecessary goods. Cash would be given in installments only as directed by the Provincial Authorities. Before compensation is made to the households, they would be provided with an Assets Compensation Form that defines the scale of the measures. The households are then required to sign the form, thus confirming acceptance of the compensation measures. The People's Commune Committee would review all grievances and aim to resolve disagreements through the RAC.

Every relocated household would receive a living allowance for the first six months, as defined by the Provincial Authority. This is often given in terms of kg or rice per family member per month. This period might be extended after the 6 months, but would be re-assessed on a case-by-case basis.

A summary of the number of impacted households, comprising those that would lose homes and/or agricultural plots is shown in Table D4.12 (see also Section D4.4 above). Almost all of the impacted households (flooded households) and their agricultural fields lie below the 550 m elevation. Thus the costs amounting from resettling and compensating households for lost assets (see below) peak and reach a plateau at this elevation. All of the costs for resettlement and compensation arise from impounding the Dong Nai No.3 reservoir. The impoundment of the Dong Nai No.4 reservoir does not incur any resettlement or compensation costs. The Dong Nai No.4 reservoir would incorporate 490 ha of forest, which is not inhabited by communes and all of the land is State owned. The diversion tunnels, waterway tunnels, and powerhouses would not require purchase of privately owned property.

The summary inventory of compensation items and their estimated costs, which was completed in September 1999 at the end of the field investigations and included in the RAP, is shown in Table D4.14. The RAP survey also includes a list of household names (257 losing homes and fields and 127 losing only fields). Compensation is required to replace flooded homes, flooded agricultural lands, animal pastures, other owned assets, and commune infrastructure such as market places, schools, medical centers, transport connections and so on. Table D4.14 shows that the total costs for resettlement and compensation amount to 147,055,600,000 Vietnamese Dong (VND; equivalent to 10.6 million US\$ at an exchange rate of 1 US\$ = 13,870 VND at the current date). The total cost, as shown in Table D4.1, comprises the following principal elements, namely: land

registration fees (642,500,000 VND; equivalent to 46,323 US\$); compensation costs (114,546,704,000 VND; equivalent to 8.26 million US\$); preparation of resettlement areas for habitation and agricultural production (28,407,319,000 VND; equivalent to 2.05 million US\$); Resettlement Action Committee costs (2,859,080,000 VND; equivalent to 206,134 US\$); and costs for an independent external "watchdog" agency to monitor the resettlement process and the actions of the resettlement management (600,000,000 VND; equivalent to 43,258 US\$). In addition to these individual budgeted items, the RAP proposes a sum of 500,000,000 VND (equivalent to 36,050 US\$) to cover planning for possible fish farming in Dong Nai No.3 reservoir. The potential to develop fish farming in the Dong Nai No.3 reservoir is discussed in Chapter D9 below. It would appear to be a remote possibility. The resettled households are opposed to adopting a livelihood based on fish farming and wish to retain their agricultural lifestyles, consistent with their ethnic and cultural values. Therefore the development of fish farming might be problematical, but may interest a commercial organization. Thus the 500,000,000 VND, to examine and review the potential for setting up fish farms in the Dong Nai No.3 reservoir, is a separately budgeted item in the RAP report, and, therefore, it is not intrinsically incorporated into Table D4.14.

Final compensation costs would be determined in relation to current market prices, the labor costs for rebuilding or replacing an asset and any ruling made by the Provincial Authorities. Institutional arrangements would ensure effective and timely design, planning and monitoring of the resettlement program. Provisions also apply to land that is temporarily affected by the Project.

According to the Provincial Authorities there are 145 very poor households with insufficient food supply. This is taken into account in the RAP, which would provide two million Vietnamese Dongs (VND) to each of the very poor households to invest in farming and to improve their living standards. The Provincial Authorities would promote these very poor households as priority cases for receiving grants and subsidies under the existing poverty alleviation and health betterment schemes.

#### **D4.10 Preparation of the Official Detailed RAP and its Schedule**

Preparation of the official final RAP would commence immediately after the baseline RAP document, which summarizes the existing laws on resettlement and compensation, as outlined above, including the ranges, modes, methods and monitoring of compensation, and the composition of the RAC, is approved by the Provincial Authorities.

Subsequent to the base-line RAP's approval, the affected households would receive a RAP information package from the Project Management Board (PMB) via the People's Commune Committee. The package would describe the full extents and nature of the Dong Nai No.3 and No.4 CHPP and the scale of their land occupancy. It would provide details of the scope of compensation measures and payments, and schedules for their implementation. It will also define the cut-off date after which settlers entering into the affected areas would not qualify for compensation measures. The cut-off date is taken as the date on which the official compensation and resettlement survey begins. These matters would be debated in public meetings held in the commune centers. Following these initial public consultations, the official revised detailed census survey of the affected households and of their assets would be undertaken to confirm the inventory of compensation measures and the limits of the impounded reservoir. The Provincial Authorities and the local People's Commune

Committee would be parties to these surveys so as to enable rapid agreement on the final compensation measures and award of costs. The final terms of compensation would be based on the results obtained from the confirmation surveys, and the applicable central and local government laws, rules and regulations as described above, and any measures imposed by the Provincial Authorities..

The Provincial Authorities, through their responsible Departments, would oversee the preparation of the resettlement sites, the resettlement and receipt of compensation. This period would also be monitored by the IMO. The exact dates that resettlement would begin, would be determined by the PMB in consultation with the RAC and the IMO, the representatives of the affected households and the responsible Departments of the Provincial Authorities.

#### **D4.11 The Resettlement Action Committee (RAC)**

The principal role of the Resettlement Action Committee (RAC) is to oversee the management of the RAP and enforce implementation of the compensation measures and resettlement program. It would ensure the effective and timely design, the planning and implementation of the RAP, as well as monitoring its progress, failures, and reviewing the RAP's content. The RAC would be formed during the period of the official detailed compensation and resettlement surveys, after planning consent for the Project is given and the Provincial Authorities have accepted the baseline RAP. The Provincial Authorities would also constitute the Provincial Resettlement Committee. This Committee would have comparable responsibilities to the RAC. It would be a significant body for ensuring that the compensation measures and allowances agreed between the Project proponent and the Provincial Authority are strictly achieved. Prior to ratification of the RAP between EVN and the Provincial Authorities, EVN would form a Project Management Board (PMB) to oversee the resettlement actions and the management of those actions through the Resettlement Action Committee. The RAC would report directly to the PMB on the progress of and any problems in the resettlement phases. The Director General of EVN would set up the PMB. It would comprise members drawn from the Ministry of Finance, the Ministry of Construction and the National Land Administration.

The Provincial People's Committees of Lam Dong and Dak Lak will chair the RAC. The RAC's membership would be drawn from the following Institutions:

- Vice Chairman of the Provincial Resettlement Committees;
- Director or Vice Director of the District Agricultural and Rural Development Departments;
- Members from the Provincial Department of Science Technology and the Environment;
- Deputy Directors of the Provincial Power Departments;
- Deputy Directors of the Provincial Land Departments;
- Deputy Director of the Provincial Financing and Price Departments
- Chairmen of the People's Committee for the impacted Districts;
- Chairmen of the People's Committee of the Project Impacted Communes;



- Representatives of the District Land and Agricultural Departments;
- Representatives from the Project Management Board; and
- Representatives of the project impacted persons.

In addition to the above, an external "watchdog" independent monitoring organization (IMO) would be appointed by the PMB to oversee the actions of the RAC and RAP. The IMO would report twice yearly to the RAC. The IMO would undertake field surveys within the resettlement locations and they would evaluate any problems encountered by the affected households and recommend measures to resolve those problems. The PMB, in conjunction with the Provincial People's Committee, through the Provincial Resettlement Committee, would likewise regularly supervise and internally audit/monitor the RAP. The PMB would be the point of contact between the organization implementing the RAP and any external Donor Agency.



## **D5 Natural Reservoir Environment**

### **D5.1 Natural Reservoir Environment**

Aspects of the natural resources of the reservoir environment comprise the physical (water), the biological (vegetation and animal species, as well as protected nature reserves), and human settlement conditions.

During May to September 1999 surveys were undertaken within the planned Dong Nai No.3 and No.4 reservoir areas to record important species of birds, mammals, reptiles, fish and of the vegetation. However, access into the planned Dong Nai No.4 reservoir location was extremely difficult owing to the rugged topography, the steep slope of the land and the very thick forest. There were no suitable access roads into the forest, and it is mostly undisturbed by human settlers. Thus it was not possible to survey and describe the species of animals that might live in this thick forest.

Environmental surveys were made to a distance of 10 km upstream of the proposed Dong Nai No.3 reservoir. Where access was possible the surveys continued within the planned reservoir areas and up to a radius of 10 km out from the proposed full supply levels. The survey area continued downstream of the proposed dam locations to the site of the planned powerhouses. Existing information on the ecology of the downstream environment from the proposed Dong Nai No.3 reservoir to the Tri An reservoir, as well as within the regional areas of the planned reservoirs, was reviewed to complement the surveyed data.

### **D5.2 Water Quality and Sediment Loads**

During the rainy season in July 1999, the Institute of Tropical Biology (Ho Chi Minh City) collected water samples from the Dong Nai River within the locations of the planned Dong Nai No.3 and No.4 reservoirs. The results of the water quality analyses are shown in Table D5.1.

Overall, the results showed water of good to high quality, with high dissolved oxygen (generally better than 6.0 mg/l) and low nutrient concentration (total P, N-NO<sub>2</sub> and N-NO<sub>3</sub>). Water of this quality is considered generally unpolluted, and all parameters are within government standard tolerable limits. The suspended solid concentrations were lower than expected for the rainy season, which is normally accompanied by high runoff entraining surface sediments. Dioxin and other forest defoliantes were not detected in any water or soil sample.

#### **D5.2.1 Project's Possible Impacts on Water Quality**

Detrimental impacts on water quality could occur at the time of vegetation clearance, during the capital works' program and after reservoir impoundment. These impacts, and the scales of impacts, are common throughout the world during all reservoir construction and impoundment phases. The dam construction, and its associated capital works, sediment mining and vegetation clearance would increase sediment transport in surface runoff. This may cause significant fish deaths local to the points of entry into rivers, and the sediment would bury shallow aquatic vegetation used by breeding and feeding fish and other aquatic animals.

The water quality of the impounded reservoirs would be entirely dependent on the amount of vegetation cleared from the reservoir area. With the relatively small reservoir areas

(approximately 50 km<sup>2</sup> for Dong Nai No.3 and 6 km<sup>2</sup> for Dong Nai No.4) it would be possible to clear and burn or sell vegetation (forest) products from most of the planned reservoir area.

#### D5.2.2 Proposed Mitigation Measures for Water Quality

It is neither practically nor economically feasible to obtain zero sediment transport into rivers during the dam and reservoir construction. The costs would be excessive and the final benefits small. Some amelioration of sedimentation impact is possible by carrying out capital construction works and vegetation clearance in a carefully planned and stepwise approach. The diversion tunnels would allow water flow to bypass construction areas at which significant suspended sediments would arise. The diversion tunnels are significant ameliorating structures. The only practical manner to ensure a degree of good water quality in the impounded reservoirs, and in the downstream river, is through burning or removing the felled vegetation. The MoSTE requires clearance of all vegetation prior to impounding reservoir areas. The removal of vegetation before impoundment would significantly reduce detrimental impacts on the post impoundment water quality. During the operational phases, measures such as the re-forestation of bare land above the reservoir full supply level and prohibiting certain kinds of land use, would enhance soil stability and limit sedimentation within the reservoir.

#### D.5.3 Natural and Managed Vegetation

The Institute of Tropical Biology (Ho Chi Minh City) carried out a vegetation survey during the field investigation stages, between June and September 1999 and mapped the vegetation cover for the EIA study. The areas and percentage of ground cover by natural vegetation (tree and shrub species) and cropped vegetation up to the full supply level of El.590 m for Dong Nai No.3 and up to the full supply level of El.440 m for Dong Nai No.4 are given in Table D5.2.

The predominance of bamboo cover within the Dong Nai No.3 area is indicative of the shifting cultivation practised by the local communities, which in turn has reduced the importance of the natural vegetation as a habitat for animals and birds. Throughout the planned Dong Nai No.3 reservoir area, large tracts of recently felled trees, burnt ground and new plantations of cash crops are clearly observed, especially below the 600 m elevation. In contrast, land adjoining the planned Dong Nai No.4 reservoir is covered in a dense vegetation of mostly undisturbed evergreen/semi-evergreen forest. This type of vegetation is prime animal habitat for many animal species, and in turn it is in urgent need for protection and conservation.

Land lying above the El.590 m contour to the northeast and east of the Dong Nai No.3 area is covered with dense pine forest (El.600 m to El.1200 m), evergreen broad-leaved forest (El.600 – El.800 m), and mixed deciduous evergreen forest (El.600 to El.800 m). These forests are well developed in certain locations and there is an urgent need to protect this resource from exploitation.

In the region of the proposed Dong Nai No.4 reservoir, the Dong Nai River flows through a steeply sided and inclined narrow gorge (maximum width of about 40 m). Here, the River descends from about El.440 m elevation to El.360 m elevation in a longitudinal distance of about 19 km. The slopes of the narrow gorge are covered with a mixed vegetation of

bamboo and hardwood forest. Owing to the very steep slope, the vegetation has variable density and bamboo is common as hardwood trees are unable to grow and survive on the shallow unstable soils covering the very steep slopes.

The Institute of Tropical Biology reports for the EIA study, that in the wider Districts surrounding the planned project areas (typically the southern central regions of Vietnam) there are up to 722 species of plants belonging to 462 genera, 139 families and to 6 plant major divisions. As there are only 8 major plant divisions in Vietnam, clearly the district areas surrounding the proposed Dong Nai No.3 and No.4 CHPP site have a significant floristic composition. The 722 species of flora comprise 32.4% of the total known plant species in southeast Vietnam. Of these species, 37 are classified as endemic; 3 are classified as threatened; 9 as rare; 10 as vulnerable and 1 as endangered.

Table D5.3 compares the floristic diversity of the planned Dong Nai No.3 and No.4 regional areas with that of the Cat Tien National Park. The Table illustrates that the diversity of the flora in the regional areas surrounding the planned Dong Nai No.3 and No.4 reservoirs is comparable to that within the Cat Tien National Park. However as mentioned above, the proposed impounded area of Dong Nai No.3 reservoir is severely impacted by shifting cultivation, and most of the natural vegetation has been destroyed and replaced with agricultural fields. The planned impoundment area of the Dong Nai No.3 reservoir therefore has a poor diversity of plant species, which comprise mostly bamboo forest and agricultural crops. Some remnant gallery forest exists alongside the Dong Nai River at the proposed Dong Nai No.3 reservoir area. However, observations made during the field surveys indicated that the gallery forest is presently exploited for timber and leveled on a very large scale for agriculture. It is therefore very unlikely that much of this gallery forest would survive beyond the next 5 years.

#### D5.3.1 Project's Possible Impacts on the Natural Vegetation

Construction and impoundment of the Dong Nai No.3 and No.4 reservoirs would result mainly in the destruction of bamboo forest in the former, and bamboo and broad-leaved forest growing on the gorge of the latter. Bamboo forest is generally of lower habitat value for a wide range of animals as compared to broad-leaved tree species. The area of 6 km<sup>2</sup> that would be inundated at Dong Nai No.4 reservoir seems negligible in terms of the 50 km<sup>2</sup> for Dong Nai No.3 reservoir and other reservoirs already constructed in Vietnam or in planning in Vietnam. The Dong Nai No.4 construction could lead to the destruction and degradation of forest above the reservoir as permanent and temporary access roads, soil, rock mines and permanent facilities around the dam and powerhouse are built. The scales of such potential impacts would reduce significantly for the Dong Nai No.3 project site, which is currently severely impacted by human settlements and agricultural developments.

The World Wide Fund for Nature (WWF), has commented that the steep and narrow gorge topography at the location of the proposed Dong Nai No.4 reservoir is one of a rare and rapidly diminishing feature within Vietnam. Similar topographies elsewhere in the world are also threatened by hydropower and reservoir resource developments. The WWF added that this inundation area is one of rare global outstanding natural beauty, with high visual and aesthetic appeal arising from the rugged topography, the surrounding dense vegetation cover and the absence of significant human settlement. Although the inundation of the Dong Nai No.4 reservoir would flood less than 400 ha of mainly bamboo forest, which is low quality

forest, the main concerns of the WWF are the loss of the aesthetic appeal of the gorge. The WWF also verbally commented that construction of the reservoir, its operations and its access roads could allow more easy penetration of human settlements into the thick virgin forest on either side of the gorge. This in turn could result in significant threat to the safety and survival of many species of animals living in the adjacent dense forest, and the destruction of the virgin forests.

#### **D5.3.2 Proposed Mitigation Measures for the Natural Vegetation**

In general it is difficult to recreate natural vegetation habitat once destroyed. In the case of forests, gallery forests and wetland habitat, it is impossible to recreate the range of natural vegetation in the short-term years. Therefore it is not possible to mitigate the effects of habitat inundation by the recreation of the habitat elsewhere.

The WWF has commented that there is an urgent need to protect the virgin forest on either side of the proposed Dong Nai No.4 reservoir. Thus stringent mitigation measures are needed to protect the natural vegetation (and its animal inhabitants) from exploitation and inhibit human settlements during the construction and operational phases of the Dong Nai No.4 reservoir. A summary of logical mitigation measures is provided below.

During construction and operations of the Dong Nai No.4 reservoir, mitigation aimed at preventing human intrusion, settlement and hunting are priority measures. Control of access roads is entirely within the powers of the project proponents. Roads should be sited as sensitively as possible to minimize the areas that could be impacted by hunters and shifting settlers. Access to roads should be controlled in some way, by manned road barriers, forest wardens, site security staff and police, etc. After construction, some roads could be dug up and removed, and their routes recovered with soil and planted with natural vegetation. It is certainly appropriate in the long term to pursue measures to protect equivalent habitat and the habitat remaining after inundation.

At this stage it is not possible to speculate on environmental protection measures that might be needed in the future for this region. Any such measures would become apparent from further ecological surveys conducted during the detailed design planning, construction and operations of the Project. However, as mentioned above, the WWF have voiced opinions on the needs for certain conservation and protection measures. The Ministry of Agriculture and Rural Development (MoARD) has not assigned protection status to any forest growing within the municipal districts bordering the planned Dong Nai No.3 and No.4 reservoirs, or which would be impounded by the reservoirs. However, the MoARD continuously reviews its policies and the necessity to allocate protection status to forests. In so doing, the Ministry acts on the advice and recommendations of the Provincial and District Forest Departments.

#### **D5.4 Mammals, Birds and Reptiles**

The Institute of Tropical Biology (Ho Chi Minh City) surveyed the project areas between May 1999 and August 1999. The Institute reports, in the EIA, that a total of 222 species of animals comprising 35 species of mammals, 157 species of birds, 8 species of amphibians and 22 species of reptiles are known to exist in the southern central regional areas surrounding the proposed Dong Nai No.3 and No.4 CHPP site. The Institute listed the number of species recorded in the literature at the Cat Tien National Park, and compared the inventory with the number of species reported from the southern central regional areas

mentioned above. A summary of the Institute's comparative list, taken from the EIA study, is shown in Table D5.4. Clearly the planned Dong Nai No. 3 and No.4 project regional areas have a rich diversity of animal life, but of a much lesser importance as compared to the Cat Tien National Park. On a national level, the project regional areas contain the following percentages of the total number of known species recorded within the entire country: mammals (13%); bird (19%); reptiles (8%) and amphibians (9%). The Institute of Tropical Biology reports in the EIA study that out of the total animal species recorded in the southern central areas surrounding the planned projects, thirty three of the species are listed in the Vietnam Species Red Book (1992). Of these 33 species, 7 are categorized as endangered, 18 as vulnerable, 2 as rare and 6 as threatened.

The Institute of Tropical Biology (Ho Chi Minh City) reported in the EIA study, that birds commonly observed at the proposed reservoir areas were pheasants, pigeons, parrots, cuckoos, owls, swifts, trogons, bee eaters, woodpeckers, swallows, shrikes, bulbuls, drongos, babblers, warblers, thrushes, flycatchers, wax-bills, starlings, sun-birds and flower-peckers. Endangered (Red Book) bird species recorded during surveys of the Dong Nai No.3 and No.4 areas (July 1999) are listed in Table D5.5. Many of these endangered bird species are dependent on flowing rivers for food and woodlands for breeding and nesting. It is not known whether these species spend their entire life cycle within the area or migrate over a much larger range. The birds possibly migrate over considerable distances. Thus the impacts of reservoir inundation would be much less on bird species compared to terrestrial animals, which have a much smaller migration range and are essentially confined to the flooded reservoir areas.

Endangered mammals that have been recorded during the last 50 or so years in the southern central districts surrounding the Dong Nai No.3 and No.4 project areas are shown in Table D5.6. Owing to the existing human presence around the planned Dong Nai No.3 reservoir and the widespread destruction of the forest habitat, this area is unlikely to contain endangered animals, as their habitat no longer exists. Endangered mammal species were not observed during the field surveys. Mammals commonly reported by the Institute of Tropical Biology (Ho Chi Minh City) to inhabit the proposed Dong Nai No.3 and No. 4 reservoirs areas, though not always observed during the field surveys, are: shrews, primates, wild dog, otters, bears, tiger, leopard-cats, small wild cats, deer, wild pig, antelope, gazelle, gaur, goat-antelope, pangolin, flying squirrels, and rats. Reptiles recorded in the EIA study comprised common toads, frogs, lizards, geckos, snakes, tortoises, and the monitor lizard. Endangered, protected or rare reptile species were not observed during the field surveys. The forest bordering the planned Dong Nai No.4 reservoir area is dense, with no access roads and there is insignificant human habitation in the forest. Consequently it was not possible to survey this area comprehensively and in any detail.

As reported above, the reservoir area of Dong Nai No.3 is highly impacted by human communes and consequently it would have limited importance to natural animal communities. The natural condition of the proposed Dong Nai No.4 reservoir area is more problematical. It is difficult to enter the land bordering the proposed Dong Nai No.4 reservoir, owing to the dense forest and the steep slope and absence of networked roads. This forest would be significant habitat for many species of common and endangered animals, birds and reptiles.

#### D5.4.1 Project's Possible Impacts on Animals

The World Wide Fund for Nature (WWF) verbally commented that the Dong Nai No.4 area thick virgin forest would be significant habitat for elephants, tigers, other large and smaller cats, primates, otters and birds. Owing to the immense difficulty in gaining access within the thick virgin forest, the animal inhabitants have not suffered previously from extensive hunting or from other exploitation. Impounding the reservoir (area less than 6 km<sup>2</sup>) would have a small impact on the animals, as they are unlikely to live on the very steep slope of the gorge, which has a very poor cover of mixed bamboo/hardwood forest. However, as verbally commented by WWF, access roads to the structure sites of the proposed Dong Nai No.4 scheme, and later developments arising from the reservoir, could facilitate increasing human immigration into the area. This could result in a cascade of impacts arising from hunting and the destruction of the virgin forests. These are significant considerations for the Dong Nai No.4 area, which, presently, is largely unpopulated by human settlers.

#### D5.4.2 Proposed Mitigation Measures for Animals

The main impact of the project is direct loss of habitat due to flooding. The potential impacts are greater for the Dong Nai No.4 area as compared to Dong Nai No.3. Impacts can only be compensated through effective protection of similar habitat within the region of the hydropower development. One important measure for minimizing the impact on wildlife is a pre-impoundment clearing of vegetation from the reservoir area. Cutting trees and clearing the vegetation would drive most animals out of the reservoir area and perhaps into more safe areas. Rising water levels would similarly drive most animals away. However, animals relocating into new areas would encounter competition and aggression from similar species and survival becomes problematical. Thus policies and measures to better protect comparable habitat elsewhere is the only practicable mitigation measure. There must be strictly applied controls on killing or purchasing live or dead animals. Frequent and vigorous monitoring of the environment is required. In constructing and operating the planned Dong Nai No.4 reservoir, the developers and station operators must locate roads as sensitively as possible, to minimize possible threats arising from hunters and potential immigrants. Access to roads should be regulated and monitored by the wildlife protection authorities and/or the police. After construction is completed, roads that are no longer required should be bulldozed and the ground surface rehabilitated with a natural cover of soils and vegetation.

#### D5.5 Aquatic Vegetation and Animals

The Institute of Tropical Biology (Ho Chi Minh City) surveyed the plankton, riverbed animals and fish in the Dong Nai River project area during May to August 1999. The plankton was diverse comprising mostly diatomaceous algae, green algae, water fleas, and small water shrimps. These are at the base of the food chain and are important in sustaining larger aquatic organisms, such as fish, shrimps and shellfish. The larger organisms, as noted elsewhere in southeast Vietnam, predominantly comprised adult and larval stages of insects, followed by shellfish (mostly mollusks, shrimps and crabs). The plankton and larger organisms were typical of low acidity rivers, and are very common throughout the rivers of southern Vietnam. None of the plankton, the small crustaceans and mollusks are considered to be endangered species or at particular risk, and would survive the impoundment of the reservoirs. However, the composition of the various species numbers would certainly



change when the river is impounded into a reservoir.

The survey reported about 70 species of fish, belonging mostly to the carp family. The species of fish are very common to this area and of all rivers in southern Vietnam. Fish species recorded in the Dong Nai River within the locations of the planned reservoirs are listed in Table D5.7. Most of these species can live in large lakes and rivers, and very many are farmed in reservoirs. Communes living alongside the Dong Nai River opportunistically catch fish to supplement the diet. Fishing is not a commercial organized activity or enterprise, and it is not significant to the livelihood of the local communes.

#### **D5.5.1 Project's Possible Impacts on Aquatic Organisms**

The Dong Nai River insect community is characteristic of shallow flowing waters. Once the open water reservoir is created, species would develop that are adapted to life in the new environment. The size of the shellfish and fish populations in the reservoir would be dependent on the oxygen content of the water. If the oxygen content falls alarmingly (as in the case that vegetation is not removed from the reservoir area), then few aquatic animals would survive. The impacts are therefore largely dependent on the water post-impoundment oxygen concentration.

#### **D5.5.2 Proposed Mitigation Measures for Aquatic Animals**

No specific mitigation measures are proposed for aquatic creatures. Almost all the species of fish, plankton and shellfish will survive in the reservoir, so long as the water quality is optimized. All of the fish species listed in Table D5.7 can be farmed, especially the carps. The development of sustainable and economical fish farming is dependent on good water quality and adequately trained fishermen. Clearing the forest and other vegetation prior to impounding the reservoir areas is the only way to ensure water of satisfactory quality and good oxygen concentration. In mitigation of the river habitat lost to fish, it may be possible to develop fish farming in the Dong Nai No.3 reservoir, which has the easiest slope for constructing access roads for transporting produce to the markets. This is discussed in some detail in Chapter D9.

#### **D5.6 Protection Areas and National Parks**

National Parks and Nature Reserves within a 100 kilometer distance of Dong Nai No.3 and No.4 are listed in Table D5.8. The Dong Nai River flows directly alongside borders of the Cat Tien National Park. It has no hydrological connection with any of the other nature reserves listed in Table D5.8. Consequently only the Cat Tien National Park was considered in some detail during the phase of the detailed field investigations undertaken from January 1999 to September 1999. In view of the local, national and international importance of the Cat Tien National Park's natural resources, the Park is reviewed in the separate Chapter D6 below. Subsequently on the basis of water level measurements made from June to December 1999, the hydrological relationships between the Dong Nai River and the Cat Tien National Park are assessed and evaluated in Chapter D7. Chapter D7 also evaluates the relationship between the proposed Dong Nai No.3 and No.4 operational modes on the water requirements for the Park and other users.

#### **D5.7 Archaeological, Historical and Cultural Assets**

Commune settlement and resettlement aspects are considered in Chapter D4 above. In this chapter it was noted that the settlements within and immediately bordering the Dong Nai

No.3 planned impoundment areas were comparatively recent immigrants. Prior to 1975, most of the area was covered in thick forest, and it was mostly uninhabited apart from a few isolated households. Following the cessation of war hostilities in 1975, migrants from the southern central plateau region rapidly colonized the area. In the short period of time since 1975, the shifting population has not established or built assets that are considered with significant cultural or historical value. The field surveys undertaken within the communes did not find any assets of significant or important historical, cultural, archaeological or religious value. Such observations are common in all young and recent settlements.

#### **D5.8 The Transmission Line Route**

The selected route of the transmission lines is shown in Chapter 7 of Main Report. Respectful of international environmental standards for laying transmission lines, the route would aim to avoid passing directly through very sensitive ecological areas and human settlement locations. Consultations would be made with appropriate environmental organizations concerning the choice of the route, so as to avoid areas of particular ecological sensitivity. As far as the line route and resettlement is concerned, Decree No.54/1999/ND-CP dated 12 July 1999 contains provisions for ensuring the safety of transmission lines and the protection of humans from power lines. The Decree contains provisions that prohibit buildings, trees and houses within 4 meters (for 220 kV lines) of the lowest strung wire. Thus houses, trees and other structures may co-exist with power lines so long as they do not encroach within 4 meters of the lowest strung line. Through this legislation, it is unlikely that the lines would have cause any significant resettlement concerns. However in relation to ecological aspects, the line route would need to be chosen carefully and in consultation with wildlife and forestry officials so as to avoid sensitive locations as far as is practicable.

The final choice of the line's route would have particular poignancy in relation to the Dong Nai No.4 reservoir area. The right bank of the Dong Nai River, alongside the proposed Dong Nai No.4 reservoir, has a lower environmental sensitivity as compared to the left bank. The right bank is closest to the National Highway Road No.28. Consequently human traffic is able to penetrate into the right bank for agriculture, forest clearance and habitation. The left bank runs parallel to the thick virgin forest, which occupies this area. As the right bank has the least environmental sensitivity, it would be prudent to connect the power lines between Dong Nai No.3 and No.4 switchyards from the right bank side.

#### **D5.9 Quarry Areas and Borrow Pits**

Appendix A discusses the proposed locations for quarries and borrows pits. The right bank of the Dong Nai River, in the region of the proposed reservoirs and their dams, is the preferred location for the borrow pits and quarries owing to the easier access onto the National Highway Road No.28. The proposed quarry and borrow sites on the right bank were selected also on the basis of the least environmental sensitivity.

## D6 The Cat Tien National Park

### D6.1 Cat Tien National Park Location: The Core Zone

The Cat Tien National Park is located just south of the central plateau southern ridge, and is about 150 km north-northeast of Ho Chi Minh City (Figure D3.2). It has a significant diversity of animal and plant species, which are of international importance and require protection. The Park is one of 12 "A" Class Priority Protection Areas listed in the Vietnam Biodiversity Action Plan. It has a total area of about 74,049 ha, and is one of the largest national parks in Vietnam. An area of land inhabited by communes divides the parkland into two distinctive geographical sectors, namely a northern sector and a southern sector. Cat Loc forms the northern sector core zone, and it has an area of 30,365 hectares. Its territory lies within the Lam Dong Province. Nam Cat Tien (38,302 hectares) and Tay Cat Tien (5,382 hectares) form the southern sector core zone. The latter forms the northern part of Nam Cat Tien. Tay Cat Tien lies within the Binh Phuoc Province, and Nam Cat Tien is situated in the Dong Nai Province. The Nam Cat Tien and Tay Cat Tien core sectors obtained protection status in 1978, as respectively a National Park and a Reserve. Cat Loc was promoted to a Rhinoceros nature reserve in 1992. In December 1998, Cat Loc and Tay Cat Tien were promoted to National Park status. Consequently since December 1998 the (three) parkland's core sectors are now collectively known as the Cat Tien National Park, and are managed by the central government Ministry of Agriculture and Rural Development (MoARD) in Hanoi. Previous to December 1998, the three responsible Provincial Authorities (namely, Dong Nai, Lam Dong and Binh Phuoc) managed the parklands.

In relation to the proposed Dong Nai No.3 and No.4 developments, the downstream distance of Cat Loc is about 50 km to the south of the planned Dong Nai No.4 dam, whereas Nam Cat Tien lies about 130 km to the south of this dam (Figure D3.2).

### D6.2 The Core Zone Animals and Plants

Cat Loc is inhabited by a sub species of the single horn Java Rhinoceros (*Rhinoceros sondaicus annamiticus*). The species is endemic to Vietnam, and does not live anywhere else in the country. The species was once common throughout Vietnam, but human pressure, particularly hunting and habitat destruction has resulted in the animal's diminution. The Cat Tien National Park's staff estimates that there are about 10 to 15 Rhinoceros in Cat Loc.

Nam Cat Tien contains a wetland, namely the Bau Sau. This wetland is populated by many migrant species of over-wintering birds, namely waders and wildfowl. The Siamese Crocodile, *Crocodylus siamensis*, also inhabits the wetland. A large number of other animal and bird species inhabit the CTNP, and these are listed in publications by the park's staff (e.g. Bird List of Cat Tien National Park, March 1999; and Animal List of the Cat Tien National Park).

The animals of the National Park are reported to include at least 55 mammal species, more than 300 species of birds, 40 reptile species, 14 amphibians and 16 species of fish (Animal and Bird List of Cat Tien National Park, 1999). The list of mammal species is impressive. Among the internationally threatened species the list includes the Asian elephant (*Elephas maximus*), Tiger (*Panthera tigris*), Banteng (*Bos javanicus*) and Gaur (*Bos gaurus*).

The Park vegetation is dominated by evergreen forest (24%), bamboo forest (40%), mixed evergreen/deciduous forest (20%) and wetland/lakes (2%). The dominant forest genera are

Dipterocarpaceae family species; Leguminosae family species; *Lagerstroemia* genera; *Bambusa* genera and *Diospyros* genera. A comprehensive list of wetland plant species is given in the Bird List of Cat Tien National Park (1999).

The Netherlands government funds the Cat Tien National Park Conservation Project. The MoARD, with the assistance of the World Wide Fund for Nature (WWF) and CARE International, administer the loan. The program aims to enhance and diversify the Park's protection measures, and to strengthen the institutional framework for promoting nature conservation.

#### **D6.3 The Dong Nai River's Alignment with the Cat Tien National Park**

From January 1999 through to September 1999 a number of field visits were undertaken to the Cat Tien National Park and discussions were held with the Park's staff. From observations made during these visits, the following inferences and conclusions are drawn concerning the relationship between the Cat Tien National Park and the Dong Nai River.

The Dong Nai River meanders as an elongated "S" shape alongside the boundary of the National Park (see Figure D3.2). In fact the river forms the northern and western boundaries of Cat Loc and the northeastern, eastern and southeastern boundaries of Nam Cat Tien. The northern and western parts of Cat Loc rise in altitude to about 500 m above mean sea level, and the Dong Nai flows in a deeply incised basalt gorge below the lowest point of Cat Loc. Thus the Dong Nai River does not and could not recharge Cat Loc. The mountains and high hills of Cat Loc are formed from igneous/volcanic rock and are cut by numerous streams, which drain the mountains/hills. These high-relief mountains and hills are the main catchment for Cat Loc. Cat Loc slopes southwestwards towards the Dong Nai River, and between Bu Dhoc (southwestern boundary of Cat Loc) and Bau Sau (northeastern boundary of Nam Cat Tien) the river deeply incises sands/sand dunes. Here the land is also at a higher elevation (about 3 to 7 m) compared to the mean elevation of water flow in the Dong Nai River. To the south of Bau Sau, the mean elevation of water flow in the Dong Nai River is similarly 3 to 7m below the land surface. Nam Cat Tien also possesses numerous igneous/volcanic outcrop hills, which are dissected by numerous streams draining onto the lower levees. These streams, as noted for the Bau Sau wetland, eventually drain into the Dong Nai River. From the above discussion it is apparent that the Dong Nai appears to have no hydrological significance in recharging the Cat Tien National Park. On the contrary the Dong Nai River perennially drains Cat Tien National Park.

Three communes residing between the southern sector of Cat Loc (La Cahn Dom) and Bau Sau occasionally pump water from the Dong Nai in the wet/dry season to irrigate paddy field lying alongside the river's bank (information provided by the Lam Dong provincial authority).

#### **D6.4 The Bau Sau Wetland**

The northeastern part of Nam Cat Tien contains a wetland namely, the Bau Sau wetland. This wetland drains via a 3 km stream (the Dak Lua stream) directly into the Dong Nai River. The Dak Lua stream drains the wetland for about 350 days a year. The wetland has a much higher elevation (more than 5 meters) than the mean height of water flow through the Dong Nai River. However during the monsoon period, the Dong Nai River's water height peaks (June/October) and water then back-flows into the wetland via the Dak Lua stream.

This reversal of the Dak Lua flow (i.e. from the Dong Nai River to the Bau Sau wetland) lasts for about 10 to 15 days per year. In the dry season the wetland reduces from 2,500 ha to about 500 hectares (corresponding to a drawdown of about 1 to 2 meters).

The Cat Tien National Park management fears that the impoundment of water by the proposed Dong Nai reservoirs could limit the seasonal back-flow of water into the Bau Sau wetland. To resolve the Park's management fears a hydrological study was undertaken at the Bau Sau wetland. In June 1999, during the field investigations, river level gauging stations were installed in three locations, namely (1) the Bau Sau wetland, (2) the middle reach of the Bau Sau stream and (3) the confluence of the Bau Sau stream with the Dong Nai River. The acquired data would be compared with the continuous gauging records made at the Ta Lai Gauging Station on the Dong Nai River, which is about 15 km downstream of the Dak Lua's confluence with the Dong Nai River. The Ta Lai gauging continuous database extends to 1979. This monitoring program would allow extrapolation of the local hydrodynamics between the Dong Nai River and the wetland as far back as 1979 as discussed in Appendix C.

#### **D6.5 Human Inhabitants of the Cat Tien National Park**

Three communes inhabit the Cat Loc sector of the Park, namely the Phuoc Cat 2, Gai Vien and Tien Hoang. The Park Director estimates these communes comprise about 10,000 persons. The Tien Hoang commune (which has a population of about 5,000 persons) is indigenous to Cat Loc and they are agriculturists. In contrast, the Phuoc Cat 2 and the Gai Vien are comparatively recent settlers who arrived after 1975. A recent immigrant commune, namely the Ta Lai, settled in the southern area of Nam Cat Tien. The immigrants are commonly nomadic minority tribes, who formerly practised slash and burn agriculture in the central highland areas.

A large number of immigrants, belonging mainly to minority tribes from North Vietnam, and fewer belonging to the majority Kinh tribe, from the southern lowlands, settled in the areas surrounding the Park after 1975. The Kinh tribe is renowned as cultivators of lowland rice. The impacts of these immigrants on the Cat Tien National Park and on the land surrounding the Park are discussed below.

#### **D6.6 Human Inhabitants in the Cat Tien National Park Buffer Zone**

In 1997 land bordering the core zone of the Cat Tien National Park was designated "the buffer zone", as explained below.

In 1997 the Ministry of Agriculture and Rural Development (MARD) re-appraised its policies and objectives to protect the forests and other natural vegetation on the land bordering the Cat Tien National Park. Subsequently in 1997, the Minister of Agriculture and Rural Development sent a letter to each Provincial Authority, which had land bordering or within the Park (namely, Dak Lak, Lam Dong, Dong Nai, Phuoc Long and Binh Phuoc). The letters listed communes that would be included in a defined zone surrounding the Park, and the Minister defined the MoARD's policy for protecting natural vegetation in the zone. The inclusive communes would form a continuous strip of land, known as the "buffer zone", surrounding the Cat Tien National Park. The outer limits of the "buffer zone" are also the outer boundaries of certain communes. Presently 32 communes inhabit the "buffer zone", and their collective population is estimated at about 150,000 to 200,000 persons. The Kinh

tribe comprises about 80% of the population living outside the Park, and the remaining 20% is composed of minority tribes. The Kinh are a majority tribe from the lowland delta regions, and they are well advanced in the techniques of growing rice. The minority tribes are typically nomadic from the central highland areas, and from North Vietnam. The minority tribes are traditionally shifting agriculturists that historically practised slash and burn agriculture. Some of the new settlements arose from the central government's programs to populate the New Economic Zones, and stabilize the nomadic lifestyle of minority tribes. The program led to a massive influx of persons into the areas surrounding the Park. Now these recent immigrants are migrating into and or encroaching upon the Park's protected territory.

The buffer zone's topography consists of volcanic hilly areas, surrounding flat plains. The hilly areas are cultivated with fruit, coffee and vegetables whereas the lowland regions are used extensively for paddy cultivation. A large number of streams arise within the hills and these form rivers, which drain into the Dong Nai River. The Dong Nai River does not recharge these rivers. Some of the rivers, as for example the Da Te, have earthen embankments or bunds to impound water during the rainy season. The shallow lakes and reservoirs formed behind the bunds are used in the dry season to irrigate crops.

The buffer zone has a high percentage of natural forests, which, for protection, require diverse management strategies. The Provincial Authorities have a strong commitment to protecting the Cat Tien National Park resources and the buffer zone forests and other natural vegetation. At the same time the Authorities recognize there are urgent needs to enhance the living standards of the buffer zone communes and to reduce their reliance on the forest resources. The Provincial Authorities presently are striving to balance the needs for nature conservation with the needs for enhancing the living standards of the people in the buffer zone.

The socio-economic conditions of the communes inhabiting the buffer zone are poor. The communes have a subsistence economy that generates little net disposable income. Many of the households in the commune are classified as poor and very poor by Vietnamese standards. The infrastructure of the communes is very basic, and in need of improvement as described in the next Section.

#### **D6.7 Current Measures Aimed at Improving Commune Living Standards in the Buffer Zone**

The Provincial Authorities are actively seeking to promote nature conservation inside and outside of the Park, and to enhance the living standards of the communes in the buffer zone. In view of these aims and objectives, the World Bank (in conjunction with the Netherlands government and the government of Vietnam) funds a program of poverty alleviation and infrastructure improvement in the buffer zone. The program aims to reduce the communes' dependency on the Cat Tien National Park resources. It also aims to increase the communes' disposable income by improving the standards of rural infrastructure and agricultural production in the buffer zone.

Measures aimed at improving the living standards in the buffer zone comprise, but are not restricted to, the following activities.

- irrigation and road rehabilitation schemes;
- constructing roads;

- supporting social grants (e.g. improving access to schools; enhancing water supplies; setting up medical centers; connecting to the electricity grid);
- upgrading minor roads, culverts and bridges;
- investing in manufacture from cottage industries; and
- promoting education facilities.

Measures chosen to enhance the ecology of the buffer zone include:

- reducing illegal logging and tree burning;
- implementing re-forestry programs and reducing the proportion of barren land;
- reducing food shortages and food insecurity; and
- integrating forestry protection mechanisms within the local provincial and district administration.

The main benefits of the World Bank funded buffer zone project are considered to be:

- protection of the Cat Tien National Park from exploitation of its resources and encroachment by human communes;
- providing an effective managerial structure for the natural forests;
- improving the socio-economic conditions; and
- improving the institutional and administrative capacity for the buffer zone.

#### **D6.8 Possible Impacts of the Dong Nai No.3 and No.4 Combined Hydropower Project on the Buffer Zone**

The discussion reported below concerns mainly the impacts of the Dong Nai No.4 project on land occupancy within the buffer zone.

Figure D3.2 shows the general plan (1:500,000) of the Cat Tien National Park (comprising the Nam Cat Tien, Tay Cat Tien and Cat Loc sectors) and only the buffers zone areas under the administration of the Lam Dong and the Dak Lak Provincial Authorities. The buffer zone boundaries of the Lam Dong and Dak Lak Provinces were obtained from consultations with the respective Provincial Authorities in March 1999, and are based on the Minister of Agriculture and Rural Development decision of 1997.

The Dong Nai River forms the Lam Dong Province buffer zone's northern perimeter boundary. The Dak Lak Province begins on the opposite side of the River, and it does not have an opposing buffer zone (see Figure D3.2). The Dak Lak Province buffer zone lies north of the Cat Loc sector of the Cat Tien National Park. The Dong Nai River forms the southern perimeter boundary of the latter's buffer zone and the River is also a boundary for Cat Loc. Two communes inhabit the Dak Lak buffer zone. The zone is divided into a protection forest area, a cultivated forest area (comprising alternating re-forestation and tree harvesting plots), and a non-protection forest area. The Dak Lak Province refers to its zone as a "forest protection area" and not as a "buffer zone". The Dak Lak Province forest protection area, or buffer zone, is about 30 km to the west of the planned Dong Nai No.4 Reservoir location (see Figure D3.2). The proposed Dong Nai No.4 reservoir would occupy only a small part (less than 5 km length and less than 0.5 km width) of the northern

perimeter of the Lam Dong buffer zone at its junction with the Dong Nai River (see Figure D6.1). The Project would not flood any protected forest in the Lam Dong or Dak Lak Provinces. The Dong Nai No.4 powerhouse would be a small building constructed on the edge of the Lam Dong buffer zone boundary with the Dong Nai River. The powerhouse and its associated infrastructure (the switchyard, etc) would be constructed on cleared and leveled ground and an access road would be required. The headrace and penstock tunnels are bored channels below the ground surface. The powerhouse grounds and switchyard would occupy a small amount of land, generally less than a maximum of 30 hectares. As the powerhouse infrastructure would occupy only a small area of land, at the junction of the Lam Dong Province buffer zone with the Dong Nai River, its overall environmental impacts would be small and of little consequence.



## **D7 Downstream Hydrological Effects**

### **D7.1 The Principal Downstream Hydrological Effects**

The current concept recognizes the need to augment electricity supply during the peak period. Thus it is planned to operate Dong Nai 3 and 4 on an 7.5 hour generation mode with 15 hours off. The larger discharge rates at Bau Sau compared to the Dong Nai No.4 location in the case of the "without the project" (and also in the case of the "with the project") are due to runoff from this catchment.

The potential effects of the project on regulating the flow discharges downstream of the dams are reviewed below.

The principal downstream hydrological effects comprise:

- 1) changes in water flow between the dams and the power house outlets;
- 2) the mode and frequency of water discharged from the power house;
- 3) river channel and riverbed erosion;
- 4) changes in the availability of water to meet the needs of others through abstraction: and
- 5) changes in the availability of water to meet the needs of sensitive ecosystems (e.g. national parks).

### **D7.2 Water Flow between the Dam and its Power House**

Immediately downstream of the dams, river discharge will be reduced to zero. The river bed, during the dry season, would in all probability remain dry as far down as the next lateral confluent. This is a fact that is relevant to any and all dam constructions. Any aquatic habitat remaining immediately downstream the dam would be affected by a severe reduction of water flow. Depending on any necessity to restore the aquatic habitat downstream of the dam to the point of the next lateral confluent, it may be possible to provide an outflow from the dam.

A tributary discharges into the Dong Nai River at a point approximately 2.3 km downstream of the proposed Dong Nai No.3 dam. The next tributary is about 10 km downstream from this dam. The Dong Nai No.4 reservoir would begin about 5 km downstream of the Dong Nai No.3 dam, and its powerhouse would discharge water into the No.4 reservoir. Thus the critical need for water downstream of dam No.3 is the first 2.3 km.

From the planned location of dam No.4, a tributary would discharge into the Dong Nai River about every 1 km downstream of the dam up to the site of its power house. The first tributary would discharge about 100 m downstream of the dam. Thus the first 100 m downstream of the No.4 dam would be the most critical for any remaining aquatic habitat.

Obviously the physical construction of dam No.3 and 4 would severely impact the near field river ecosystem. This fact is relevant to any and to all dam constructions. The loss of habitat immediately downstream of the dam and up to the next tributary is of minor importance compared to the river habitat and land flooded during impoundment. For aesthetic, rather than ecological reasons, it would be beneficial to restore the aquatic habitat immediately downstream of the dam accepting that any such restoration would be of minor ecological importance to the localized area.

### **D7.3 River Channel and River Bed Erosion**

The riverbed of the Dong Nai is essentially composed of metamorphic sedimentary sandstone/silt-stone (Jurassic age) rock overlying basaltic rock. This is hard rock that is highly resistant to mechanical abrasion. Currently, the bed is swept clean of sediment and there are no significant sediment deposits in the river. Consequently, as the bedrock and river channels are highly resistant to erosion, the envisaged release of water from the power house (about 200 m<sup>3</sup>/sec) would not change the river morphology or increase suspended sediment concentrations. The "with project" 200 m<sup>3</sup>/sec value is of smaller magnitude than the wet season "without project" 250 m<sup>3</sup>/sec.

The Dong Nai River passes through considerable sand deposits at and downstream of the southwestern boundary of Cat Loc. Here a thick blanket of sand covers the river bedrock and sand dunes and sand deposits occur on either side of the river. The gentle slope of the land in this region affects the current velocity allowing a net depositional regime for suspended solids. The sand material is particulate quartz originating upstream of the planned Dong Nai No.3 reservoir. The construction of the dams would trap the suspended particulate sands. Therefore as a consequence of the diminishing supply of suspended particulate sand in the river flow, there might be some erosion of the riverbed sands and sandy banks at this location. This requires further detailed study to assess any future impact on the morphology of the Dong Nai River bordering the southwestern part of Cat Loc and the north and northeastern parts of Nam Cat Tien. Both of these locations form part of the Cat Tien National Park.

### **D7.4 Water Availability for Abstraction**

A hydrological analysis was undertaken of the Dong Nai River discharge at the location of the proposed Dong Nai No.3 and No.4 dam sites and at Nam Cat Tien (the southern sector of the Cat Tien National Park). The analyses aimed to investigate whether water impounded by Dong Nai No.3 would cause intolerable changes in the downstream Dong Nai flow. The preliminary hydrological analysis results are discussed in chapter C6 of Appendix C.

From the preliminary hydrological analysis, it is foreseen that the annual monthly maximum outflow from the Dong Nai No.4 reservoir would be reduced, especially in the draught years, by a considerable margin. This reduction is a direct consequence of the regulatory (storage) functions of the planned Dong Nai No.3 (and No.4) reservoir.

Many tributaries discharge into and recharge the Dong Nai River between the planned Dong Nai No.4 powerhouse and the Cat Tien National Park (and the Tri An reservoir). Therefore in the wet season the reduced outflow from the Dong Nai No.3 and No.4 reservoirs would be mitigated by inflows from the tributaries draining into the Dong Nai River downstream of the Dong Nai No.4 powerhouse. Consequently during the wet season, the storage operations of the reservoirs would not appear to result in significant environmental concerns.

Furthermore, the preliminary hydrological analysis reveals that the Dong Nai storage reservoirs (principally Dong Nai No.3, because of its large storage volume) would not result in a severe reduction of peak flow at the Cat Tien National Park during the wet season. This is because tributaries draining downstream of the planned Dong Nai No.4 powerhouse would augment water flowing in the Dong Nai River. The reduction in the monthly maximum discharge of the Dong Nai River at its confluence with the Dak Lua stream for the

condition "with the Project" ranges from about 20 to 30%. Consequently the development of the Project is not considered to pose considerable environmental concerns in relation to the availability of water to meet future agricultural and potable requirements alongside and downstream of the Cat Tien National Park.

Surveys were undertaken alongside the margins of the Dong Nai River with the Cat Tien National Park during the field investigation stages, from January until September 1999. Discussions were also held with the Irrigation and Land Departments of the Lam Dong and Dak Lak Provinces. The Irrigation and Land Use Departments of the Lam Dong and Dak Lak Provincial Authorities commented that the Dong Nai has no significance to agricultural production in the buffer zones. The Lam Dong Provincial Authority stated it knows of only three locations lying between La Cahn Dom (just north of Nam Cat Tien) and Tai Lai, where water is occasionally pumped from the river to irrigate some paddies. This was confirmed from the observations made during the field investigations. Observation revealed there are no significant points of water abstraction from the Dong Nai River between the Dong Nai No.4 powerhouse and the Tri An reservoir for the purposes of irrigation, industrial manufacture and drinking. Paddy and vegetable fields are common in the area between the north of Nam Cat Tien and south of Cat Loc, and to the east of Nam Cat Tien towards Tri An reservoir. Within the latter area there are about 6,200 hectares of paddy and vegetable fields. The fields are at a much higher elevation than the mean flow of water in the Dong Nai River. Water is rarely pumped from the Dong Nai River to supply irrigation needs for these fields. Tributaries that eventually drain into the Dong Nai River supply the irrigation requirements. Commonly these tributaries are bunded with earthen embankments to impound water in the wet season, and they form shallow reservoirs. Irrigation channels radiate outwards from these shallow reservoirs and ponds, and supply the fields during the dry season. Thus the development of Dong Nai No.3 and 4 would not severely impact these agricultural lands. Likewise the Dong Nai River is not a significant source for drinking water, and there are no major industrial concerns between the planned powerhouses and the Tri An reservoir that would rely on a constant supply of water from the Dong Nai River.

From the above analyses, it becomes apparent that after commissioning the Dong Nai No.3 and No.4 CHPP, there would be an enhanced flow of water in the Dong Nai River during the dry season. This would be beneficial for irrigation and other water requirements during this season. On the other hand, there is a possibility that the peak operation of the Dong Nai No.4 power station might have an adverse effect on the availability of water pumped for the occasional irrigation requirement, just north of Nam Cat Tien, mentioned above. There would be, of course, no impact on water availability for other purposes during the wet season. As the riverbed would never be dry after the dam construction, there would always be a supply of water for these paddies.

#### **D7.5 The Bau Sau Wetland in the Cat Tien National Park**

Chapter D6 above reports that Cat Tien National Park is at a much higher elevation compared with the annual water level in the Dong Nai River. Thus throughout the year, water drains from the Cat Tien National Park and into the Dong Nai River. However there is one seasonal exception to this rule. During the monsoon peak discharge (generally from June to October) water back flows from the Dong Nai River, through the Dak Lua stream and recharges the Bau Sau wetland. This seasonally observed phenomenon is discussed in Chapter D6 (Section D6.4). The following discussion reports the results and analyses of a

hydrological survey that was undertaken at the Bau Sau wetland. The study aimed at determining the significance, if any, of the Dong Nai River to sustaining the wetland's ecology. The study was undertaken with the cooperation of the Cat Tien National Park staff, between June and December 1999. The study results are presented in Chapter 6 of Appendix C.

In particular, it has to be noted that, during a field reconnaissance trip conducted in September 1999, the households reported that land bordering the Dak Lua stream was inundated to roof-top level during the heaviest periods of rainfall, in June and July. The local households reported that such a severe flooding occurs only every 25 to 30 years. From the available historical record it is apparent that a comparable flood would have a 20-year return period. The households expressed an overwhelming response for a means to control and mitigate these floods, which invariably destroy their homes, crops and agricultural lands. In this regard, the Dong Nai No.3 No.4 CHPP would contribute to the mitigation of flood in this downstream reach.

The short but comprehensive study led to the view that engineered and programmed artificial floods from the Dong Nai No.3 and No.4 Combined HPP would not be required to maintain the integrity of the Bau Sau wetland and its ecosystem, although it is recommended to perform the further study in the detailed design phase.

## **D8 Environmental Monitoring and Management**

### **D8.1 The Principles of Environmental Monitoring and Management**

Environmental monitoring should be undertaken during all stages of the project (namely: pre-construction; construction; commissioning operations) to verify that the impacts are no greater than as predicted in the EIA, and to ensure that impacts are kept at an acceptable level. The monitoring program would identify adverse environmental impacts and indicate where changes in operational procedures are required to mitigate the impacts. Compensation measures and costs for mitigating forced resettlement and losses are considered in the RAP, which is discussed at detail in Chapter D4 (Sections D4.7 through to D4.11). The RAC and the appointed independent external monitoring organization would monitor and implement the RAP's provisions and ensure that the affected families receive the agreed levels of compensation and allowances. As the RAP is considered at some length in the appendix sections mentioned above, it is excluded from the following discussion reported below. The discussion below concerns impacts on the ecology and on workers' health and safety arising out of the construction and operation phases of the Project. Chapter D5 above reported that the main ecological concerns are: the protection of the virgin forest bordering the planned Dong Nai No.4 reservoir area (mainly from the left bank) and its animal inhabitants; preservation of good water quality so as to ensure the conservation of the downstream aquatic wildlife and vegetation; and maintaining an ample supply of water in the Dong Nai River downstream of the site of the planned Dong Nai No.4 powerhouse.

The ranges of probable environmental impacts that are commonly observed from hydropower developments and which are generally monitored are summarized below.

#### **(1) Construction impacts**

- Temporary occupancy of areas outside the future reservoirs (e.g. burrow area; work camps; camps for material storage; temporary access roads, etc.).
- Vegetation clearance, removal and burning.
- Disturbance to wildlife and vegetation by construction staff and construction activities.
- Relocation of affected communes.
- Disturbance to humans, wildlife and habitats at the relocation commune areas.
- Water quality.
- Noise levels affecting the work force.
- Illnesses and diseases within the work force.

#### **(2) Commissioning impacts**

- Wildlife trapped by the rising reservoir level.
- Reduction of river habitat for use by wildlife and fish.
- Increase in habitat favored by mosquitoes.
- Interactions between drowned vegetation and water quality.

**(3) Operational impacts**

- Changes in river flow patterns downstream of the powerhouses.
- Interactions between drowned vegetation and water quality.
- Access roads allowing easier passage of humans into and out of the reservoir areas.
- Increased exploitation of animals and plants due to easier access to the reservoir areas.
- Interactions of communes on the water quality (e.g. pollution arising from domestic wastes and fish farming).
- Changes in water availability for other purposes downstream of reservoirs (some of these changes may be beneficial; e.g. prevention of seasonal flooding of land).

**(4) Monitoring and Mitigation during Construction**

Monitoring and mitigation during the construction phase shall aim to ensure:

- Preservation of the Dong Nai flow downstream from the dams, and the conservation of a viable aquatic plant and animal community in the river.
- Vegetation clearance is carried out in a systematic and gradual process, within sequential plots, so that clearance in one plot is completed before work commences on an adjacent plot.
- Clearance shall proceed in such a manner that there is minimal danger from uncontrolled fires breaking out and spreading through the forests.
- All unnecessary activities that are harmful or disturbing to the natural environment shall be avoided and prohibited.
- Measures shall be taken to allow the safe passage of animals from disturbed to safe areas.
- Surveys of animal and plant vegetation shall continue during the construction phase and the data collected shall be used to complement the existing EIA database.
- Water and soil samples shall be collected and analyzed as required by regulations and conditions defined by the environmental protection agencies.
- The health conditions of the resettlement communities and the adjoining communes, as well as the construction force, shall be monitored regularly so as to improve the existing bench mark database.
- Construction work medical facilities will be made available to the resettlement communes and the work force.
- Noise levels will be monitored daily and ear muffs provided as necessary to protect the work force from particularly harmful noise levels, as prescribed within the Provincial MoSTE regulations.
- Analyses of any failures of the RAP and monitoring its progress.
- Development and publication of a watershed management plan.

**(5) Monitoring and Mitigation during Commissioning**

Monitoring and mitigation during the commissioning phase shall aim to ensure:

- Adequate water flow is preserved downstream of the dams, as required, to permit the continuation of viable aquatic habitats.
- Wildlife is able to move away from rising water levels, without threat from the workforce or the local communes.
- Water samples are collected from pre-defined locations within the impounded reservoirs and upstream of the reservoirs.
- Water samples are analyzed and the data stored in a database for later reference.
- Commune inhabitants are discouraged from venturing into the catchment area.
- Successes or failures in the RAP are reported and there are adequate means available for resolving any conflicts arising within the affected households.
- Implementation of the watershed management plan

**(6) Monitoring and Mitigation during Reservoir Operations**

Monitoring and mitigation during operations shall aim to ensure:

- Successes or failures in the RAP are reported and there are adequate means available for resolving any conflicts arising with the resettled households.
- The needs and aspirations of the RAP are achieved.
- Adequate provision of healthcare, education needs, etc., as identified within the scope of the RAP.
- Provision is made to allow a flow of water downstream of the dams to ensure the survival of aquatic habitats.
- Continuation of the water sampling and analyses program, and, if necessary, wildlife surveys and further measures for their protection.
- Policies are made and implemented, and complied with, for the protection of wildlife and wildlife habitats within the project area.
- Control of soil erosion within the reservoir catchment, by limiting unsustainable land use and re-planting forest in denuded areas.
- Implementation of the watershed management plan.
- Measurement of sedimentation rates in the reservoirs.
- Evaluation of catchment erosion rates.

The majority of the mitigation measures would not incur cost or have only a small cost. Most are integrated within the technical requirements and specifications for the capital works' programs. Other measures would not incur extrinsic costs. For example, to ensure the protection of sensitive habitats the construction workforce would be prohibited from entering these areas. The planning and siting of access roads to avoid sensitive areas would not incur costs. Most of the civil engineering works' programs would comply with international (and national) codes of practice to protect the health and safety of the workers

both on site and in the camps. These measures would be integrated within the civil engineering costs, and in the tendering specifications, and would not appear as an environmental cost. These aspects, especially in relation to the Project construction, are discussed and analyzed at some detail in the Main Report. The range of operational impacts would be very much smaller than that resulting from construction. The most important operational measure would be maintaining flow downstream of the No.4 powerhouse to meet the needs of other water users. Water flow in the Dong Nai River during and after commissioning the Project would be dependent on the operational mode of the power cycle. If water release was required to mitigate an observed downstream impact, that release would not incur an intrinsic cost. The mitigation release might subsequently, however, affect the power plant to operate efficiently later in the period.

The need for other mitigation measures might develop from and during the detailed design stage for the Project. These would need to be integrated, perhaps with costs, into the final monitoring program. Monitoring during the operational cycle of the power plant would be met through the National Budget.

The institutional arrangements for monitoring are considered below.

#### **D8.2 Institutional Requirements for Monitoring and Mitigation**

Discussions were held with the Ministry of the Science Technology and the Environment (MoSTE), which is ultimately responsible for prescribing and governing environmental protection and monitoring programs. As a result of these discussions the following formalities were noted. The MoSTE devolves these responsibilities to the Provincial Authority Department of Science Technology and the Environment (DoSTE). The DoSTE undertakes to license all major developments within its jurisdiction and to approve all environmental protection and monitoring measures associated with the defined project. The project proponent (in this case EVN) is required to establish a Project Management Board (PMB), which is responsible for overseeing environmental protection and monitoring. The PMB may appoint external consultant organizations to assist the Board in carrying out its duties to monitor the project's impacts on the environment. The appointed consultants, acting together with the project's managers, would report directly to the PMB who in turn report to the DoSTE. In setting out the tender documentation for developing a project, the project proponents are required to stipulate the required environmental protection and mitigation measures, as may be defined and prescribed by DoSTE for a particular process, together with the required technological means to meet the expected environmental standard. Environmental protection measures are, for example, prescribed for forest clearance, liquid and solid waste treatment and disposal, water abstraction, health and safety at work regulations for the workers and for the general public, protection of natural resources from unnecessary exploitation, deployment of mechanical and motorized equipment, fuel and chemical storage, use of explosives, quarrying, etc. Furthermore, the MoSTE is overhauling and revising regulations governing environmental quality standards for land, water and air, and some of the new standards would apply to hydropower plants. The new standards would not be available for several years. The Provincial Authorities have powers to impose local environmental standards for air, water and soils and these are prescribed according to the type of project. The project proponent through its PMB, is responsible for overseeing that environmental mitigation and monitoring is carried out as prescribed and regulated by the Provincial Authority. Failure to meet any prescribed environmental standard, at any



stage in the project, could result in severe penalties. Thus during the preparations and construction phases of the Project the mitigation and monitoring costs would be integrated within the technical specifications. However during the operational phases of the Project, monitoring and mitigation costs would be met from the National Budget. During the operational phase of the project, the Project Operations Management Board (POMB) replaces the PMB. Effluents arising from the project operations, or any activity associated with the project, are required to meet the legislative environmental standards. Where there is failure to comply with environmental standards, measures must be taken to rectify the failures.

### **D8.3 Recommendations for Monitoring and Mitigation Planning**

There are a number of government and non-government agencies that could interact with the project PMB to ensure that all legislative environmental protection measures are complied with. These organizations would be contacted during the project detailed design phase, as they may be able to provide expertise for enhancing environmental protection measures and defining specific measures. With regard to wildlife and the natural resources, many of the species and resources within the project area, especially that bordering the Dong Nai No.4 reservoir, could be of international importance and significance. Thus international organizations such as the WWF might be invited to participate in the environmental monitoring and protection program (both during construction and operations) to provide appropriate comment (on conservation) and the transfer of technological information. These international organizations should not be excluded as many of them have on-going projects currently within locations close to the planned Dong Nai No.3 and No.4 developments.

### **D8.4 Technological Requirements**

PECC2 have contacts with many local agencies with environmental protection and surveying expertise. Some of these agencies have substantial knowledge of the environment within the planned project. Such agencies as and when required would be integrated into the environmental management and protection plan, to monitor the impacts of the construction, commissioning and operations of the project. They would be consulted on measures to avoid impacts. Animal, plant and water surveys should continue during the construction, commissioning and operation phases. Such surveys require the expertise of ecologists, and the costs could be furnished from within the construction program and later from the revenue generated in supplying electricity. During the operational phases, water quality surveys should continue on a twice-yearly basis: i.e. once in the dry season and once in the wet season, for the inflowing and outflowing water, and the water in the reservoir. Water analyses methods are economical as they use only low cost well-tested chemical technologies. Useful parameters for the reservoir waters are the depth dependent: pH; temperature; conductivity; particulate and dissolved carbon, nitrogen and phosphorous; total inorganic phosphorous; nitrate, nitrite; BOD; COD; suspended solids; rates of sedimentation (by using sediment traps); coliform bacteria; etc.

### **D8.5 Watershed Management**

The Provincial and District Forestry and Land Departments are responsible for the management and protection of the watershed resources and for implementing controls to eliminate soil erosion. In respect of the Dong Nai No.3 and No.4 proposed developments, Lam Dong and Dak Lak are the responsible Provincial Authorities. These Authorities would

need to evaluate, plan and implement a program of measures for watershed management. EVN as a stakeholder in the area and concerned with minimizing soil erosion above the reservoirs and sedimentation in the reservoirs would need to contribute with planning the program. The National Budget would need to cover the costs for the implementation of the watershed management plan.

The primary objective of watershed management is the conservation of both the hydropower water resource and good quality water. In turn, this is achieved through protecting forests and preventing soil erosion within the catchment. The protection of existing and future forest cover on inclined slopes is central to watershed management and minimizing soil erosion above the reservoir FSL. The watershed management plan would outline and review the importance of existing forests in the catchment, the means of regulating soil erosion and provide rates of reservoir sedimentation. The development of the plan would need to address and integrate the responsibilities of State forestry departments and other State departments with powers to protect watersheds. The aims would be to minimize land degradation and soil erosion within the reservoir catchment. Controlling the way that human inhabitants exploit the land in the catchment is central to planning effective watershed management. Reforestation of denuded areas and the prohibition of forest clearance and shifting cultivation are the main criteria for developing an effective plan. Consequently, the co-operation of the Provincial Authorities and their respective forest and wildlife departments are crucial aspects. Reforestation measures would need to look at:

- Developing tree nurseries, the associated infrastructure and work force for rearing saplings and re-planting denuded catchment areas.
- Protecting existing tree cover.
- Upgrading land quality and forest protection.
- Improving groundcover, thus minimizing surface erosion and sediment supply to the reservoirs.
- Upgrading wildlife habitats.

## D9 DEVELOPMENT OF FISH FARMING IN DONG NAI NO.3 RESERVOIR

The Dong Nai No.4 reservoir would have a surface area of less than 6 km<sup>2</sup>, which is too small to develop a meaningful aquaculture industry. Its very steep slope is another excluding factor. The Dong Nai No.3 reservoir with a surface area of about 50 km<sup>2</sup> and the more gentle slope is more suitable and accessible for developing fish culture. The fish species currently inhabiting the river (mostly species of carp and catfish) are commonly farmed in reservoirs throughout East Asia. The potential of the Dong Nai No.3 reservoir to support fish farming would be entirely dependent on the water quality. In turn the water quality would be entirely dependent on the amount of vegetation removed from the reservoir area prior to impoundment. Fish farming would not be possible for up to two years after impounding the reservoir, as the water quality would be poor owing to the degradation of organic matter remaining in the soils and on the land at the time of flooding the reservoir. This organic matter would remove oxygen from the water, and pollute the water with poisonous gases. The Dong Nai River water quality is low in nutrients and human and animal wastes do not pollute the water. Therefore, so long as the vegetation is removed from the impoundment area, water of good quality should develop in the reservoirs.

As pointed out in Chapter D4 (Section D4.3) and Chapter D5 (Section D5.5) the local commune households are not interested in fish farming, and prefer the agricultural livelihood consistent with their ethnic habits and cultural values. South Vietnam might lack the expertise for developing fish culture in mid-altitude reservoirs, and international assistance might be required in this respect. The development of a reservoir fisheries would require significant injection of capital to: finance research, educate potential fish farmers in the required technology, purchase floating fish-cages, build fish-cage infrastructure, purchase boats, build floating homes, construct fish hatcheries, construct fish nurseries, maintain brood stocks, control disease, transport produce to market, etc. All-year-round transport and passable roads are required to carry produce from the farms to the markets. Research would be required to define the maximum stocking density of fish-cages.

The resettled families are very poor by most standards, and they are essentially subsistence farmers. They have little excess income, and would need funds to purchase fish-farming equipment and other funds to support the initial installation of cages and floating homes and the initial production costs. They would also need to be enthusiastic about fish farming, which apparently they are not at the moment.

Most reservoirs would tolerate a total area of fish cages not exceeding 1% of the reservoir FSL surface area. Thus with a surface area of about 50 km<sup>2</sup>, the Dong Nai No.3 reservoir could support 5,000 cages of dimension 10 x 10m (and say 3 m deep). Reservoir fisheries can be a high risk and fragile industry, experiencing annual boom-and-bust cycles. Throughout East Asia farms can and do suffer from catastrophic fish deaths resulting from poor water quality. This is particularly true for mid-altitude reservoirs with a highly irregular (dendritic) shape, as would be the case with the Dong Nai No.3 reservoir. A major problem with fish culture is that the artificial fish food does pollute the water, especially when the food is over supplied. In many Indonesian reservoirs, the annual mass inflow of nitrogen and phosphorous from human sewage equals the mass input of nitrogen and phosphorous from the fish food. Here, fish farming is a high-risk industry, dangerously balanced, that experiences annual mass fish deaths, especially during the rainy season. The

deaths are caused from the high nutrient (N and P) concentrations in the water, which ultimately promote the removal of oxygen from the water. To offset the losses, the farmers place more cages in the water. More cages mean more self-pollution from the food used to feed the fish. More self-pollution means higher fish deaths. Many farmers are now trapped in a vicious circle with a positive feedback leading back to higher fish losses. Tri An reservoir, stripped of vegetation before impoundment, later suffered from an oxygen deficiency and a partial collapse of fish stocks and production caused by farmers oversupplying artificial fish food to caged carps.

Consequently, if the households were to venture into fish farming they would need to rely on an alternative income source to sustain the family in the case that the fishery would collapse. Culturally, the local communes are shifting cultivators, operating a slash-and-burn agricultural regime to the detriment of the forests. The presence of any agricultural fields above the FSL could have severe consequences for the watershed management regime. In consideration of the risks from collapsing fish stocks, the fish farmers would need to grow rice (as a staple food) and supplement the income with a cash crop. This could lead to further destruction of forest and soil erosion above the reservoir FSL. If any significant number of households remained or returned to the Dong Nai No.3 reservoir they could constitute a threat to the sensitive virgin forest bordering the Dong Nai No.4 reservoir. Thus at the household level, fish farming in Dong Nai No.3 could have severe consequences both for the wider environment and for the poor households that might venture into this livelihood. However, a commercial organization might have the funds to set up the floating cages and employ individual households to look after and rear fish through remuneration. This too has economical limitations. A catastrophic collapse of fish stocks would leave the employees without pay. The employees may yet try and exploit the land above the reservoir, and beyond, to gain an additional source of income. This in turn could impact the land, the forests and promote soil erosion above the reservoir.

Taking all of these considerations into account, fish farming might become a less-than-likely possibility for the Dong Nai No.3 reservoir. From now on, on the other hand, further discussions should be made with the Provincial and District Fisheries departments to further evaluate the potential for commercial organizations to establish fish farming, when judged necessary to do so.

## **D10 RECOMMENDED ADDITIONAL ENVIRONMENTAL SURVEYS**

### **D10.1 Additional Dong Nai No.4 Environmental Surveys**

In consideration of the present difficult access to the Dong Nai No.4 reservoir location and its wider environment, as reported in Chapter 5 above, the ecological surveys should continue, above on an *ad hoc* basis, so that further information could be added to the existing knowledge base. As further investigations are made of the area, and in the likelihood of access roads appearing in the future, ecologists should be invited survey, monitor, describe and report the animal and plant species and recommend appropriate impact mitigation measures. In particular, the WWF and IUCN, have global expert knowledge and survey technical experience for this form of habitat. They could be invited to accompany further field investigators and subsequently propose measures to protect especially endangered wildlife and vegetation species, not only from the Dong Nai No.3 and No.4 development, but also from interference through other human activities.

### **D10.2 Watershed Management**

The Provincial and District Forestry Departments are responsible for the management and protection of forest resources and for eliminating soil erosion. In respect of the proposed Dong Nai No.3 and No.4 developments, the Lam Dong and Dak Lak are the responsible Provincial Authorities. These Authorities would need to evaluate, plan and implement a program of measures for watershed management. EVN as a stakeholder in the area and concerned with minimizing soils erosion above the reservoirs and sedimentation in the reservoirs would need to contribute with planning the program. The National Budget would need to cover the costs for the implementation of the watershed management plan.

During the detailed design phase for the Dong Nai No.3 and No.4 CHPP, an outline watershed management plan should be developed, in consultation with the provincial authority forestry departments. The aims of the plan would be to minimize land degradation and soil erosion, within the reservoir catchment and from the land sloping above the reservoirs. The plan would be of more importance for the protection of the Dong Nai No.3 reservoir catchment, as here the agricultural practices of the local communes tend to promote soil erosion. The plan would, *inter alia*, need to evaluate the means and mechanisms for protecting forests, undertaking re-forestation schemes, establishing tree nurseries, controlling illegal hunting and logging, preventing settlement by migrant households in the forests and above the reservoirs, prohibiting certain forms of land use and land development, etc.

### **D10.3 Reviewing Potential Fish Farming for the Dong Nai No.3 Reservoir**

The communes show little enthusiasm for embarking on an economy based on fish farming and wish to preserve their identities within the ethnic and cultural lifestyles, which is based on farming the land. The communes are aware of the financial losses facing the Tri An reservoir fish farming community, arising out of large-scale fish deaths resulting from poor water quality. However, as pointed out in Chapter 9 above, the development of fish farming might attract a commercial organization with sufficient capital reserves to build the infrastructure and to off-set financial losses arising out unpredictable large-scale fish deaths due to disease or poor water quality.

Practical solutions to developing a fishery in Dong Nai No.3 reservoir would need to be

reviewed at some length during the detailed design for the Project. Vietnam aquaculture specialists have detailed knowledge of coastal (seawater) shellfish culture, but would not be experienced in mid-altitude reservoir fisheries. There are many overseas organizations with specialist knowledge and experience of these matters, especially in relation to developing fish farms in mid-altitude reservoirs (notably, for example, The International Center for Living Aquatic Resources Management, Philippines - ICLARM). This organization could provide technical advice and assistance in this respect.