Table 4.5 Composition of Ethnic Groups within the 7 Communes Occupying Land within the Dong Nai No.3 and No.4 Planned Reservoir Areas

Ethnic Group	Commune							Total
	Quang Khe	Dak Som	Dak Plao	Loc Lam	Loc Phu	Loc Bao	Dinh Tr. Thuong	
Kinh	135	34	33	143	901	79	25	1350
Ma	2220	1600	930	1192	352	1040	1750	9084
M'Nong			14					14
Chiu								21
Others	56		27		21		11	94
Total No.	2411	1634	1004	1335	1274	1119	1786	10,563

Source : the 1998 District Statistical Yearbook

Table 4.6 Main Ethnic Groups within the Bao Lam, Di Ling and Dak Nong Districts

Ethnic Group	Dak Nong District		Di Ling District		Bao Lam District	
	Population	%	Population	%	Population	%
Kinh	13,582	49.0	73,605	64	54,512	69.84
Ma	4,071	14.7	1,850	1.6	11,682	14.94
K'ho	-	-	32,526	30.9	7,399	9.54
M'Hong	8,957	32.3	-	-	-	-
Hoa	-	-	1,100	1.0	882	1.12
Nung	-	-	1,483	1.3	1,488	1.9
Tay	-	-	61	0.05	1,547	1.97
Ra-Glay	-	-	964	0.80	-	-
Thai	160	0.6	69	0.05	43	0.05
Others	950	3.4	394	0.30	501	0.64
Total	27,720		115,052		78,054	

Source : the 1998 District Statistical Yearbook

Table 4.7 Socio-Economic Census Survey Data (20% Sample) Collected during February to August 1999 from the Dinh Trang Thuong and Dak Plao Households living within the Proposed Dong Nai No.3 Reservoir Area (1/3)

Commune Name	Dinh Trang Thuong	Dak Plao
Demographic Characteristics:		
· Main Tribe (as % of persons interviewed)	Ma (100%)	Ma (90%)
· Other Tribes (as % of persons interviewed))	Not Applicable	Kinh (10%)
· House Construction Material (e.g. wood, thatch)	All the houses are made of bamboo, or wood, with walls and roofs of thatch and leaves. Minimum house area is16 m^2. Maximum house area is 38 m^2.	40% made from bamboo and thatch; and leaves, 60 % made from wood with metal roofs. Minimum house area is 24 m^2. Maximum house area is 70 m^2.
Health Aspects:		
· Mortality – Malaria	2 cases	none
· Mortality – Diarrhea	none	none
· Mortality – Parasites	none	none
· Mortality – Lung Disease	none	none
· Mortality – Other Cause	2	2
· Cause of Death in Children < 5 years of age	Malaria	Malaria
· Cause of Death in Children aged 5 – 18 years	Malaria	Malaria
· Principal Cause of Death in Adults	Malaria	Malaria
· Principal cause of Death in Children	Malaria	Malaria
· Other Causes of Illness : Measles; Mumps, Diphtheria; Tetanus; Malaria; Whooping Cough etc	All reported in the commune	All reported in the commune
Principal Means of Livelihood:		
· Land Ownership (number of fields)	Each family has 3 to 5 fields	Each family has 2 to 6 fields
· Size of fields	0.5 ha to 2.5 ha	0.5 ha to 2.5 ha
· Fields (Land) Owned within the Commune Location	All within commune boundary: about 0.3 to 2.5 km far from houses.	All within commune boundary: about 0.5 to 1.5 km from houses.
· Fields (Land) Owned outside of Commune Location	none	none
· Number of Fields outside of Commune that will be Impounded by the Reservoir No.3	none	none
· Area of Fields (Land) Impounded by Reservoir No.3	17.6 ha	26.3 ha
· Paddy (Number of harvests per year)	1 to 2 crops	1to 2 crops
· Paddy Pests and Diseases	Insects; rodents and fungus	Insects; rodents and fungus
· Livestock (cattle; goats; pigs; chicken; other)	Buffaloes; Cows; Goats; Pigs; and Chickens.	Buffaloes; Cows; Goats; Pigs; Chickens; and Ducks
· Home Garden	From 150 m^2 to 1500 m^2	From 200m^2 to 1850 m^2.

(Continued...)

Table 4.7 Socio-Economic Census Survey Data (20% Sample) Collected during February to August 1999 from the Dinh Trang Thuong and Dak Plao Households living within the Proposed Dong Nai No.3 Reservoir Area (2/3)

Commune Name	Dinh Trang Thuong	Dak Plao
· Fruit (and Fruit type)	Bananas, jack fruit, papaya, mango, orange etc.	Bananas, jack fruit, papaya, mango, orange etc.
· Fruit – Area of Cultivation (ha)	From 150 m^2 to 1500 m^2.	From 200m^2 to 1850 m^2.
· Fruit – Number of Harvests per year	1 to 2 crops	1 to 2 crops
· Principal Fruit Pests and Diseases	Insects	Insects
· Common Types of Vegetables (grown between coffee bushes)	Gourd, Pumpkin and Green Vegetables	Gourd, Pumpkin and Green Vegetables
· Vegetable – Area of Cultivation (ha)	Mixed in the Coffee Fields	Mixed in the Coffee Fields
· Vegetable – Number of harvests per year	1	1
· Principal Vegetable Pest and Disease	Insects and rodents	Insects and rodents
· Forestry	Ever-green forest, regenerated and replanted forest	Ever-green forest, regenerated and replanted forest
· Fishing (see footnote below)	none	none
· Handicrafts	none	none
Commune Economics:		
· Household Annual Income (VND)	From 5 to 22 millions	From 3 to 30 millions
· Household Annual Expenditure (VND)	From 5 to 20 millions	From 3 to 16 millions
Infrastructure:		
Health Services:		
· Type of Health Service and Provisions	Basic Health Center	Basic Health Center
· Location of Closest Medical Facility	Commune Basic Health Center	Commune Basic Health Center
· Distance to Closest Basic Medical Facility	From 1.2 to 12 km	From 0.2 to 0.6 km
Road Services:		
· Major Road Facilities and Connections Close to the Commune	National Highway road no.28 and link roads	National Highway road no.28and link roads
· Commune Road Construction Material	Compacted earth	Compacted earth
· Existing Road Surface (Good; Fair; Poor; Bad)	Fair in the dry season; often impassable in wet season	Fair in the dry season; often impassable in wet season
· Roads without a surface; e.g. mud compacted	Without surface finish	Without surface finish
· Public Transport (Type of Public Transport)	Bus, truck.	Bus, truck.
· Frequency of Public Transport Services	Bus 2 to 3 times a week in the dry season and severely erratic service in wet season	Bus 2 to 3 time a week in the dry season and severely erratic service in the wet season
Education Facilities:		
· Primary Education Facility	One in Commune	One in Commune
· Distance to Primary Education Facility	From 1.2 km to 12 km	From 0.2 to 0.6 km.
· Secondary Education Facilities	None	None
· Distance to Secondary Education Facility	More than 20 km	More than 20 km

(Continued...)

Table 4.7 Socio-Economic Census Survey Data (20% Sample) Collected during February to August 1999 from the Dinh Trang Thoung and Dak Plao Households living within the Proposed Dong Nai No.3 Reservoir Area (3/3)

Commune Name	Dinh Trang Thuong	Dak Plao
Electricity Supplies:		
• Number of houses connected to grid	none	none
• Diesel or Other Electrical Generator	1	1
Water Supplies:		
Type of Water Supply (River; Standpipe; Well; etc)	Tube and dug wells and from streams / river	Tube and dug wells and from streams / river
• Water Quality (Good; Poor; Polluted) for Drinking	Good	Good
• Irrigation Supplies (for paddy etc)	Rain-fed and private pumps	Rain-fed and private pumps
• Reliability of Water Supply (note any failures)	No Failures	No Failures
Sanitation and Waste Disposal Facilities:		
• Note any sanitation provisions (pits etc.)	None	None
Archaeological, Historic and Cultural Assets:		
• Places of Religious Significance	None in commune	None in commune
• Temples	None in commune	None in commune
• Archaeological and Historical Sites of Importance	None in commune	None in commune

Source : RAP prepared under contract in the Field Investigation Stages June – September 1999

Table 4.8 Summary of the Schedule for Implementing the Main Compensation Measures (1/2)

Lost Asset	Location of Lost Asset	Person or Authority Affected	Compensation Measures	Implementation of Compensation Measure
Residential homes, other fixed assets and land	Reservoir area	The owner or temporary (shifting cultivator) land occupier.	Providing new homes, or the cash equivalent to purchase materials and the labor for rebuilding homes in the resettlement areas. Providing land- owners with replacement land of equable area at the resettlement location. Providing non-owners of land (shifting cultivators) with land or cash subsidy to purchase land.	Provided no less than 4 months before commencing resettlement.
Residential homes, other fixed assets and land	In the safety (security) margin (strip of land) surrounding the reservoir above the FSL, and surrounding the power house, switch yards etc.	The owner or temporary (shifting cultivator) occupier.	Providing new homes, or the cash equivalent to purchase materials and the labor for rebuilding homes in the resettlement areas. Providing land- owners with replacement land of equable area at the resettlement location. Providing non-owners of land (shifting cultivators) with land or cash subsidy to purchase land.	Provided no less than 4 months before commencing resettlement.
Cemeteries and graves.	Within and outside of the reservoir area, the powerhouse, switch yards etc.	The owner or temporary (shifting cultivator) land occupier.	Cash allowances and all expenditure for exhuming the grave, transporting corpses, and rebuilding the grave sites in the resettlement areas. Reasonable cash compensation for erecting fencing or walls around the cemetery perimeter.	The Project Management Board (PMB) and the Local Provincial Authority will consult with and advise the affected households of the arrangements, one to two years before commencement of construction works. From that date burial in existing cemeteries would be prohibited. Preparation and provision of construction materials for the new cemeteries will begin at the same time.

(Continued...)

Table 4.8 Summary of the Schedule for Implementing the Main Compensation Measures (2/2)

Lost Asset	Location of Lost Asset	Person or Authority Affected	Compensation Measures	Implementation of Compensation Measure
Animal pastures and cropped land	Reservoir area, and any exclusion limits above the FSL	The owner or temporary (shifting cultivator) land occupier.	Full market value cash compensation for the land and the crop, or provision of new fields of equable area in the resettlement locations.	Provided at least one to two years before compulsory land acquisition to allow preparation and sowing of the fields for the new harvests.
Public amenities and utilities owned by the Provincial and Local Authorities.	All amenities and utilities impacted by constructing and operating the Project.	Provincial and Local (District) Authorities.	Full costs for rebuilding and replacing the amenities and utilities.	Provided before land acquisition for developing the project.

Source : RAP prepared under contract in the Field Investigation Stages June – September 1999

Table 4.9 Dong Nai River Water Quality : Upstream, Downstream and in the Mid Region of the Planned Dong Nai No.3 and No.4 Reservoirs

Parameter	Unit	Upstream DN3	Mid Point DN3	Upstream DN4	Planned Tailrace DN4
Temperature	°C	23.6	24.2	22.2	28.3
pH		7.1	7.0	7.0	7.0
SS	mg/l	17	20	17	19
DO	mg/l	6.4	6.9	6.6	5.8
Total P	mg/l	0.03	0.03	0.09	0.03
N-NO2	mg/l	0	0	0	0
N-NO3	mg/l	0.19	0.19	0.28	0.17
BOD5	mg/l	8	4	9	2
COD	mg/l	15	5	14	5
Dioxin	mg/l	0	0	0	0
Total Coliform bacteria	mnp per 100 ml	110,000	400	240,000	240,000

Source : The water quality survey and analyses were conducted as part of the EIA Study prepared under contract in the Field Investigation Stages June – September 1999

Table 4.10 Types of Vegetation and their Areas covering the planned Dong Nai No. 3 and No.4 Reservoir Areas (all units are in hectares).

(Unit :ha)

Vegetation Type	Dong Nai 3	Dong Nai 3 (Percentage)	Dong Nai 4	Dong Nai 4 (Percentage)
Broad-leafed forest	3.07	0.1	11.07	3.50
Mixed broad-leafed / bamboo forest	0	0	111.32	35.22
Bamboo forest	4722.06	90.6	193.61	61.28
Shrub-grassland	31.90	0.6	0	0
Agricultural fields (fruit, rice, coffee, etc)	453.3	8.7	0	0
Total area by vegetation cover	5213.33	100	316	100

Source : The vegetation survey and analyses were conducted as part of the EIA Study prepared under contract in the Field Investigation Stages June – September 1999

Table 4.11 Endangered (Red Book) Bird Species Recorded in the Planned Dong Nai No. 3 and No. 4 Regional Areas

Family and Species	Vietnamese Name	English Name	Status
Pheasants			
· Lophura nycthemera	Ga Loi van	silver pheasant	threatened
· L. diardi	Ga Loi hong tia	siamese fireback	threatened
· Polyplectron germaini	Ga tien mat do	germain peacock pheasant	threatened
· Pavo munctius	Cong	green Peafowl	rare
Hornbil			
· Buceros bicornis	Hong hoang	great hornbill	threatened
Tits			
· Sitta solangiae	Treo cay tran den	velvet fronted Nuthatch	threatened
Babblers			
· Garrulax milleti	Khuou dau den	black hooded laughing thrush	rare
· G. vassali	Khuou dau xam	white cheeked laughing thrush	threatened

Source : EIA Study prepared under contract in the Field Investigation Stages June – September 1999

Table 4.12 Endangered (Red Book) Animal Species Recorded in the Planned Dong Nai No.3 and No.4 Regional Areas

Family and Species	Vietnamese Name	English Name	Status
Primates ・Nycticebus pygmaeus ・Macaca arctoides ・Hylobates gabriella	 Cu li nho Khimat do Vuon den	 loris stump-tailed macaque gibbon	 vulnerable vulnerable endangered
Wild dogs ・Cuon alpinus	Soi do	dhole	endangered
Bear ・Helarctos malayanus		sun bear	protected
Otters ・Lutra perspicillata	Rai ca long muot	smooth otter	vulnerable
Wild cats ・Panthera tigris ・Neofelis nebulosa ・Felis bengalensis	 Ho Bao gam	 tiger clouded leopard leopard cat	 endangered vulnerable protected
Deer ・Tragulus javanicus ・Cervus unicolor ・Muntiacus muntjac	Cheo cheo Nam Duong	 mouse deer sambar deer barking deer	 vulnerable protected protected
Wild Oxen ・Bos gaurus	Bo tot	gaur	endangered
Goat-Antelope ・Capricornis	Son duong	serow (goat-antelope)	vulnerable
Elephant ・Elephas maximus	Voi an do	asian elephant	vulnerable

Source : EIA Study prepared under contract in the Field Investigation Stages June – September 1999

Table 4.13 Fish Species Recorded in the Dong Nai River at the Planed Dong Nai No.3 and No.4 Reservoir Locations

Family	Species	Vietnamese name	English name
Mastacembelidae	Mastacembelus armatus	ca chach bong	spiny eel
	Mastacemebelus circumcinctus	ca chach khoang	
(Carps) Cyprinidae	Mystacoleulus greennaiyi	ca lai xuoc	
	Mystacoleulus magrinatus	ca vay xuocx	
	Cosmochilus harmandi	ca duong bay	
	Hampala macrolepidota	ca ngua nam	Barb
	Tor duronensis	ca me	
	Tor stracheyi	ca ngua gai	
	Tor tambroides	ca ngua xam	
	Cyclocheilichthys apogon	ca coc dam	
	Cyclocheilichthys tapiensis	ca cay	
	Probarbus jullieni	ca trac soc	Barb
	Puntius vernayi	calai	
	Puntius foxi	ca hong nhan	
	Puntius huguenini	ca diec coc	
	Osteochilus prosemion	ca lui	Barb
	Osteochilus hisschtii	ca lui (me)	
	Osteochilus vittatus	ca lui soc	
	Labeo dyocheilus		
Channidae	Channa striatus	ho ca loc	also carp
	Channa lucius	ca trau day	
Siluridae (catfish)	Ompak bimaculatus Kryptopterus cryptopterus	ca tren bau ca tren da	
Sisoidae	Bagarius suchus	ca chien	
	Bagarius yarelli	ca chien	

Source : EIA Study prepared under contract in the Field Investigation Stages June – September 1999

Table 4.14 Peak Flow Reduction Rate in the Downstream Reach of Dong Nai No.4 Power Station

Year	Maximum Monthly Discharge (m^3 per second)		
	Monthly inflow to the Dong Nai No.3 Reservoir	Monthly Outflow from the Dong Nai No.4 Reservoir	Reduction Rate (%)
1979	243.7	178.0	27.0
1980	218.9	133.9	38.8
1981	212.5	177.3	16.6
1982	247.3	126.8	48.7
1983	223.7	85.9	61.6
1984	267.6	193.3	27.8
1985	156.4	80.1	48.8
1986	262.2	179.4	31.6
1987	190.9	102.1	46.5
1988	165.1	80.8	51.1
1989	181.0	82.3	54.5
1990	236.9	110.8	53.2
1991	248.4	204.8	17.6
1992	205.9	154.8	24.8
1993	201.7	84.0	58.4
1994	290.0	272.4	6.1
1995	230.0	82.9	64.0
1996	212.7	172.6	18.9
1997	248.5	197.4	20.6
1998	163.3	80.7	50.6

Data Source : Analyses for the Feasibility Study December 1999

Table 4.15 Peak Flow Reduction of the Dong Nai River at the Point of Confluence with the Dak Lua Stream which Drains the Bau Sau Wetland

Year	Maximum Monthly Discharge (m^3 per second)		
	Monthly Discharge at the Junction "Without Project" Scenario	Monthly Discharge at the Junction "With Project Scenario"	Reduction Rate (%)
1979	587.6	461.7	21.4
1980	527.9	375.6	28.9
1981	512.4	401.6	21.6
1982	596.3	415.5	30.3
1983	539.5	382.2	29.2
1984	645.3	437.9	32.1
1985	377.2	287.3	23.8
1986	632.3	429.8	32.0
1987	460.3	335.9	27.0
1988	398.2	299.5	24.8
1989	436.5	322.0	26.2
1990	571.3	400.9	29.8
1991	599.0	463.4	22.6
1992	496.4	357.0	28.1
1993	486.4	351.2	27.8
1994	699.4	656.5	6.1
1995	554.6	387.4	30.1
1996	513.0	441.9	13.9
1997	599.2	461.2	23.0
1998	393.9	297.0	24.6

Data Source : Analyses for the Feasibility Study December 1999

Table 4.16 Summary of Construction Impacts and their Corresponding Mitigation Measures

I. 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.
-

II. Monitoring and Mitigation during Construction:

-
- 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 DoSTE regulations.
- Analyses of any failures of the RAP and monitoring its progress.
- Development and publication of a watershed management plan.

Table 4.17 Proposed Frequency of Water Quality Monitoring during the Construction Phase

Parameter	Downstream Station	Upstream Station
pH	twice monthly	twice monthly
Suspended solids	twice monthly	twice monthly
Dissolved oxygen	twice monthly	twice monthly
BOD	twice monthly	twice monthly
COD	twice monthly	twice monthly
Nitrate (+Nitrite)	twice monthly	twice monthly
Ammonium	twice monthly	twice monthly
Phosphate – dissolved	twice monthly	twice monthly
Total chlorophyll	twice monthly	twice monthly

Source : EIA undertaken during the Field Investigation Stages – June to September 1999

National Road No.28

X. Đak Nia - Commune

X. Quảng Khê - Commune

Dự kiến khu Tái định cư
Proposed resettlement area

Nhà máy - Power house

Nhà máy - Power house

X. Đak Som - Commune

Tuy nen - Tunnel exit

Tuy nen - Tunnel exit

ĐỒNG NAI 4 - RESERVOIR

X. Lộc Bảo - Commune

ĐỒNG NAI 3 - RESERVOIR

X. Đak Plao - Commune
(Resettled 150 families)

X. Lộc Lâm - Commune

X. Lộc Phú - Commune

X. Phúc Thọ - Commune

X. Đinh Tr. Thượng - Commune
(resettled 100 families)

Scale : 1/100,000

Dự kiến khu Tái định cư
Poposed resettlement area

Figure 4.1

Proposed Resettlement Areas

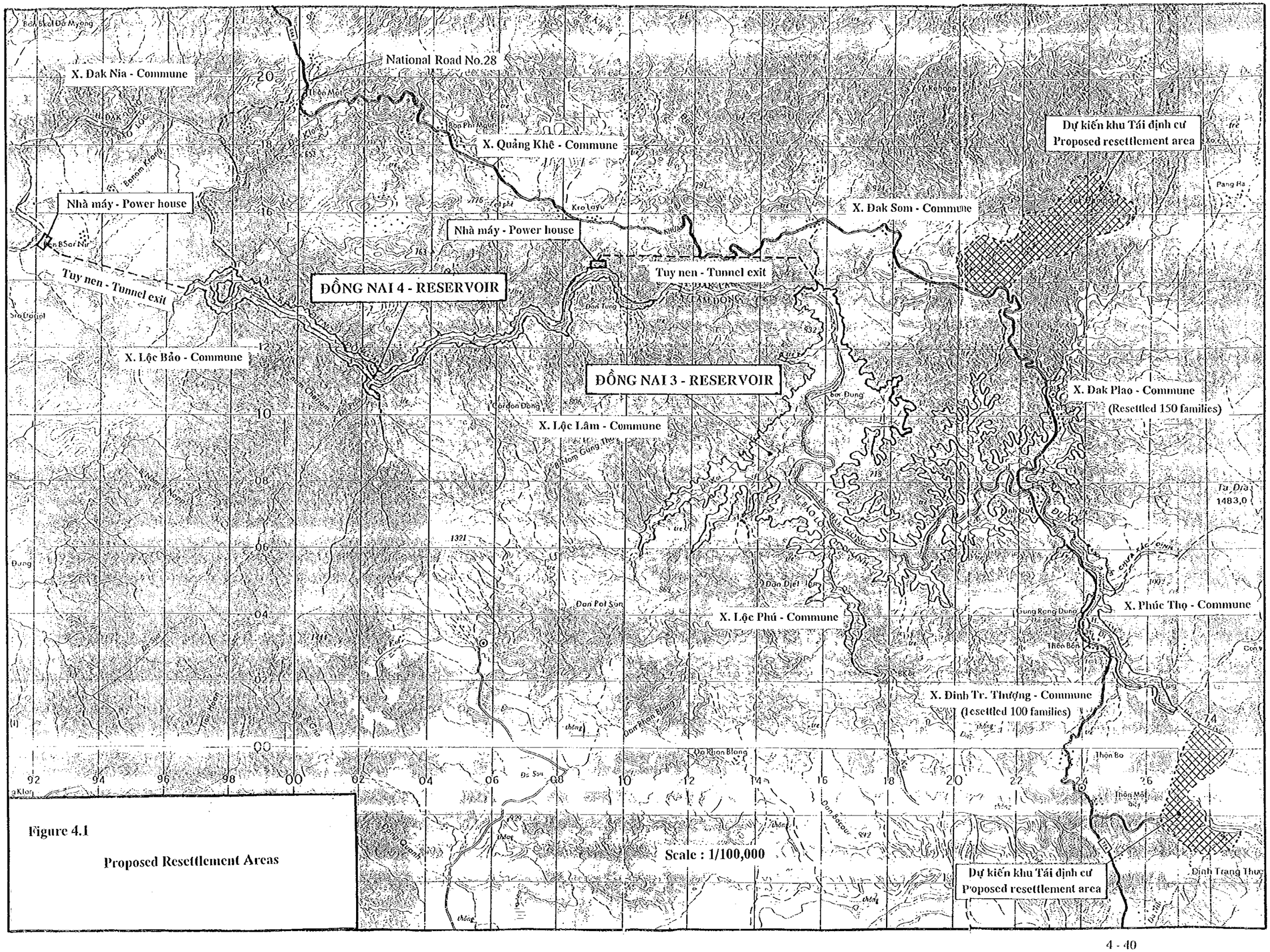


Figure 4.1

Proposed Resettlement Areas

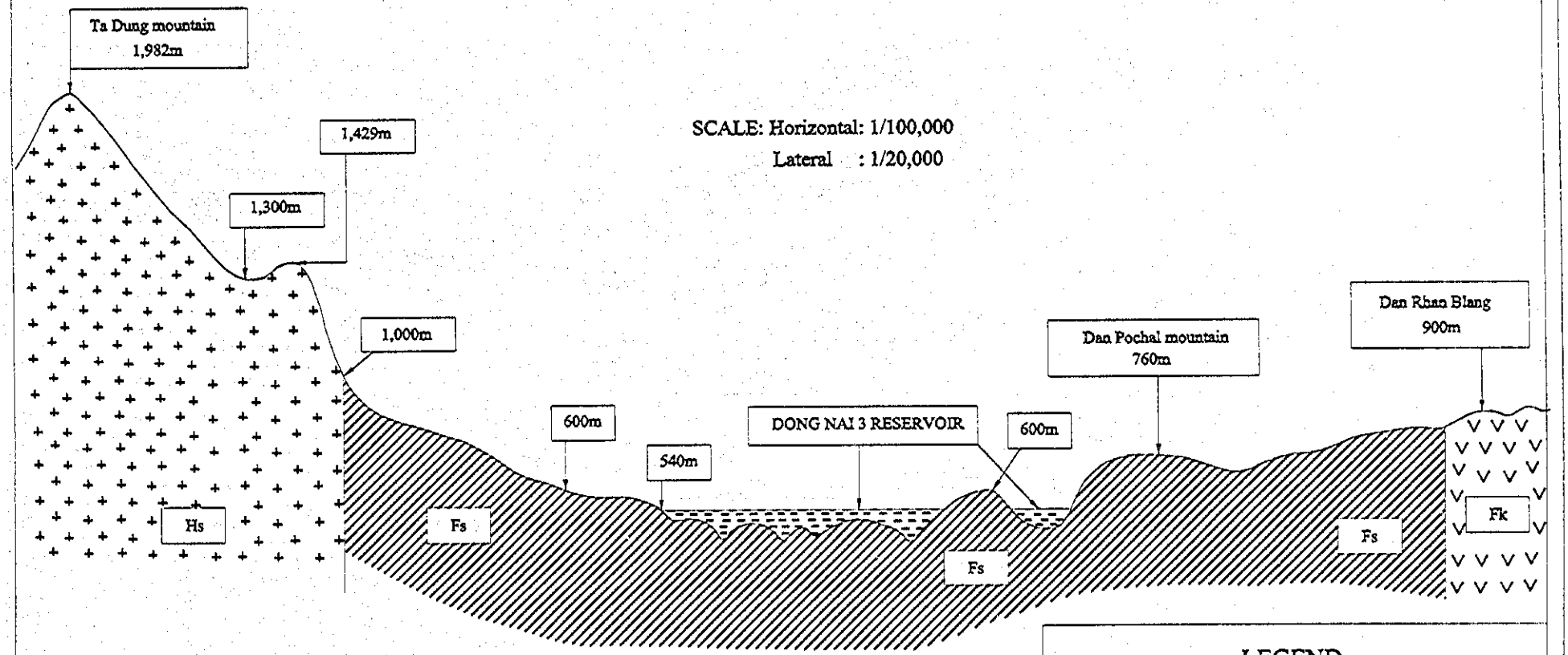


Figure 4.2 Cross-section on Pedo-Topography Across Dong Nai No.3 Reservoir from the North-East to South-West

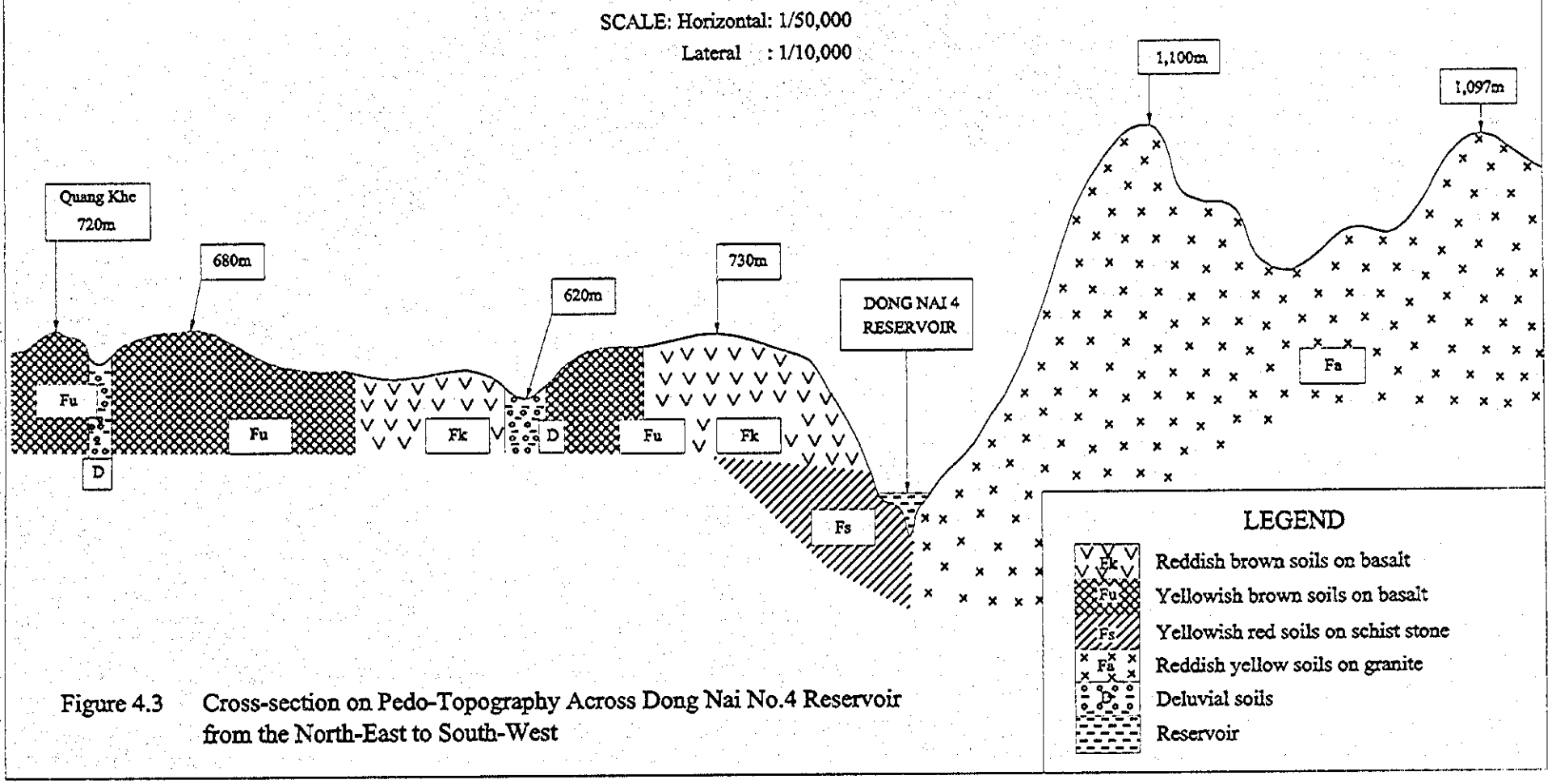
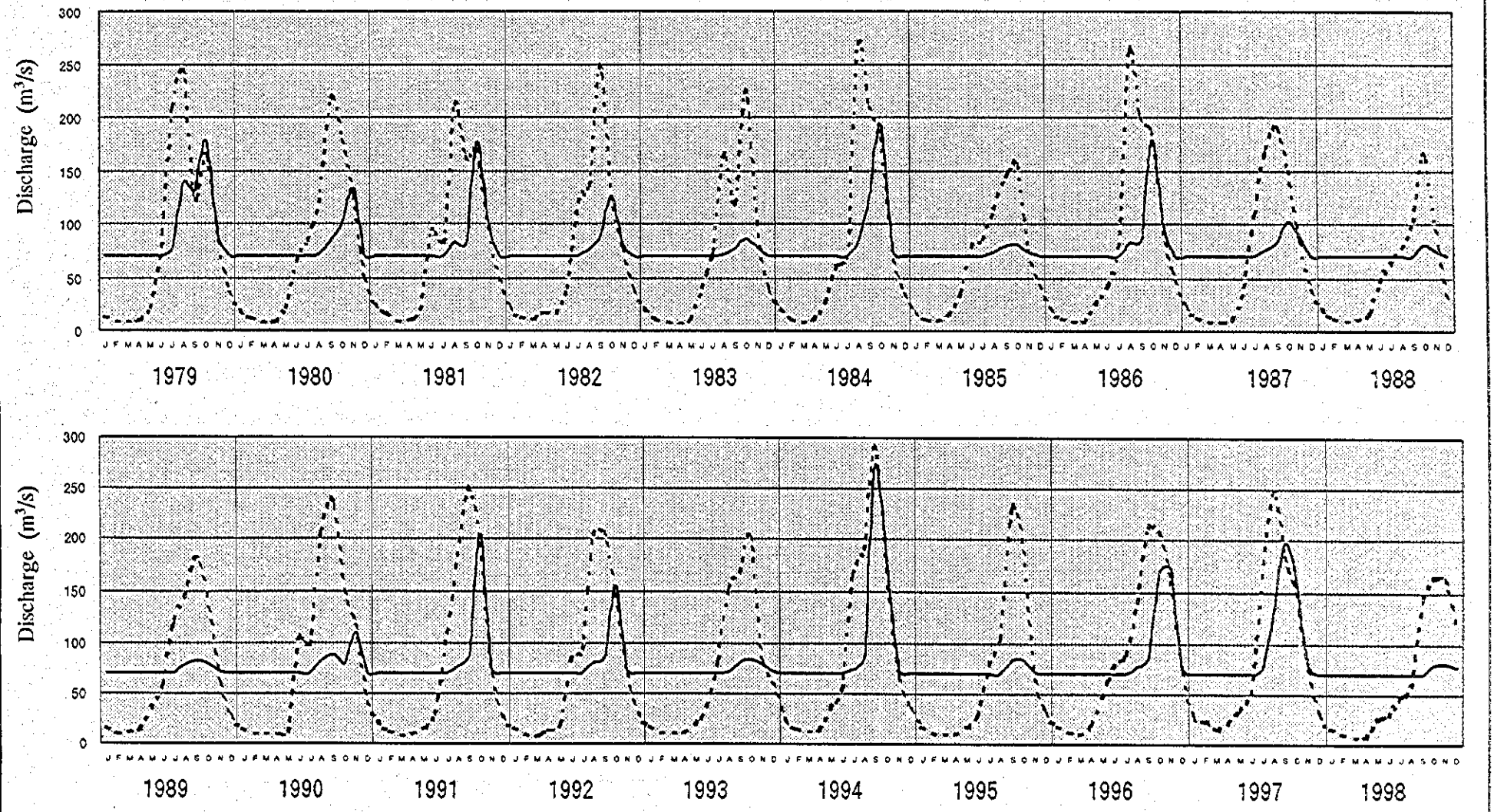
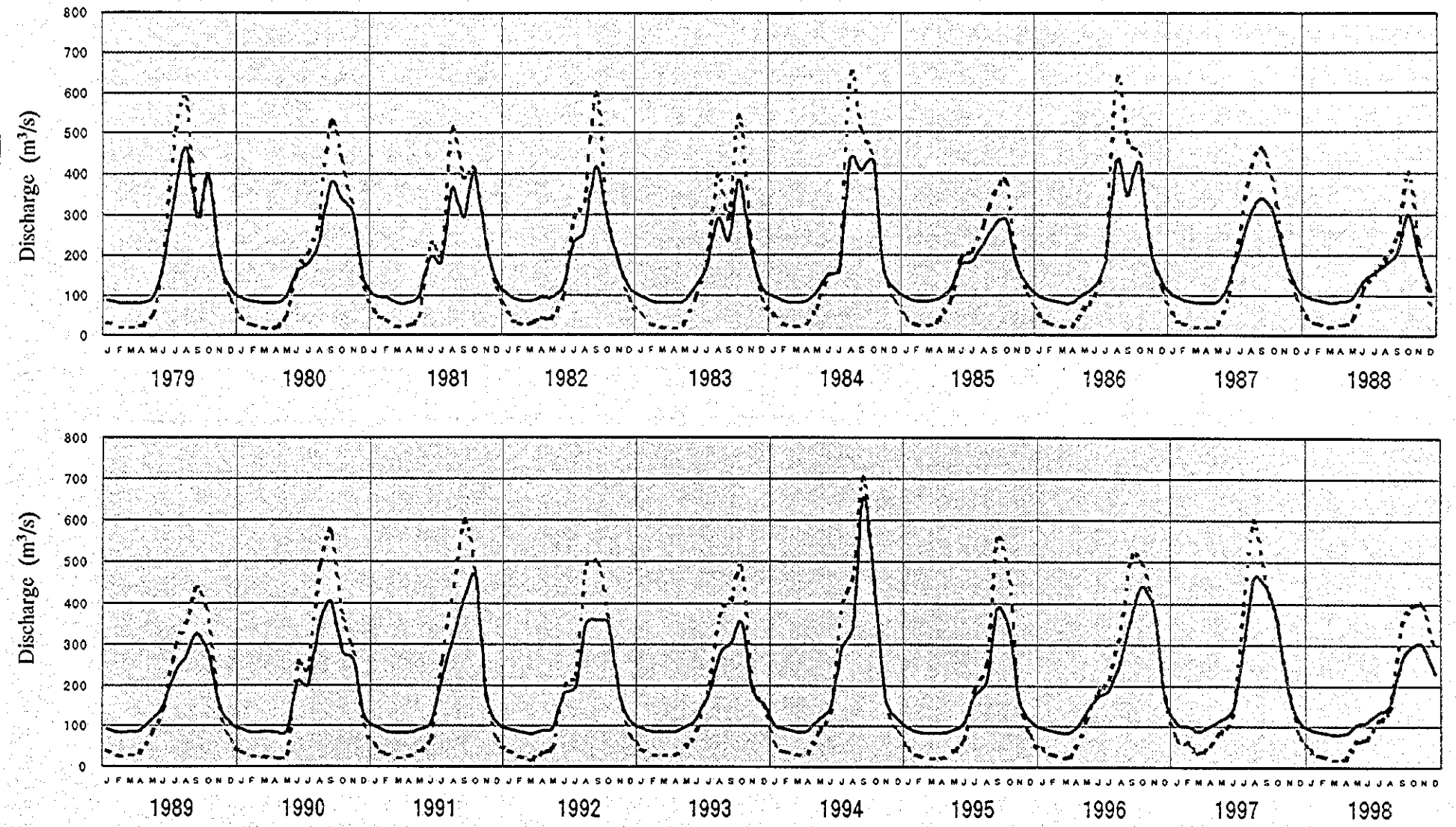


Figure 4.3 Cross-section on Pedo-Topography Across Dong Nai No.4 Reservoir from the North-East to South-West



Note : These two hydrographs show mean monthly inflow to Dong Nai No.3 reservoir and mean monthly outflow from Don Nai No.4 dam/power station.

Figure 4.4 Monthly Inflow to Dong Nai No.3 Dam and Monthly Outflow from Dong Nai No.4 Scheme



Note : These two hydrographs show mean monthly runoff at Cat Tien National Park at junction of Dak Lua stream and the Dong Nai mainstream on the condition with and without the Dong Nai No.3 and No.4 Combined Hydropower Project.

Figure 4.5 Hydrological Influence to Wet Land of Cat Tien National Park

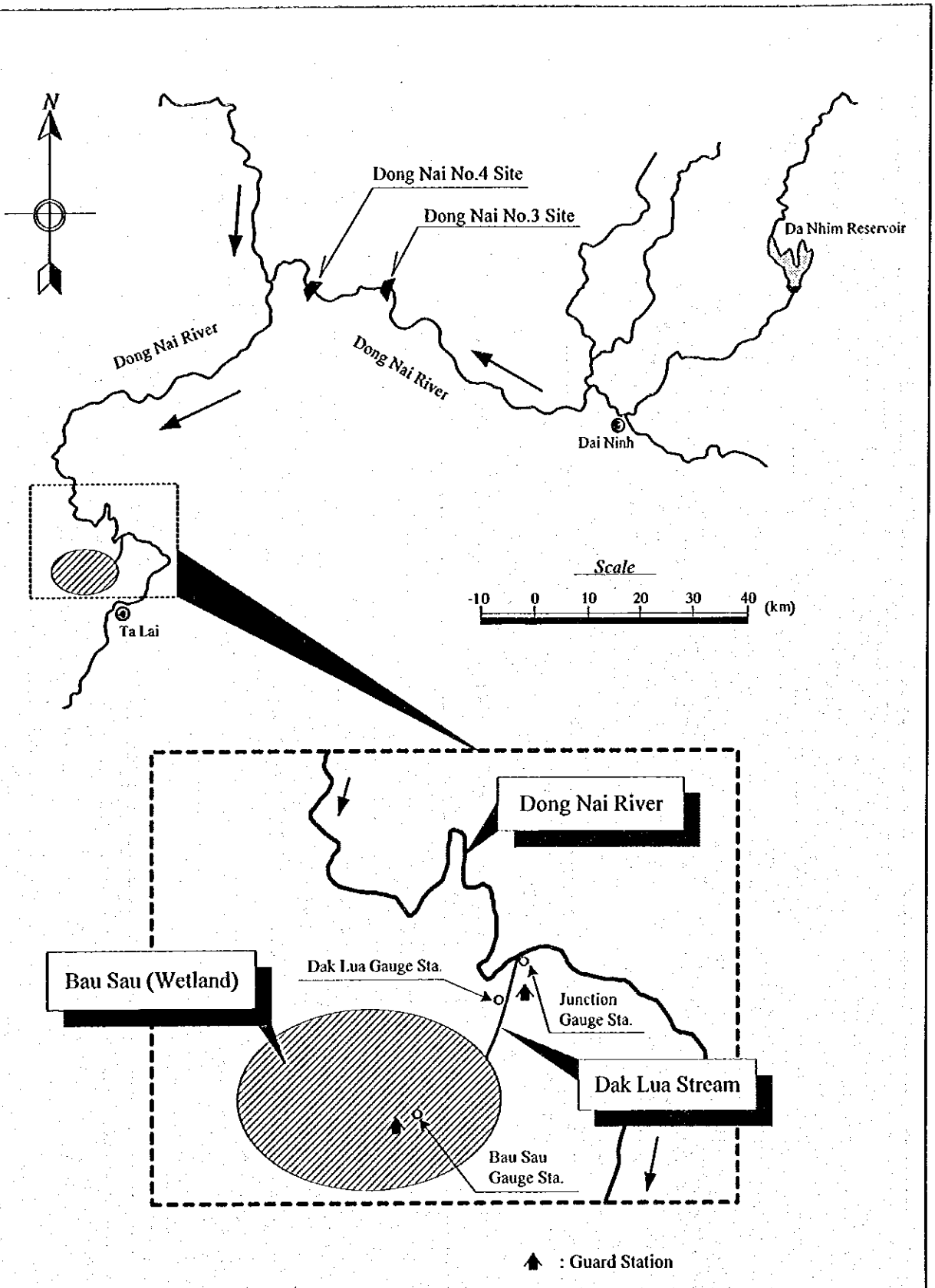
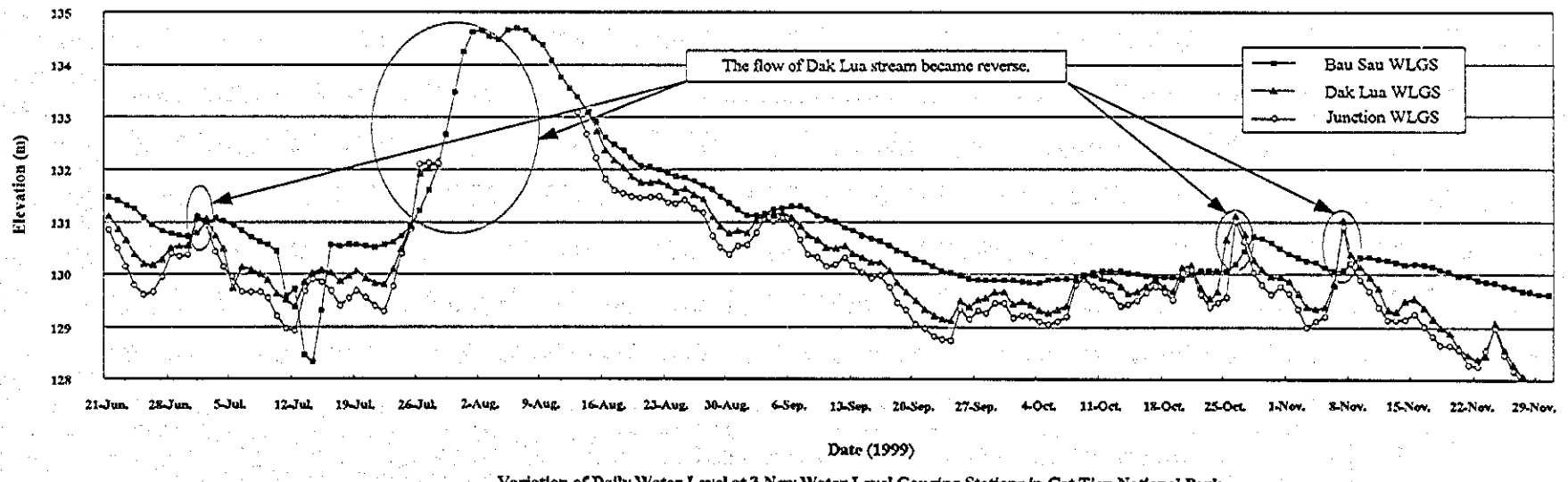
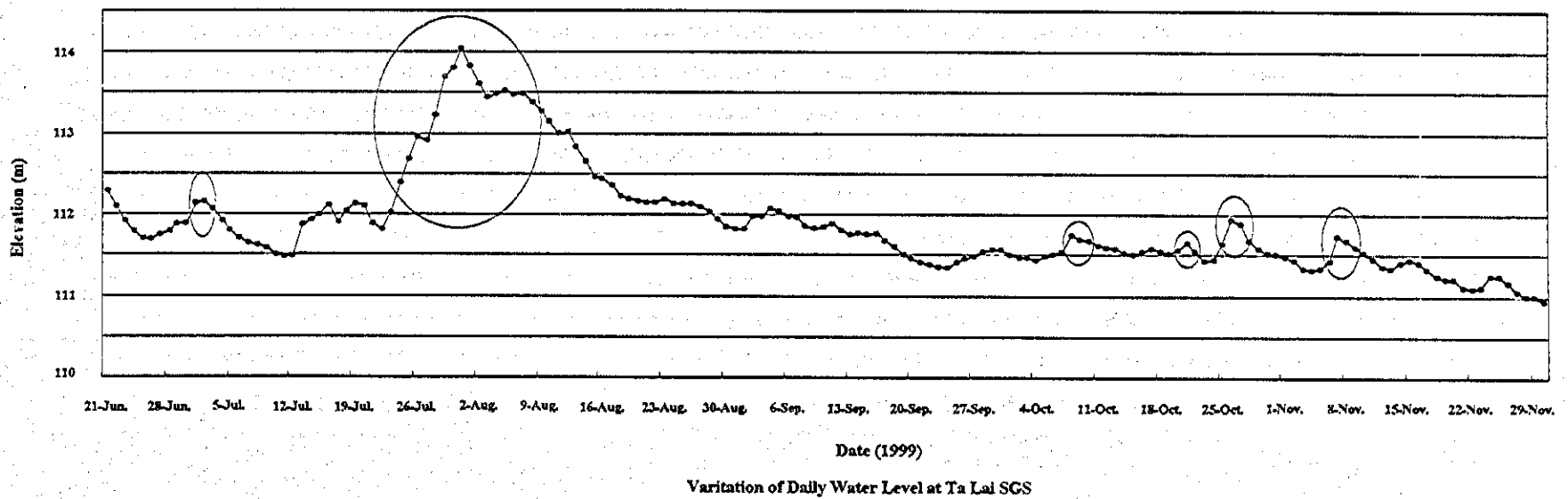


Figure 4.6 Location Map of New Water Level Gauging Stations in Bau Sau Wetland of CTNP



Variation of Daily Water Level at 3 New Water Level Gauging Stations in Cat Tien National Park



Varitation of Daily Water Level at Ta Lai SGS

Figure 4.7 Relation of Variation of Water Level between at Newly Installed Water Level Gauging Stations in Cat Tien National Park and at Ta Lai SGS

CHAPTER5 POWER SURVEY

5.1 Power Sector Organization and Tariff System

5.1.1 Institutional Aspects of Power Sector

Until recently, the Vietnam's power sector was divided into three distinct regional systems and these systems were managed by Power Company No.1 in the North area, Power Company No.2 in the South area, and Power Company No.3 in the Central area.

In January 1995, the Government established a holding company, the Electricity of Vietnam (EVN) for the entire power sector. EVN is the State Corporation established under the State Enterprise Law and EVN's Board of Management is authorized to perform the ownership function on behalf of the State. With the creation of EVN, the operations in the power sector are managed by the following entities:

(1) North:

Power Company No.1 (PC1)	Power generation below 30 MW, regional load dispatch and power transmission and distribution at or below 35 kV in the North area except Hanoi.
Power Company of Hanoi	Power distribution in Hanoi.
Transmission Company 1	Power transmission above 35 kV in the North.
Transmission Company 4	National load dispatching center and 500 kV transmission.
Five Generation Units	Pha Lai, Uong Bi, Ninh Binh, Hoa Binh and Thac Ba.

(2) South:

Power Company No.2 (PC2)	Power generation below 30 MW, regional load dispatch and power transmission and distribution at or below 35 kV in the South area, except HCMC.
Power Company of HCMC	Power distribution in HCMC.
Transmission Company 2	Power transmission above 35 kV in the South area.
Six Generation Units	Thu Duc, Tra Noc, Ba Ria, Tri An, Thac Mo, Da Nhim

(3) Central:

Power Company No.3 (PC3)	Power generation below 30 MW, regional load dispatch and power transmission and distribution at or below 35 kV in the Central area.
Transmission Company 3	Power transmission above 35 kV in the Central area.
One Generation Unit	Vinh Son

In addition to these entities, there are companies for engineering, design, construction, manufacturing and associated service entities. The Institute of Energy (IOE) provides the planning and analytical support to the power sector. The entire sector is under the control of the Ministry of Industry (MOI). The whole organization of EVN is depicted in Figure 5.1. The number of staff of EVN in December 1994 is listed in Table 5.1.

Under the new charter of EVN, some entities were restructured into financially

"independent" business units. The Independent business units comprise the following:

- PC No.1, PC No.2, PC No.3, PC Hanoi City and PC Ho Chi Minh City
- Power Engineering Consulting Company No.1 (PECC1), PECC No.2 (PECC2), PECC No.3 (PECC3) and PECC No.4 (Nha Trang) (PECC4)
- Electric Telecom Company
- Manufacturing Companies

These are independent accounting enterprises that are accountable directly to the EVN's Director General as profit centers.

Other business units than the above are subject to dependent accounting and consolidation of account takes place only at the level of EVN as a whole. They are required to be responsible only for their own costs.

5.1.2 Financial Aspects of EVN

Tables 5.2 and 5.3 contain financial results of EVN operation in 1997 and 1998. The net sales from operation of VND 13,473 billion (US$ 1,013 million equivalent) resulted in a profit after tax of VND 1,101 billion (US$ 83 million equivalent) in 1998. Compared to 1997, the profit after tax increased more than two times in 1998. The reduction of costs including those of sales and administration was attributed to the increase in profit.

The EVN's equity capital amounted to VND 25,199 billion (US$ 1,895 million equivalent) with the capital ratio (the ratio of net-worth to total capital employed) of 58.3% in 1998 which was rather high. However, rates of return in 1998 were rather low though improved when compared to the previous year: the return on equity (ROE) was 4.4% (2.0% in 1997) and the return on assets employed was 2.5 % (1.1% in 1997).

5.1.3 Power Tariff System

The amendment of electric power tariff requires the approval of the National Assembly and the Government thereafter. The inter-ministerial Governmental Pricing Committee, the Ministry of Industry, is responsible for publishing the amended electric tariff schedule. The electric tariff schedule currently valid was issued in May 1997 and is tabulated in Table 5.4 together with the previous one. Due to the Government's introduction of the value added tax (VAT) in January 1999, tariff rates are recognized as those inclusive of VAT (10%) since then.

Tariffs are currently uniform across the whole Vietnam. Industrial, business and commercial consumers pay according to regular, peak and off-peak tariffs. However, few of these customers have time-of-day metering and therefore this tariff schedule cannot be actually applied. The introduction of these meters for appropriate consumers will be an important step in establishing a cost reflective tariff that will provide incentives for conservation of energy at peak times.

The present tariff structure broadly reflects differences in costs associated with voltage level and type of consumer. Therefore, tariff rates to industrial consumers are highest for those supplied at low voltage of 6 kV or below, and lowest for those supplied at high voltages of above 110 kV. A tariff schedule for foreign customers of both business and residential status is comparatively high.

The average tariff is about 5.2 US¢/kWh in October 1999. Currently, EVN proposes the Government to raise the average tariff to 6.2 US¢/kWh in 2000 and 7.0 US¢/kWh in 2001. While, the World Bank recommends EVN to adjust the tariff schedule to 7.5 US¢/kWh in average by the year 2005 through raising 0.5 US¢/kWh every year.

5.2 Electric Power Market

5.2.1 Historical Trend of Power Demand

The historical trend of electric power demand from 1989 to 1998 is summarized in Tables 5.5 and 5.6 and Figures 5.2 and 5.3.

The electric power demand (sales of power) not including power plant auxiliaries and system losses is increasing steadily from 5,661 GWh in 1989 to 9,198 GWh in 1994 and 17,739 GWh in 1998. The annual average growth rate of total demand during 1993-1998 was 17.2%. The growth rates of the industrial, household, service and commercial and agricultural sectors were 13.3%, 22.2%, 14.9% and 10.7%, respectively. Especially, growth rate of household demand is remarkable. This shows that the rural electrification is progressing rapidly and that the per capita electricity consumption amount is increasing gradually.

5.2.2 Electric Power Demand by Region

The electric power demands by region (the Northern, Central, and Southern region) are shown as follows:

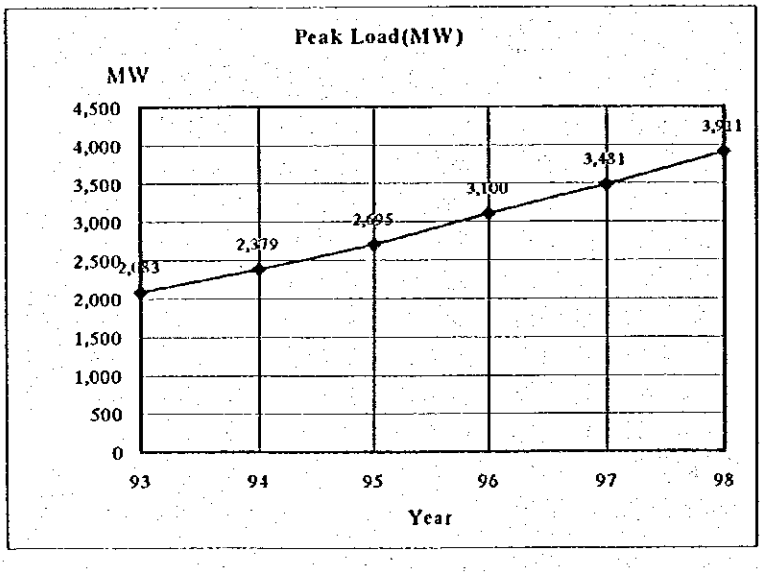
Historical Electric Power Demand by Region

Year	Total (GWh)	North		Central		South	
		GWh	Share (%)	GWh	Share (%)	GWh	Share (%)
1995	11,185	4,915	43.9	1,005	9.0	5,264	47.1
1996	13,374	5,753	43.0	1,240	9.3	6,381	47.7
1997	15,303	6,462	42.2	1,472	9.6	7,368	48.1
1998	17,739	7,277	41.0	1,748	9.9	8,714	49.1

As seen in this table, the power demand in every region has increased steadily. The share of power demand of the southern region has been increasing year by year, while that of the northern region has gradually decreased for these four years.

5.2.3 Peak Demand, Daily Load Curve and Load Factor

The historical trend of peak demand from 1993 to 1998 is shown below:



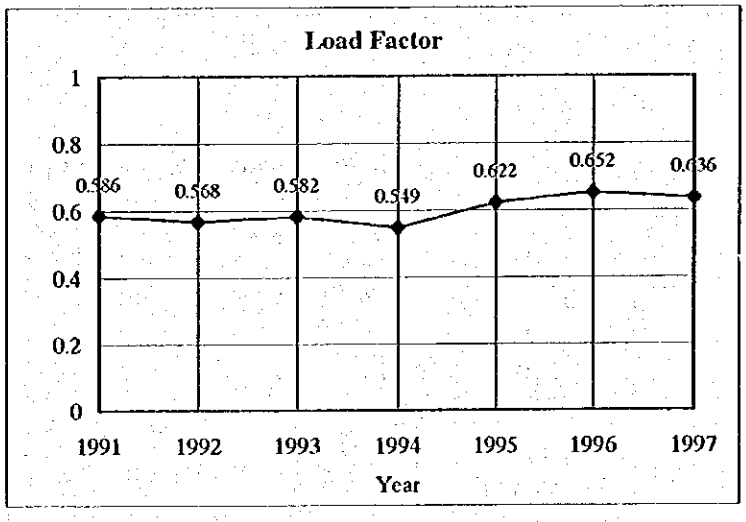
The peak demand has increased at an annual average growth rate of 13.4 % for these five years.

The monthly peak demand curve and typical daily load curve in 1998 are shown in Figures 5.4 and 5.5, respectively.

Monthly peak demand curve is very flat from January through December, since there is not a large fluctuation of temperature by each season.

As can be seen from the daily load curves of holiday and weekday in Figure 5.5, the daily peak time takes place usually from 18:00 to 21:00. The electricity consumption in this time zone is attributed mainly to lighting demand in households. It is typical so-called turn-on-a-light peak type. The peak of electricity consumption appears in the evening when each household begins to turn on a light and to prepare for meals. Moreover, the daily load curve of holiday and that of weekday are similar in shape.

The historical trend of load factor is shown below:



This figure shows an upward tendency of the load factor from the previous 50% level to over 60% level in a couple of recent years. In future, it is expected that the electric power consumption in the daytime will increase owing to the growth of the industry demand so that load factor will raise at a higher growth rate.

5.3 Existing Power Plants

5.3.1 Historical Trend of Electric Power Generation

The historical trend of electric power generation is shown in Table 5.7 and Figures 5.6 and 5.7.

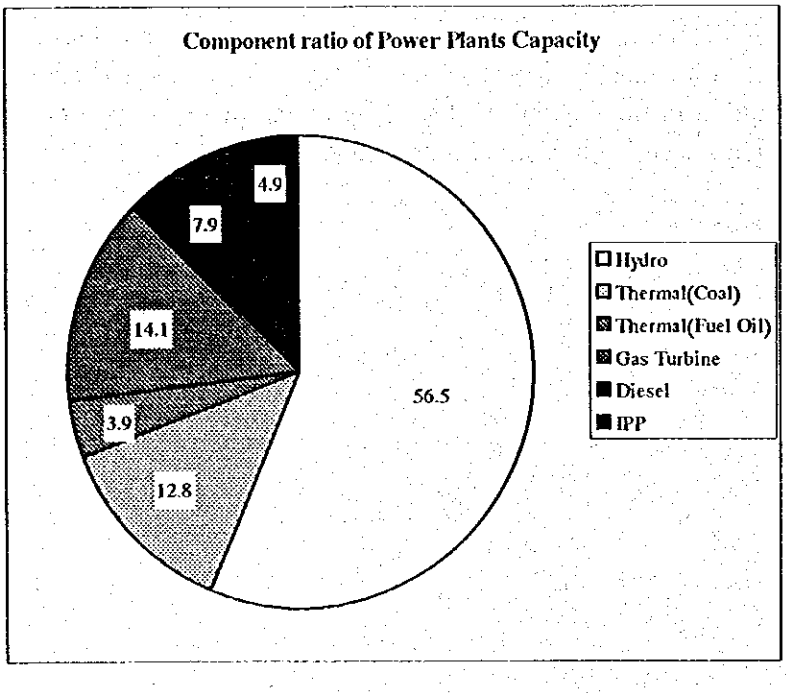
Electric power generation increased from 7,792 GWh in 1989 to 12,283 GWh in 1994 and 20,850 GWh in1998.

The component rate of hydropower plants was about 70% of the whole generation for the period from 1992 to 1996. It has been decreasing gradually year by year from 70.4 % in 1996 to 61.0% in 1997 and 53.2% in 1998. On the other hand, the component rate of thermal power plants has been increasing little by little from 19.4% in 1996 to 22.6% in 1997 and 23.1% in 1998. Besides gas turbine power plants have expanded their share largely from 8.5% in 1996 to 15.2% in 1997, 22.0% in 1998. This is because there was no commissioning of hydropower stations in 1996, 1997, and 1998 and increasing demand was covered by additional power generation of existing thermal power stations and newly developed gas turbine power stations.

5.3.2 Existing Power Generation Facilities

Existing installed capacity of power stations in the country is 5,055 MW (including IPP of 250 MW) as of the end of 1998 as shown in Table 5.8. The details are given below:

Hydro	2,854MW	56.5%
Thermal (coal)	645MW	12.8%
Thermal (fuel oil)	198MW	3.9%
Gas Turbine	711MW	14.1%
Diesel	1,397MW	7.9%
IPP	250MW	4.9%
Total	5,055MW	



The generated energy by main power plants in 1998 are shown in Table 5.9 and the largest five power plants in terms of the generated energy are shown below:

Major Power Plants in Terms of Energy Generation in 1988

Name of Power Plants	Energy Generation in 1988	Share
· Hoa Binh	6,912.8 GWh	31.9%
· Pha Lai	2,386.7 GWh	11.0%
· Phu My 2-1	1,981.0 GWh	9.1%
· Tri An	1,615.9 GWh	7.5%
· Ba Ria	1,456.4 GWh	6.7%

5.4 Existing Transmission System Facilities

5.4.1 Transmission Lines and Substations

The existing 500 kV and 220 kV transmission lines and substations are shown in Tables 5.10 and 5.11.

The present power system diagram of the 500 kV and 220 kV systems of the whole country is shown in Figure 5.8 and their locations are depicted in Figure 5.9.

The transmission system of Vietnam is composed of 500 kV trunk transmission system and 220 kV major transmission system.

The total circuit lengths of transmission lines are as follows:

500 kV	1,487 km
220 kV	2,435 km

The total capacity of substations is as follows:

500 kV	2,700 MVA
220 kV	4,410 MVA

5.4.2 500kV Transmission Line

The North-South 500 kV transmission line was constructed to interconnect the three regions of the country. It is nearly 1,500 km in total route length starting from Hoa Binh hydropower plant site and terminating at Phu Lam substation, which is compensated by the series capacitors for the purpose of increasing the stability. The operating records from 1994 to 1998 are shown below:

Power Transmission between North and South Areas by Existing 500 kV Transmission

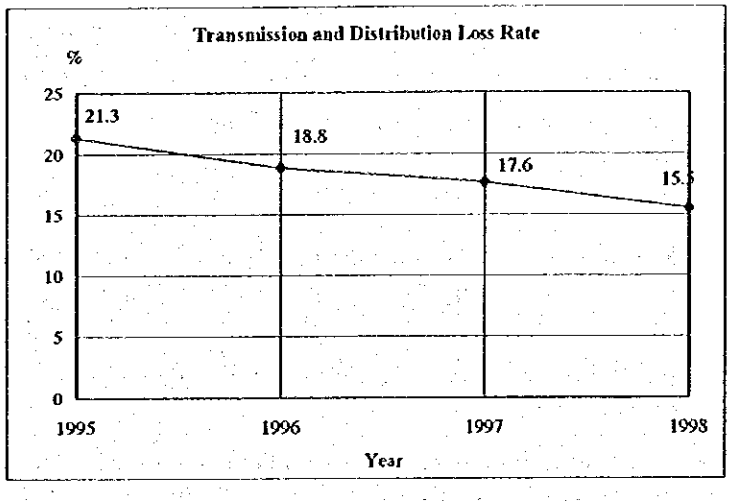
(Unit : GWh)

	1994	1995	1996	1997	1998
from North to South	1,006	2,790	2,718	2,691	2,036
from South to North	-	-	-	30	231

This line was originally designed to carry power from the north, which had a surplus of hydropower to the south. However, it may be specially noted that power was sent from the south to the north due to the output reduction of the northern hydropower plants in the dry season of 1997 and 1998.

5.4.3 Transmission and Distribution Losses

The historical trend of transmission and distribution loss rate is shown below:



The transmission and distribution loss rate is decreasing year by year, but the figure is still higher compared to the figures of industrially developed nations.

5.5 Power Demand Forecast

5.5.1 Methodologies and Procedures Applied

To forecast the electric power demand, the following two methods are generally adopted:

1) Demand-plus method: the method where the electric power demands in the sectors classified according to the electricity use are summed up.
2) Macro method: the method of conducting analysis from the overall (nation wide) viewpoint

To forecast the electric power demand, the "demand-plus method" is applied in principle, in which demand is estimated separately for each sector concerned with electricity use. The aggregated total demand of the sector demands is then checked against the total demand that is estimated the macro-method based on the correlation between total demand and gross national product.

In fact, the forecast should not rely on only one method but should consider the situation from different aspects and employ a variety of forecasting tools. From the results, the forecast with the highest accuracy should then be chosen.

In the power demand forecast by the demand-plus method, the power demand is estimated for each of the four sectors of industry, commercial, agriculture, and household, and those sector demands are totaled to obtain the demand of the whole country. Whereas, with the macro method, the whole country's energy generation is estimated based on its correlation with GNP. The value considered to be most appropriate is chosen out of the two results.

A work flow for the power demand forecast is shown in Figure 5.10.

5.5.2 Electric Power Demand Forecast by EVN

EVN is currently in the process of compiling Phase V of the Master Plan that is scheduled to submit to the Government in December 1999. The Phase V contains the power demands forecast for the period up to the year 2020.

The energy generation and peak power demands for the whole country and three regions (North, Central and South) are calculated by EVN as shown in Table 5.12. The energy generation and peak power demands forecast by EVN are shown in Figures 5.11 and 5.12.

According to the EVN's forecast that is made based on the actual peak power demand of 3,911 MW in 1998, it is forecast that the peak demand will increase at the following increase rates until the peak power demand reaches 26,854 MW or approximately 6.9 times the present value in 2020:

Period	Annual Growth Rate of Peak Power Demand Power
between 2001 and 2005	10.7%
between 2006 and 2010	9.4%
between 2011 and 2015	8.9%
between 2016 and 2020	8.5%

5.5.3 Conditions of Forecast by the JICA Study Team

(1) Demand Forecast Period

Assuming the year 1998 to be the base year, it was decided to adopt the 17 years from 1999 through 2015 as the demand forecast period.

(2) Demand Forecast by Consumer Sector

The demand was forecast separately for each of the four consumer sectors, namely, industry, commercial, agriculture, and household, according to the EVN's classification of consumers.

5.5.4 Macro Demand Forecast

The common feature of power demand in almost all countries is that the power demand has a extremely close correlation with GDP. Accordingly, when forecasting future power demand, the future GDP of the country concerned is first forecast and then the elasticity coefficient of electricity (value obtained by dividing past power demand growth rate by past GDP growth rate) is used to forecast the future power demand.

(1) Elasticity Coefficient of Electricity

The historical trends of GDP and energy generation between 1990 and 1998 are indicated in the following table:

Year	GDP (billion VND)	Energy Generation (GWh)
1990	29,526	8,679
1991	31,286	9,153
1992	33,991	9,652
1993	36,735	10,660
1994	39,982	12,283
1995	44,980	14,634
1996	50,385	16,939
1997	55,059	19,139
1998	59,867	20,850

The correlation between the two factors was obtained using the linear approximation from the Excel scatter diagram method as shown in Figure 5.13 and summarized below:

Linear approximation $Y = 0.4198 X - 4252.9$ $R^2 = 0.9946$

(Where, X = GDP, Y = Generation)

This correlation analysis clarified that there is an extremely strong correlation between the two factors. Accordingly, the elasticity coefficient of electricity over the past eight years was obtained as follows:

(Annual Average Energy Generation Growth Rate) / (Annual Average GDP Growth Rate)
= 12.11 % / 9.24 %
= 1.311

(2) Future Power Demand Forecast

Based on the future GDP forecast obtained in Chapter 2, the energy generation demands were calculated using the above elasticity coefficient of electricity, and the peak loads were forecast from the annual load factor. The results of the electric power demand are shown in the following table. With regard to the load factors in the future, the figures forecast by IOE were used in the present electric power demand forecast.

Year	GDP Growth Rate	Energy Generation (GWh)	Load Factor	Elasticity = 1.311	
				GWh	MW
1990					
1991					
1992					
1993					
1994	0.924	0.1212			
1995					
1996					
1997					
1998				21,654	3,911
1999	0.050		0.660	23,073	3,991
2000	0.060		0.633	24,888	4,285
2001	0.072		0.667	27,238	4,662
2002	0.072		0.670	29,809	5,079
2003	0.072		0.673	32,622	5,533
2004	0.072		0.675	35,702	6,579
2005	0.072		0.678	39,072	6,579
2006	0.072		0.680	42,760	7,178
2007	0.072		0.683	46,796	7,821
2008	0.072		0.685	51,213	8,535
2009	0.072		0.687	56,047	9,313
2010	0.072		0.690	61,337	10,148
2011	0.065		0.692	66,564	10,981
2012	0.065		0.694	72,237	11,882
2013	0.065		0.696	78,392	12,858
2014	0.065		0.698	85,072	13,913
2015	0.065		0.700	92,322	15,056

5.5.5 Demand-plus Method Forecast

The electric power demand was classified into the four types, namely demands in industrial, commercial, agricultural, and household sectors. The sectoral future demand was forecast from past records on sector power demands in each category including data on sold electricity.

(1) Industry

Concerning industry, as well as in the case of macro forecast mentioned above, the elasticity coefficient of electricity was obtained from past GDP and power sales in the industrial sector. The future power demand in the industrial sector was predicted based on the future GDP forecast in the said sector. The results are indicated in Table 5.13.

(2) Commercial

Also concerning the commercial sector, the elasticity coefficient of electricity was obtained from the past GDP and power sales in the commercial sector. The future power sales in the commercial sector were predicted based on the future GDP forecast in the sector as shown in Table 5.14.

(3) Agriculture

Likewise, the elasticity coefficient of electricity for the agricultural sector was obtained from past GDP and power sales in the agriculture sector. The future power sales were predicted based on the future GDP forecast in the sector as shown in Table 5.15.

(4) Household

Concerning household demand, the correlation equation showing a relationship between past population changes and household power sales was obtained since this is closely related to population growth. Applying the future population growth rates projected in the foregoing Chapter 2, the future power sales were predicted. The results are shown in Table 5.16.

(5) Demand-plus Method

Based on the total power sales in the four consumer sectors, the peak power demand was calculated taking into account the transmission loss rate, plant service power rate, and load factor. The results are shown in the following table:

Year	Sales (GWh)		Transmissi -on Loss Rate	Generation at Sending End (GWh)	Plant Service Rate	Generation at Generating End (GWh)	Load Factor	Peak Load (MW)
	Results	Forecast						
1993	8,007							
1994	9,199							
1995	11,185							
1996	13,374							
1997	15,303							
1998	17,739							
1999		19,652	0.156	23,284	0.027	23,930	0.660	4,139
2000		21,876	0.154	25,858	0.028	26,602	0.633	4,580
2001		24,267	0.150	28,550	0.028	29,372	0.667	5,027
2002		26,445	0.147	31,002	0.029	31,928	0.670	5,440
2003		28,753	0.145	33,629	0.030	34,669	0.673	5,881
2004		31,204	0.140	36,283	0.030	37,406	0.675	6,326
2005		33,811	0.135	39,088	0.030	40,297	0.678	6,785
2006		36,689	0.127	42,026	0.030	43,326	0.680	7,273
2007		39,795	0.120	45,222	0.029	46,573	0.683	7,784
2008		43,155	0.114	48,708	0.028	50,111	0.685	8,351
2009		46,797	0.108	52,462	0.027	53,918	0.687	8,959
2010		50,751	0.103	56,579	0.026	58,089	0.690	9,610
2011		54,609	0.100	60,676	0.026	62,296	0.692	10,277
2012		58,775	0.097	65,088	0.028	66,963	0.694	11,015
2013		63,281	0.095	69,923	0.030	72,086	0.696	11,823
2014		68,161	0.093	75,150	0.032	77,634	0.698	12,697
2015		73,454	0.093	80,985	0.035	83,922	0.700	13,686