THE REPUBLIC OF TURKEY

FEASIBILITY REPORT ON ÇORUH RIVER HYDROELECTRIC POWER DEVELOPMENT PROJECT

DECEMBER 1986

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the Republic of Turkey, the Japanese Government decided to conduct a survey on the Coruh River Hydroelectric Power Development Project and entrusted the survey to the Japan International Cooperation Agency.

J.I.C.A. sent to Turkey a survey team headed by Mr. Mamoru Takaichi, Electric Power Development Co., Ltd., twice in a period from May 28, 1985 to February 28, 1986.

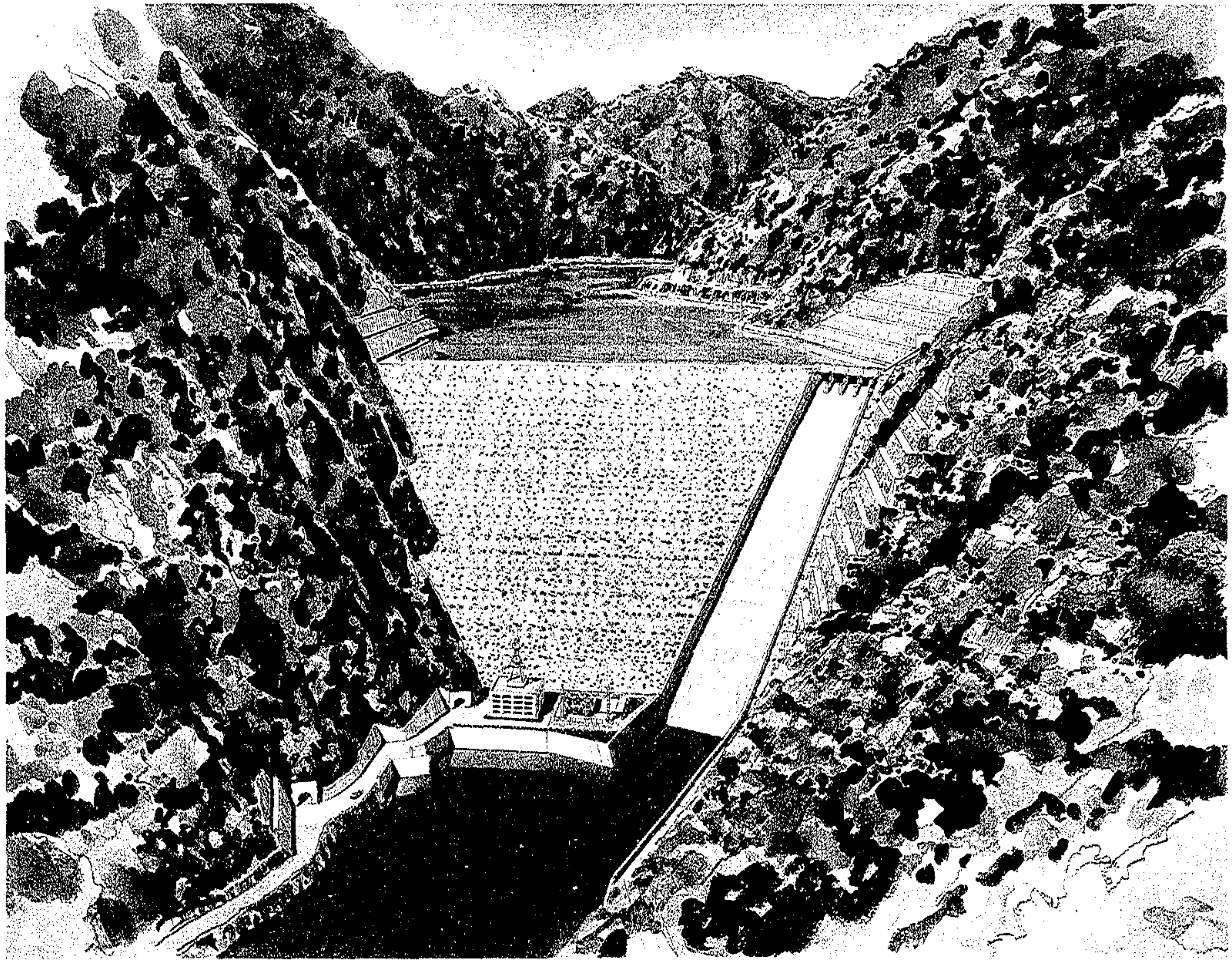
The team had discussion with the officials concerned of the Government of the Republic of Turkey and conducted a field survey (in the Coruh River area).
After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the project and contribute to the promotion of friendly relations between our two countries.

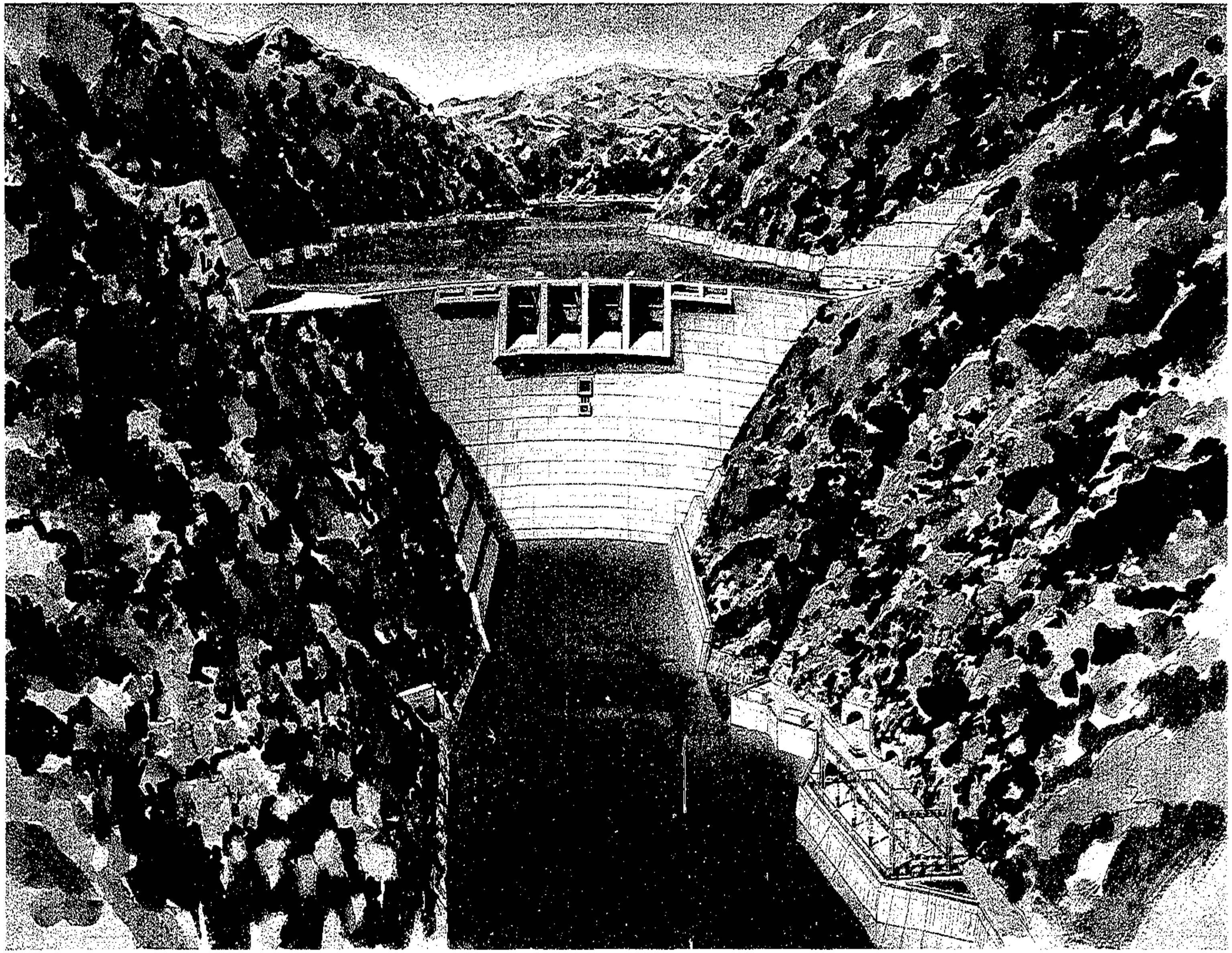
I wish to express my deep appreciation to the officials concerned of the Government of the Republic of Turkey for their close cooperation extended to the team.

December, 1986

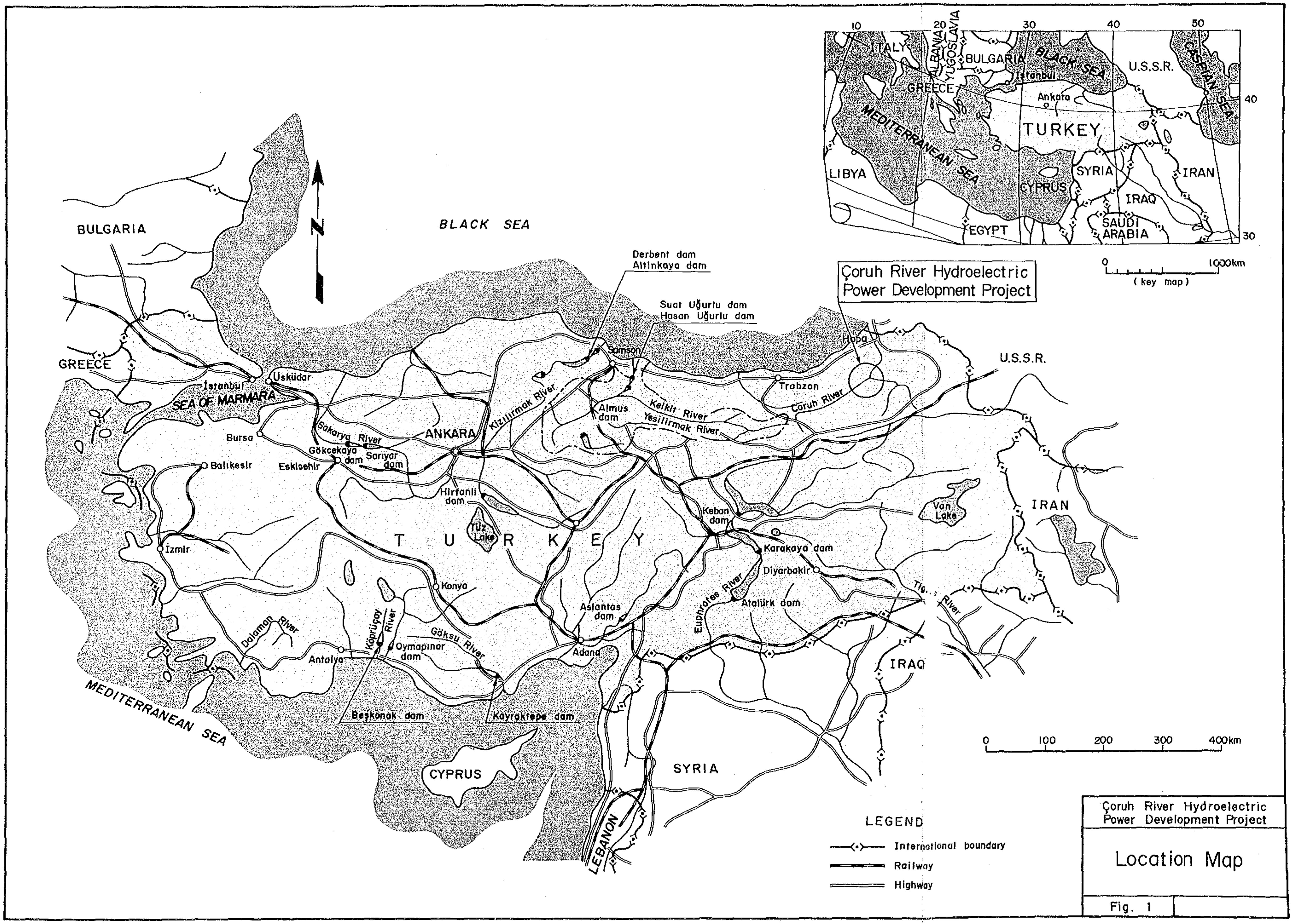
Keisuke Arita
President
Japan International Cooperation Agency



Artist's Conception of Yusufeli Dam



Artist's Conception of Artvin Dam



Çoruh River Hydroelectric Power Development Project

Location Map

Fig. 1

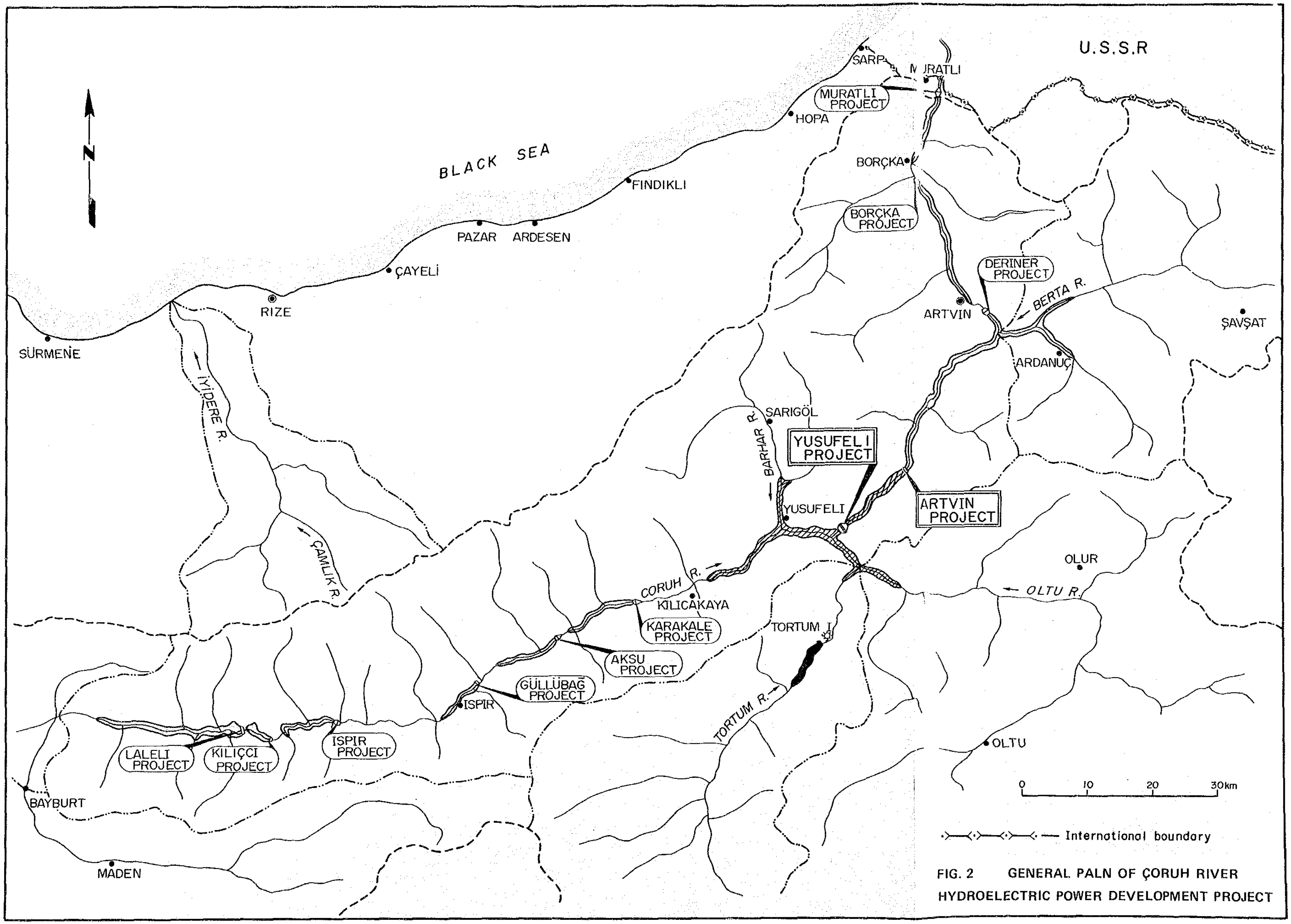


FIG. 2 GENERAL PALN OF ÇORUH RIVER HYDROELECTRIC POWER DEVELOPMENT PROJECT

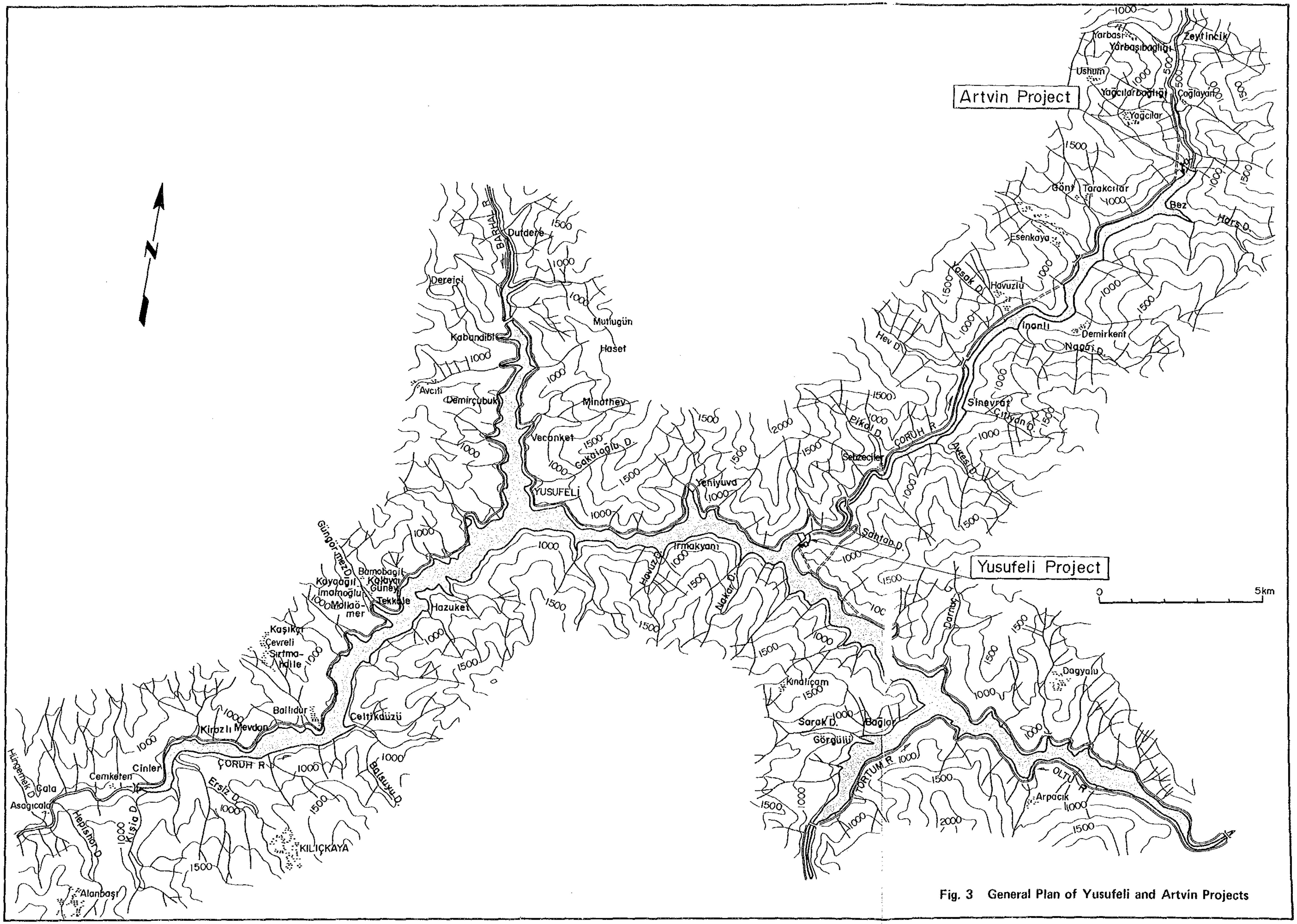
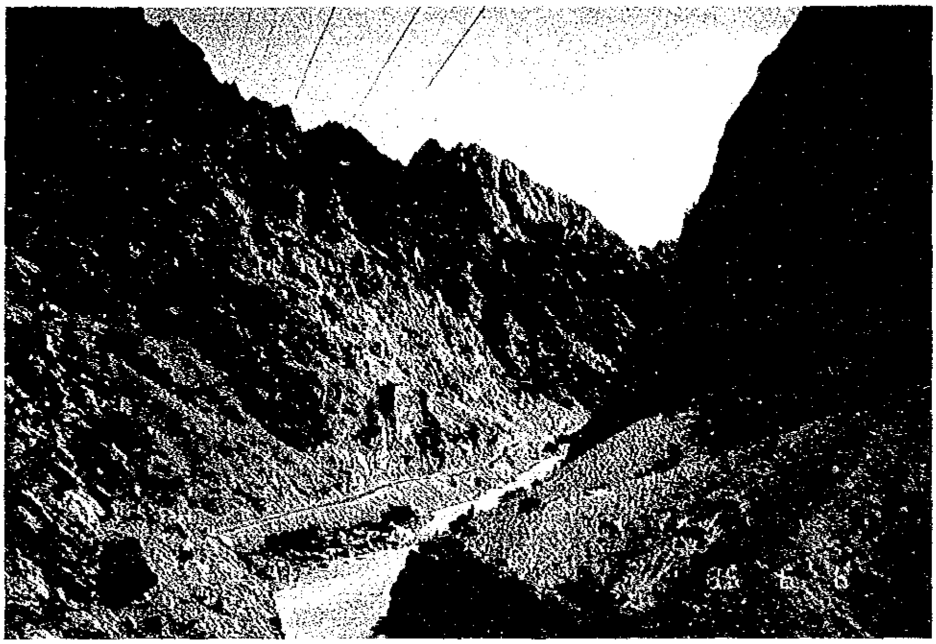
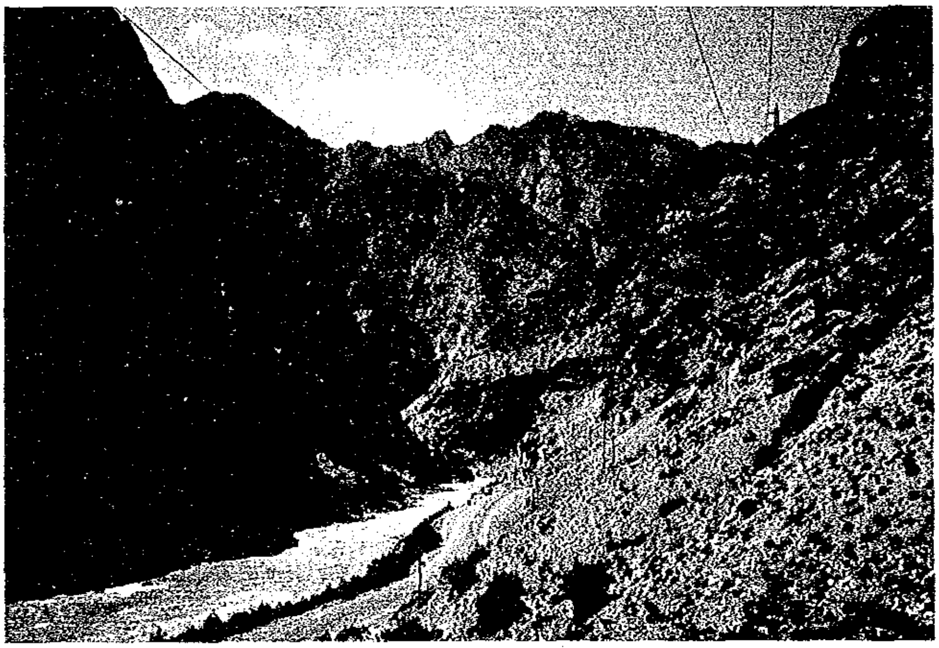


Fig. 3 General Plan of Yusufeli and Artvin Projects



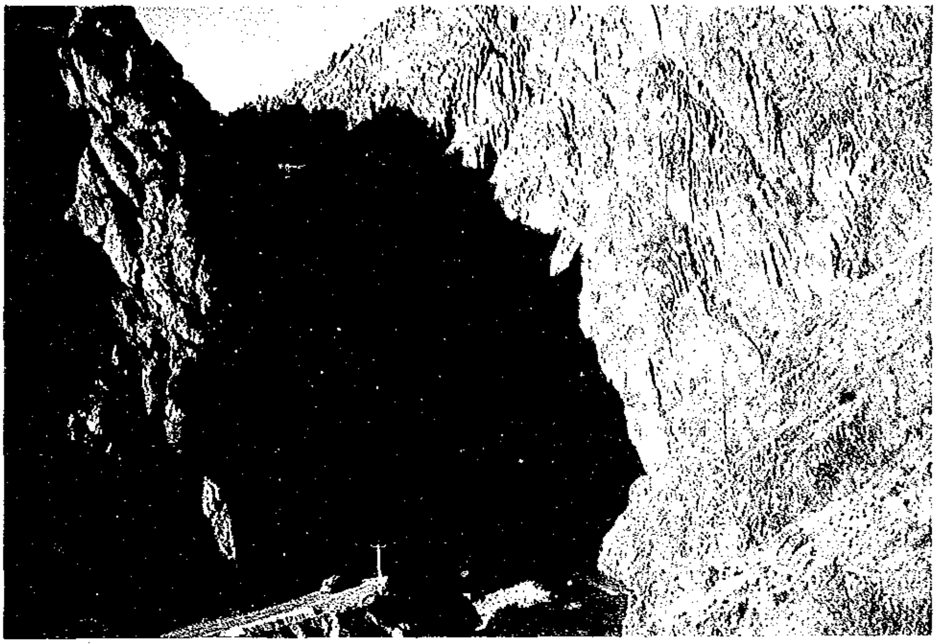
Yusufeli Dam Site

– Looking from the Upstream Side –



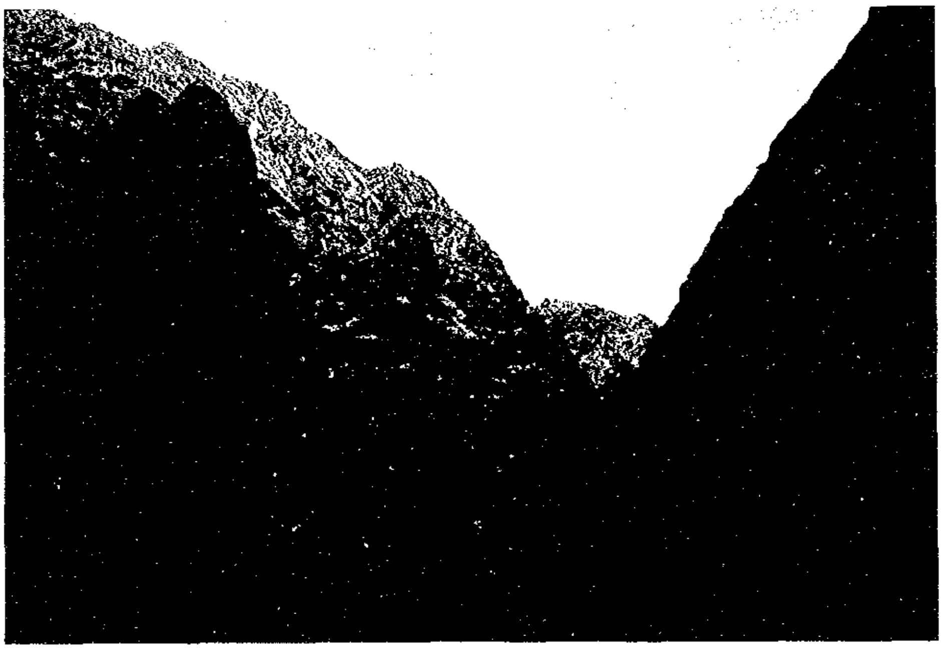
Yusufeli Dam Site

– Looking from the Downstream Side –



Artvin Dam Site

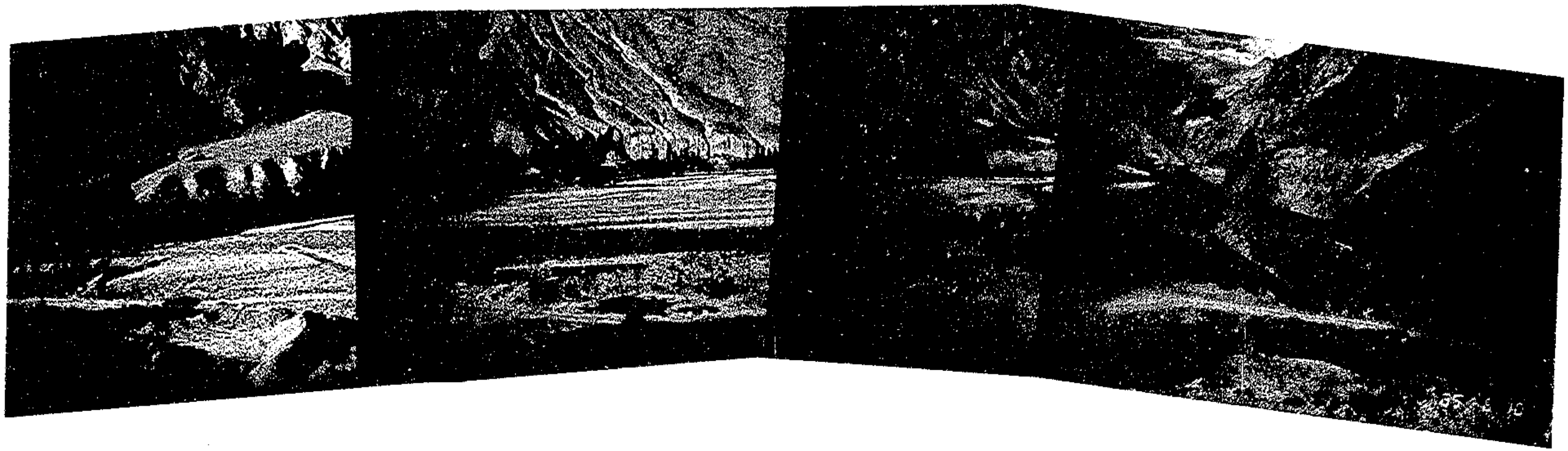
– Looking from the Upstream Side –



Artvin Dam Site

– Looking from the Downstream Side –

Borrow Area (Gorgulu)



Proposed Aggregate Site

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SUMMARY

SUMMARY

This report concerns the feasibility study of the Coruh River Hydroelectric Power Development Project of the Republic of Turkey. The feasibility study has been conducted from 1985 to 1986 by the Japan International Cooperation Agency (JICA) under a technical cooperation program of the Government of Japan.

This report is submitted by JICA, through the Ministry of Foreign Affairs of the Japanese Government, to the Elektrik Isleri Etut Idaresi (EIE) of the Government of Turkey.

A brief summary of the results of the feasibility study is presented in the following part of this section.

(1) Features of the Project

The Coruh River Hydroelectric Power Development Project comprises Yusufeli Project and Artvin Project, and a transmission line from Yusufeli and Artvin Power Plants to the primary end Hopa Substation. (The Inanli Project was renamed Artvin Project and the Artvin Project renamed Deriner Project, as of May 6, 1986.)

The drainage area of Coruh River covers the northeastern part of the Republic of Turkey, its total area within the territory of Turkey is 19,750 km^2, corresponding to 2.5% of the total area of Turkey.

The total length of Coruh River inside Turkey is approximately 390 km, and the average annual run off is 5.96×10^9 m^3.

The Laleli dam site at the uppermost stream of this river, the Yusufeli dam site at the midstream, and the Deriner dam site at the downstream, are the three locations where reservoirs with large storage capacities can be constructed to control the abundant run off of the Coruh River.

The Yusufeli dam site is located approximately 800 meters downstream of the confluence of the Coruh River and a tributary, Oltu River.

The average annual inflow of the river at the Yusufeli dam site is approximately $3,780 \times 10^6$ m^3. The construction of Yusufeli Dam will create a reservoir having a gross storage capacity of 2,130 x 10^6 m^3, and an effective storage of 1,080 x 10^6 m^3. This effective storage corresponds to approximately 30% of the average annual inflow.

Yusufeli Project is the key project in the comprehensive hydroelectric power development project of the Coruh River. That is, the large reservoir of Yusufeli is capable of controlling the river flow so that the 4 hydroelectric power plants (Artvin, Deriner, Borcka and Muratli) to be constructed downstream can be operated at high efficiencies.

The Artvin dam site is located about 19 km downstream of the Yusufeli dam site, and its reservoir will form the afterbay immediately downstream of Yusufeli Dam.

(2) Rationale for the Development

The power generation capacity of Turkey, as of 1984, consists of 3,875 MW of hydroelectric power (generating 13,426 x 10^9 kWh) and 4,584 MW of thermal power (17,187 x 10^9 kWh), the total being 8,459 MW (30,613 x 10^9 kWh). As this supply capacity is not sufficient to meet the power demand, 275 MW (2,653 x 10^9 kWh) of power was imported in 1984 from U.S.S.R. and Bulgaria.

Projection of the future electric demands (for the period from 1985 to 2005) from two sources are presented below. One projection was prepared by TEK, and the other was made by a macroscopic method.

	TEK Projection		Macroscopic Projection	
	(GWh)	(MW)	(GWh)	(MW)
1985	36,850	6,570	35,500	6,300
1990	63,300	11,290	55,200	9,800
1995	102,450	18,270	83,700	14,900
1997	123,600	22,045	97,400	17,400
2000	162,600	29,000	123,800	22,100
2005	239,938	40,500	180,700	32,200

The table indicates that the average annual growth of electricity demand until year 2005 is 9.9% according to the TEK Projection, and 8.6% according to the macroscopic projection.

New power plants are being constructed to meet this demand growth, including Elbistan Thermal Power Plant (4,200 MW), Karakaya Hydro Power Plant (1,800 MW), Altinkaya Hydro Power Plant (700 MW) and Ataturk Hydro Power Plant (2,400 MW). At the same time, preparation works are in progress to start more plant constructions in early years, including Kayraktepe Hydro Power Plant (420 MW), Ilisu Hydro Power Plant (1,200 MW) and Boyabat Hydro Power Plant (510 MW).

Yusufeli Project and Artvin Project represent a group of large development projects which are to follow the large projects being implemented as cited above, and these two projects have very important roles from the point of view of balancing power supply and demand. That is, these are the important hydroelectric resources that must be fully committed to the electric power grid of Turkey in around year 2000. From the standpoint of demand and supply, the promotion of the implementation of the planned hydro and thermal projects is indispensible, and should these projects be smoothly implemented, in the year 1989 and after, the ratio of reserve capacity will take a descending trend in relation to demand. Therefore, in order to maintain an optimum reserve capacity, it is necessary to develop annually 1,000 to 2,000 MW of hydro power. In the year 2000, when almost all large hydroelectric potentials will have been developed, it is essential to implement the development of Yusufeli Project (540 MW) and Artvin Project (320 MW). Another aspect of the significance of these two projects is the fact that they are located in the north-eastern part of Turkey where small amount of national investment has been allotted so far. That means these project could substantially contribute to the economic development of these backward areas.

(3) Meteorology and Hydrology

The temperature in the Yusufeli site is maximum 43.8°C, minimum -14.2°C and average 14.2°C. The annual average precipitation in the drainage area of the Yusufeli site, and the annual evaporation are 440 mm and, 1,181 mm respectively. The annual inflows at the Yusufeli site and Artvin site are 3,777 x 10^6 m^3 and 3,873 x 10^6 m^3 respectively.

The estimated value of sedimentation rate at the Yusufeli site is 403 $t/km^2/year$ (337 $m^3/km^2/year$). The design sedimentation is taken as 400 $m^3/km^2/year$ x 50 years.

The design flood discharge for care of river during construction is as given below.

	Yusufeli site	Artvin site
10 year return period flood (m^3/s)	1,093	1,121
25 year return period flood (m^3/s)	1,329	1,362

The probable maximum flood at the Yusufeli site is 9,000 m^3/s.

(4) Geology and Material

Yusufeli Project

It is judged that there will be no problem concerning the water-tightness of the reservoir of Yusufeli. Although two large landslides are found at Gorgulu and Vecanket in the upstream part of the Yusufeli reservoir area, it can be judged that these landslides do not present an obstacle against construction of Yusufeli Dam.

The geological formations at the dam site consist of granite, diabase, etc., and will not present a problem against construction of a rock-fill dam or a concrete arch dam of 270 meter high class if normal foundation treatment is performed.

Artvin Project

Although there are two landslides, Havuzlu and Demirkent, in the Artvin reservoir area, it is judged that these landslides are of a nature not presenting a problem against construction of a dam. Also, there will be no problem in the water-tightness of the reservoir.

The geological formations at the dam site consist of diabase, tuff, etc. It can be judged that no problem will be presented against construction of a concrete arch dam at this locaton if adequate foundation treatment is performed. However, according to one completed drill hole, it was disclosed that a fault exists at the river bottom. Therefore, the definite type of dam should be studied based on the data of further detailed geological investigations.

Construction Material

Concerning the soil material, red soil is found at the Gorgulu area. This red soil has superior characteristics and is available in sufficient amount.

Concerning the concrete aggregate, river bed gravels of sufficient quality and quantity can be found at a location near the confluence of Oltu River and Tortum River.

(5) Result and Evaluation of In-Situ Rock Test

The results and evaluations of the plate bearing tests and block shear tests performed at the Yusufeli dam site are as presented below.

Plate Bearing Test Results

The deformation moduli are:

[A] Class; 68,100 - 142,000 kg/cm^2.
[B] Class; 29,400 - 78,200 kg/cm^2.

Thus the rock is hard having small deformation characteristics.

The tangential moduli of elasticity are:

[A] Class; 91,100 - 206,400 kg/cm^2.
[B] Class; 47,900 - 103,700 kg/cm^2.

Thus the moduli of elasticity are very high, indicating hard and good quality rock characteristics.

Block Shear Test Results

As described in Chapter 7.4 in detail, the shear strength could not be determined due to the strength of the concrete block. But the estimated shear strength was determined as below by correlation to the modulus of elasticity.

	Angle of Internal Friction (ϕ)	Cohesion (kg/cm²)
[A] Class	60°	50
[B] Class	52°	35

(6) Seismicity

In order to determine the design seismic intensity, the maximum ground acceleration at the Yusufeli dam site was evaluated by the probability method.

The data collected by NOAA of the United States were used for this study, and the number of data amounts to 1658, covering the period from 1910 to 1984.

Based on the results of this analysis, and taking into consideration general dam behavior, the design seismic intensities for the conventional pseudo-static stability analysis at the Yusefeli dam site were selected at 0.15 for the rock-fill dam and 0.30 for the arch dam.

(7) Environment Assessment

Detailed environmental assessment for the evaluation of quantitative impacts of this project on the ecology and social conditons in the project area and its neighboring areas has not been conducted yet.

General aspects of the environmental impact of this project can be evaluated, however, based on the data and information available at this stage of the study, as described below.

In this project, scenery, plants or animal specie of particular value cannot be found in the area which is going to be submerged by the large reservoir to be created by the Project. There is a possibility of the ecological system being altered by construction of this large reservoir. Based on considerations on the present status of the environment around the project site, it is anticipated that the nature of such ecological change can not be a serious one. It would be required, however, to study the possible change of water quality caused by the reservoir.

There is no historical monument or cultural asset in this project area.

As the population in the area to be submerged by the Yusufeli reservoir is approximately 7,000, relocation of people must be studied and planned in advance.

The national highway from Artvin City to Erzurum City runs through this project area, and it is necssary to re-route certain sections of this highway which are to be submerged or affected by the Project. As re-routing of this highway is one of the key factors controlling the start of this project, it is required to establish in advance a detailed re-routing plan of this national highway.

(8) Optimum Development Plan

The Yusufeli Project has the greatest effect on the whole development plan, as Yusufeli Project is larger in scale than Artvin Project, and it is located upstream on the river. For this reason, the development schemes and the scale of development, including the selection of dam type, were studied for the Yusufeli Project first, and then Artvin Project was studied based on the optimal plan of Yusufeli Project.

The outlines of Yusufeli Project and Artvin Project are presented below.

Yusufeli Project

A general description of Yusufeli Project is given below.

A rock-fill dam, 270 m high and 21 x 10^6 m^3 in volume constructed 800 m downstream of the confluence of the Coruh River main stream and its tributary Oltu river, to provide a gross storage capacity of 2,130 x 10^6 m^3, and an effective storage of 1,080 x 10^6 m^3. This reservoir regulates the average annual inflow of the river amounting to 3.78 x 10^9 m^3.

An intake structure will be constructed on the right bank immediately upstream of the dam, from which maximum discharge of 321 m^3/sec will be conducted to an underground power plant to be constructed under the right bank of the river through a penstock, to generate a maximum of 540 MW and annual energy production of 1,704.6 x 10^6 KWh.

The estimated construction cost of Yusufeli Dam and Power Plant described above is 367,025 x 10^6 T.L (132,563 x 10^6 T.L in foreign currency and 234,462 x 10^6 T.L in domestic currency), and the period required for construction will be 9 years.

The electric power generated by Yusufeli Power Plant and Artvin Power Plant will be transmitted to Hopa Substation by the 380 kV transmission line. The estimated construction cost of this transmission line is 8,927 x 10^6 T.L (6,176 x 10^6 T.L in foreign currency and 2,751 x 10^6 T.L in domestic currency). Of this transmission line cost, the portion to be born by Yusufeli Project is 6,340 x 10^6 T.L (4,417 x 10^6 T.L in foreign currency and 1,923 x 10^6 T.L in domestic currency).

The net present value (B-C) and the benefit-cost ratio (B/C) of the Project are 92,955 x 10^6 T.L and 1.65 respectively, adopting a thermal plant burning imported coal as the alternative plant.

The financial internal rate of return (FIRR) and the economic internal rate of return (EIRR) of the Project are 9.7% and 12.4% respectively, using the revenue from sales of electricity as the benefit.

Artvin Project

A general description of Artvin Project is given below.

An arch type dam, 160 m high and 500 x 10^3 m^3 in volume, is to be constructed on the Coruh River 19 km downstream of Yusufeli Dam, to create a reservoir having a gross storage capacity of 167 x 10^6 m^3 and an effective storage of 4 x 10^6 m^3. This reservoir will regulate the discharge from Yusufeli Power Plant and the inflow from the residual drainage area.

An intake structure to be constructed on the left bank immediately upstream of the dam will provide a maximum discharge of 333 m^3/sec to the underground power plant to be constructed under the left bank of the river through penstocks, to generate a maximum of 320 MW and annual energy production of 988.8 x 10^6 kWh.

The estimated construction cost of Artvin Dam and Power Plant is 154,428 x 10^6 T.L (62,160 x 10^6 T.L of foreign currency and 92,268 x 10^6 T.L of domestic currency). The period required for the construction will be approximately 6 years.

The power generated by Artvin Power Plant will be transmitted to Hopa Substation by the 380 kV transmission line connecting Yusufeli Power Plant to Hopa Substation.

The portion of the transmission line construction cost to be born by Artvin Project will be 2,587 x 10^6 T.L (1,759 x 10^6 T.L foreign currency and 828 x 10^6 T.L domestic currency).

The net present value (B-C) and the benefit-cost ratio (B/C) of the Project will be 97,334 x 10^6 T.L and 2.15 respectively.

The financial internal rate of return (FIRR) and the economic internal rate of return (EIRR) of the Project are 12.8% and 15.9% respectively.

The power generated by Yusufeli and Artvin Power Plants and transmitted to Hopa Substation will be then transmitted to load centers of Ankara and other regions.

Summary of Yusufeli Dam and Power Plant

Item	Unit	Description
Location	-	The Coruh River
Catchment Area	Km^2	15,250
Annual Inflow	10^6m^3	3,777
Design Flood	m^3/sec	9,000
Reservoir		
Normal High Water Level	m	710
Low Water Level	m	670
Available Drawdown	m	40
Sedimentation Level	m	618
Reservoir Area	Km^2	33.1
Gross Storage Capacity	10^6m^3	2,130
Effective Storage Capacity	10^6m^3	1,080
Diversion Tunnel		
Diameter	m	9.2
Length	m	1,258
Design Flood	m^3/sec	1,330
Number	-	1
Yusufeli Dam		
Type	-	Rockfill Dam with Impervious Core
Elevation of Crest	m	715
Height of Dam	m	270
Length of Crest	m	430
Volume of Dam	10^3m^3	21,050
Spillway		
Type	-	Chute with Radial Gates
Capacity	m^3/sec	7,970

Item	Unit	Description
Number of Gates	set	4
Size of Gate	m	Width 13.5 x Height 15.0
Power Intake		
Control Gate	-	Roller Gate
Number of Gates	set	1
Penstock		
Type	-	Inclined Shaft and Embedded Steel
Length	m	47.0 (No.1), 366.0 (No.2) 47.9 (No.3)
Diameter	m	9.0 - 4.2
Number	-	1 - (3 Branch)
Tailrace Tunnel		
Type	-	Pressure Tunnel
Length	m	90.0 (No.1), 403.0 (No.2) 89.4 (No.3)
Diameter	m	5.7 - 10.0
Number	-	1 (3 Branch)
Powerhouse		
Type	-	Underground Power Plant
Size	m	Width 20 x Length 86
Power Generation Facilities		
Number of Units	unit	3
Unit Capacity	MW	180
Installed Capacity	MW	540
Turbine		
Number	unit	3
Type	-	Vertical Shaft Francis

Item	Unit	Description
Rated Intake Water Level	m	696.7
Rated Tail Water Level	m	500.4
Gross Head	m	196.3
Normal Effective Head	m	190.8
Maximum Discharge	m^3/sec	321
Standard Output	MW	184
Revolving Speed	rpm	188
Generator		
Number of Units	unit	3
Type	-	Three-phase Synchronous
Output	MVA	200
Voltage	kV	14.4
Power Factor	-	0.9 (Lag)
Frequency	Hz	50
Revolving Speed	rpm	188
Main Transformer		
Number of Units	unit	3
Type	-	Three-phase Indoor type
Capacity	MVA	200
Voltage	kV	$380/\sqrt{3}/14.4$
Switchyard		
Nominal Voltage	kV	380
Type of Circuit Breaker	-	SF_6 Gas Insulated Switchgear
Transmission Line		
Number of Circuit	-	Yusufeli - Artvin 1 cct Artvin - Hopa 2 cct
Nominal Voltage	kV	380

Item	Unit	Description
Construction Period	years	9
Annual Energy Production		
Total Energy	10^6kWh	1,704.6
Firm Energy	10^6kWh	1,129.0
Secondary Energy	10^6kWh	575.6
Project Cost		
Dam and Power Plant	10^6T.L	367,025
Transmission Line	"	6,340
Total	"	373,365
At Sending End		
Per kW	10^3T.L/kW	680
Per kWh	T.L/kWh	215
Net Present Value (B-C)	10^6T.L	92,955
Benefit Cost Ratio (B/C)	-	1.65
Financial Internal Rate of Return (F.I.R.R.)	%	9.7
Economic Internal Rate of Return (E.I.R.R.)	%	12.4
Equalized Discount Rate (EDR)	%	17.3
Exchange Rate		1 US$ = 550 T.L

Summary of Artvin Dam and Power Plant

Item	Unit	Description
Location	-	The Coruh River
Catchment Area	Km^2	15,540
Annual Inflow	$10^6 m^3$	3,837
Design Flood	m^3/sec	8,200
Reservoir		
High Water Level	m	500.0
Low Water Level	m	499.0
Available Drawdown	m	1.0
Sedimentation Level	m	414
Reservoir Area	Km^2	4.1
Gross Storage Capacity	$10^6 m^3$	167.0
Effective Storage Capacity	$10^6 m^3$	4.0
Diversion Tunnel		
Diameter	m	10.0
Length	m	549
Design Flood	m^3/sec	1,120
Number	-	1
Artvin Dam		
Type	-	Concrete Arch Dam
Elevation of Crest	m	505
Height of Dam	m	160
Length of Crest	m	217
Volume of Dam	$10^3 m^3$	500
Spillway		
Type	-	Chute with Radial Gates
Capacity	m^3/sec	8,200
Number of Gates	set	4

Item	Unit	Description
Size of Gate	m	Width 13.0 x Height 15.0
Power Intake		
Control Gate	-	Roller Gate
Number of Gates	set	2
Penstock		
Type	-	Vertical shaft and Embedded steel
Length	m	213 (No. 1), 251 (No. 2)
Diameter	m	6.5 - 5.2
Number		2
Tailrace Tunnel		
Type	-	Pressure Tunnel
Length	m	184 (No. 1), 207 (No. 2)
Diameter	m	7.5
Number	-	2
Powerhouse		
Type	-	Underground Power Plant
Size	m	Width 23, Length 63
Power Generation Facilities		
Number of Units	unit	2
Unit Capacity	MW	160
Installed Capacity	MW	320
Turbine		
Number	unit	2
Type	-	Vertical Shaft Francis
Rated Intake Water Level	m	500
Rated Tail Water Level	m	384.1

Item	Unit	Description
Gross Head	m	115.9
Normal Effective Head	m	112.9
Maximum Discharge	m^3/sec	333
Standard Output	MW	167
Revolving Speed	rpm	150
Generator		
Number of Units	unit	2
Type	-	Three-phase Synchronous
Output	MVA	182
Voltage	kV	14.4
Power Factor	-	0.9 (Lag)
Frequency	Hz	50
Revolving Speed	rpm	150
Main Transformer		
Number of Units	unit	2
Type	-	Three-phase, Indoor Type
Capacity	MVA	182
Voltage	kV	$380/\sqrt{3}/14.4$
Switchyard		
Nominal Voltage	kV	380
Type of Circuit Breaker	-	SF_6 Gas Insulated Switchgear
Transmission Line		
Number of Circuit	-	Artvin - Hopa 2 cct
Nominal Voltage	kV	380
Construction Period	years	6

Item	Unit	Description
Annual Energy Production		
Total Energy	10^6kWh	988.8
Firm Energy	10^6kWh	661.8
Secondary Energy	10^6kWh	327.0
Project Cost		
Dam and Power Plant	10^6T.L	154,428
Transmission Line	"	2,587
Total	"	157,015
At Sending End		
Per kW	10^3T.L/kW	483
Per kWh	T.L/kWh	156
Net Present Value (B-C)	10^6T.L	97,334
Benefit Cost Ratio (B/C)		2.15
Financial Internal Rate of Return (F.I.R.R.)	%	12.8
Economic Internal Rate of Return (E.I.R.R.)	%	15.9
Equalized Discount Rate (EDR)	%	37.7
Exchange Rate		1 US$ = 550 T.L

CONCLUSION AND RECOMMENDATION

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The Project is composed of two hydroelectric power development plans, Yusufeli Project and Artvin Project, both of which are to be developed in the middle reaches of Coruh River that flows through the northeastern part of Turkey and drains into the Black Sea. It is concluded, according to the result of study based on available data so far, that the implementation of this Project is feasible both technically and economically.

The conclusion and recommendation drawn from this study are presented below.

CONCLUSION

(1) The objective of this project is to construct large hydroelectric power plants by effectively utilizing the water resource in Turkey, one of richest indigenous resources of this country, to secure abundant and stable electric power in meeting the increasing electric demand.

At the same time, this project is expected to contribute to economic development of the northeastern region of Turkey where relatively small amount of national capital for regional development has been invested so far.

(2) The growth of electric demand in the Republic of Turkey slowed down during the period from 1980 to 1983 due to the scheduled load shedding which were enforced due to the shortage of power supply capacity. However, the power demand growth in 1984 amounted to an order of 12%, owing to the increase in domestic power supply capacity and the import of electricity from abroad. The total installed generation capacity of Turkey amounts to 8,459 MW (generating 30,613 GWh) as of 1984.

In meeting the power demand of this magnitude, the Government of Turkey is now advancing large hydroelectric power development programs by utilizing indigenous water resources.

The projection of future power demand conducted in this study indicated that the annual average growth of energy demand will amount to

8.6%. That is, the power demand and annual energy at the bus bar will amount to 9,800 MW and 55,200 GWh respectively in 1990, which is 1.56 times and 1.55 times the power demand and annual energy of 1985, that were 6,300 MW and 35,500 GWh respectively. In 2000, these figures are expected to grow to 22,100 MW and 123,800 GWh respectively.

(3) The proper timing for commencement of services by the power plants of this Project will be around the year 2000, when the time required for the additional surveys, detailed designs and the constructions are taken into account, and if the power demand and supply forecast of Turkey at this amount progresses according to the planned schedules.

(4) This Project is to be implemented by the concerted development of the two projects, Yusufeli Project and Artvin Project.

Considering the construction time required for these two projects, the construction of Yusufeli Project located upstream should be started first, to be followed by Artvin Project, and the two Projects should be completed at the same time. As the effect of Yusufeli Project on Artvin Project is great, it is judged not appropriate to start developing Artvin Project ahead of Yusufeli Project.

Yusufeli Project, Artvin Project, and the related transmission line project are described below.

Yusufeli Project

(5) The Yusufeli dam site is located about 800 m downstream of the confluence of Coruh River main stream and Oltu River, which had been the dam site proposed in the Master Plan. The dam site is the most appropriate location from the points of view of topography, geology, landslide conditions, reservoir efficiency, and effective utilization of the river flow.

Although there are two large landslides at Gorgulu and Vecanket within the area of Yusufeli Reservoir, it can be judged that these landslides do not present obstruction against construction of Yusufeli Dam, because they are located on the tributaries and far from the dam site. It is necessary, however, to study the effects of possible landslide which may affect the upstream areas after the reservoir is impounded.

It can be judged that there is no problem of water-tightness of the reservoir. The geology at the dam site consists of granite and diabase, and it can be judged that there is no obstruction against construction of a rock-fill dam or a concrete arch dam of 270 meter high class, if conventional foundation treatment is performed.

(6) In selecting the type of Yusufeli Dam, the topography, geology, meteorology, availability of soil material, and other factors were taken into consideration, and comprehensive studies were conducted on the dam including spillway, and type and location of power plant. 4 cases of preliminary designs were worked out for rock-fill dams and concrete arch dams which were assumed to be the most fit types of dams.

As the result of these studies, it was judged that the rock-fill dam is more desirable from both economic and technical points of view.

As discussed later, it is judged that the optimal high water level of the reservoir is elevation 710 m. With this high water level, the height and volume of Yusufeli dam are 270 m and 21 x 10^6 m^3 respectively.

The spillway of a surface chute type is located on the left bank, and the power plant is an underground structure to be constructed under the right bank.

(7) To select the high water level of Yusufeli Reservoir, 4 cases, with the high water levels at elevation 690 m, 700 m, 710 m and 720 m, were studied with due consideration on the amount of sedimentation and the effective storage capacity.

Also, a comparative study was performed on 4 cases of different available draw-downs, 30 m, 40 m, 50 m and 60 m.

Based on the results of these comparative studies, and with overall considerations on the project economy, topography, geology and other relevant conditions, it was finally judged that the optimum reservoir high water level is 710 m and the available draw-down is 40 m. The gross storage capacity and the effective storage capacity are 2,130 x 10^6 m^3 and 1,080 x 10^6 m^3 respectively.

(8) In order to determine the optimal installed capacity of Yusufeli Power Plant, a comparative study was performed on 12 cases with different combinations of peak duration time and maximum water discharge. This comparative study proved that the most advantageous selection is the maximum discharge of 321 m^3/s and the installed capacity of 540 MW, which will provide annual generation of $1,704.6 \times 10^6$ kWh.

(9) The power generated by Yusufeli Power Plant will be transmitted to Hopa Substation by 380 kV transmission line (93 km) via the switching station of Artvin Power Plant.

(10) The total amount of initial investment required for development of Yusufeli Project will be $373,365 \times 10^6$ T.L at the currency value as of July 1985, consisting of the following items.

Yusufeli Dam, Power Plant, and associated facilities:

Domestic currency;	$234,462 \times 10^6$ T.L
Foreign currency ;	$132,563 \times 10^6$ T.L
Total	$367,025 \times 10^6$ T.L

Transmission line:

Domestic currency;	$1,923 \times 10^6$ T.L
Foreign currency ;	$4,417 \times 10^6$ T.L
(Subtotal)	$6,340 \times 10^6$ T.L

The construction cost of the part of transmission line which is to be commonly used for power transmission of Yusufeli and Artvin Power Plants are allocated to each power plant according to the ratio of the power plant capacity.

In this calculation, the construction period of Yusufeli Project is assumed to be 9 years.

The per-kW and per-kWh construction costs of Yusufeli Power Plant at the sending end are 680×10^3 T.L and 215 T.L respectively.

(11) For the purpose of benefit-cost analysis, an imported-coal fired thermal power plant capable of substituting this Project was assumed, and the costs compared. The result of this study indicated that the

net present value (B - C) and the benefit cost ratio (B/C) are 92,955 x 10^6 T.L and 1.65 respectively.

(12) The financial soundness of the Project was evaluated by comparing the financial internal rate of return (FIRR) based on the market prices with the borrowing interest rate expected for this project. The financial internal rate of return of the Project is 9.7%, exceeding the expected borrowing interest rate of 9.5%.

Next the economic internal rate of return (EIRR) was calculated by the modification market price (conversion to border price), which were obtained by modifying the market price used in the FIRR. Then this economic internal rate of return was compared to the opportunity cost of capital within the Republic of Turkey to evaluate the economic value of the Project. The economic internal rate of return of the Project is 12.4%, exceeding the capital opportunity cost in Turkey of 12%. Thus it can be concluded that the Project is feasible from both financial and economic points of view.

Artvin Project

(13) Artvin Project is to be located between the two large reservoirs of Yusufeli Project and Deriner Project, to effectively utilize the head available between the two reservoir sites.

Concerning the dam site which was previously proposed as the Artvin dam site (hereinafter called original dam site) in the Master Plan, the result of the site survey created a concern that the Havuzlu landslide, located in proximity of the original dam site on the upstream left bank, may have a serious effect on the dam. For this reason, two alternative dam sites were selected, one approximately 3 km upstream of the original dam site (hereinafter called the upstream dam site), and another approximately 8 km downstream of the original site (hereinafter called the downstream dam site).

For the upstream dam site, a rock-fill dam was selected based on considerations of topography and geology, and a dam-conduit type power plant was planned with a headrace running from the dam to the power plant. For the downstream site, a concrete type dam was selected based on considerations of topography, geology, landslides, availability of soil material, etc., and a dam type power plant was planned with the power plant constructed directly downstream of the dam.

By comparing the above two plans, it was judged that the downstream dam site is more economical. The plan for the downstream dam site (hereinafter called Artvin Project) is described below.

(14) There are two large landslides at Havuzlu and Demirkent, which are inside the reservoir area of Artvin Project. It can be judged, however, that these two landslides do not present substantial obstacles against the construction of dam. It can also be judged that there is no problem concerning the water-tightness of the reservoir.

The geology at the dam site consists mainly of diabase and tuff, and there will be no geological problem of serious nature for construction of a concrete arch dam according to presently available geological data.

(15) In studying the type of Artvin Dam, the topography, geology, status of landslides and availability of soil material were considered, and the different combinations of the dam spillways, power plant types and layouts were compared comprehensively.

As discussed before, the topographical and geological conditions, the possibility of landslide at Havuzlu, and the unavailability of the soil material in the proximity of the dam site made the selection of a concrete dam recommendable.

Further, it was estimated that an arch-gravity dam and an arch dam were promising among concrete dams. Thus preliminary designs were developed for these two dam types, and a comparative study was conducted.

In developing the preliminary design of the arch dam, presumptions were made on the geological factors which had not been confirmed by the geological surveys, such as the size and direction of the river bed fault and the geological status of the right abutment, and the design was developed based on these assumptions.

The result of comparative study indicated that the arch dam was more economical than the arch-gravity dam, even if substantial additional costs were estimated for the foundation treatment.

Accordingly, the arch dam was selected at this stage of the study. It is deemed necessary, however, to conduct further comparative study between the arch type and arch-gravity type in the stage of the detailed design, based on the results of the further geological investigation works.

As discussed later, the high water level of Artvin Reservoir is elevation 500 m. Consequently, the dam height and the dam volume will be 160 m and 500 x 10^3 m^3 respectively.

The spillway was designed as a center overflow at the dam center. The power plant was designed as an underground structure which is to be constructed under the left bank.

(16) The high water level of Artvin Reservoir was selected at elevation 500 m, making reference to the tailrace level of Yusufeli Power Plant.

The Artvin Power Plant will be operated for peak power supply by means of the discharge from Yusufeli Power Plant and by regulating the inflow from the residual drainage area.

The relation between the maximum discharge of Artvin Power Plant and the required effective storage capacity was studied. Taking into account some margin, the available draw-down of 1.0 m and the effective storage capacity of 4.0 x 10^6 m^3 were selected.

The maximum discharge of Artvin Power Plant will be 333 m^3/sec, which is the sum of the Yusufeli Power Plant's maximum discharge of 321 m^3/sec and the regulated residual flow.

With these design selections, the installed capacity of Artvin Power Plant will be 320 MW, generating 988.8 x 10^6 kWh of electricity annually.

(17) The power generated by Artvin Power Plant will be transmitted to Hopa Substation by a 380 kV transmission line (76 km long).

(18) The total initial investment required for development of Artvin Project will be 157,015 x 10^6 T.L at the currency value as of July 1985, which consists of the following items.

Artvin Dam, Power Plant, and associated facilities:

Domestic currency;	92,268 x 10^6 T.L
Foreign currency ;	62,160 x 10^6 T.L
Total	154,428 x 10^6 T.L

Transmission Line:

Domestic currency;	828 x 10^6 T.L
Foreign currency ;	1,759 x 10^6 T.L
Total	2,587 x 10^6 T.L

The construction cost of the transmission line was provisionally allocated to Yusufeli Power Plant and Artvin Power Plant according to the ratio of power plant capacity.

The period required for construction of Artvin Power Plant is assumed to be approximately 6 years.

The per-kW and per-kWh construction costs of Artvin Power Plant at the sending end are 483 x 10^3 T.L and 156 T.L respectively.

(19) The net present value (B - C) and the benefit cost ratio (B/C) of the Project are 97,334 x 10^6 T.L and 2.15 respectively.

(20) The financial internal rate of return of the Project is 12.8%, and this has an advantage over the expected borrowing interest rate of 9.5%.

The economic internal rate of return of the Project is 15.9%, exceeding the capital opportunity cost in Turkey which is 12%. Thus it can be concluded that the Project is both financially and economically feasible.

Power Transmission Plan

(21) The scope of power transmission study is from Yusufeli and Artvin Power Plants to the receiving end of Hopa Substation. 3 different schemes were studied and compared for the power transmission from the said power plants to Hopa Substation.

As the result of the study, the plan of constructing a 380 kV transmission line, 93 km in length, from Yusufeli Power Plant to Hopa Substation via the switching station of Artvin, was selected.

(22) The total amount of initial investment required for construction of this transmission line was estimated according to TEK's data at 6,433 x 10^6 T.L (excluding Project Controlling and Interest during construction) in the currency value as of July 1985.

The items of this construction cost are presented below, in which the expenditures by domestic and foreign currencies were estimated based on the past records.

Yusufeli Power plant to Artvin Power Plant
(380 kV single circuit x 17 km)

Domestic currency;	296 x 10^6 T.L
Foreign currency ;	1,157 x 10^6 T.L
(Subtotal)	1,453 x 10^6 T.L

Artvin Power Plant to Hopa Substation receiving end
(380 kV double circuit x 76 km)

Domestic currency;	1,351 x 10^6 T.L
Foreign currency ;	3,629 x 10^6 T.L
(Subtotal)	4,980 x 10^6 T.L

The period required for construction of this transmission line was assumed to be approximately 26 months.

(23) Almost all power systems in Turkey are mutually interconnected to form a nation-wide grid. The feature of these interconnected system is that the load centers are located in Ankara and in the western areas such as Istanbul, Izmir, etc., while a large part of the power supply

capacity is located in the eastern region. The power consuming areas and the power generating areas are interconnected by long 380 kV transmission lines, which form the key transmission system connecting the east and west of Turkey.

As the distance between the power consuming areas and the power generating areas amount to about 1,000 km, it is expected that the power systems will face various technical problems as the electric demand increases in the future.

In planning power transmission for this Project which is situated in the northeastern region of Turkey, it would be required to conduct power system analysis studies, including the possibility of introducing a higher system voltage.

(24) The power system analysis study related to this Project was excluded from the scope of the present study after consultation with the Government of Turkey held in February, 1986, because it was difficult at this stage to collect the data and information required for power system analysis. For this reason, a detailed power system analysis was not conducted relating to the present study.

However, a very general power transmission study was conducted based on the concept that the power output of this Project is transmitted to Ankara from Hopa Substation via Samsun, of which results are presented in Appendix 5.

This transmission study was conducted with the objective of economic evaluations, which are presented in sections (11), (12), (19), and (20).

RECOMMENDATION

It is recommended that the Yusufeli Project and Artvin Project be implemented because these two projects are feasible both technically and economically.

In order to start developing Yusufeli and Artvin Projects, the following matters must be implemented.

(1) Preparatory measures which are necessary for starting construction works, such as detailed design and preparation of tender documents, must be completed.

(2) In the detailed designs, the items requiring additional surveys and tests, such as those stated in Chapter 14 of this Report, "Further Investigations", must be conducted and the results reflected in the detailed designs.

(3) The specific re-routing plan for the national highway to be affected by this Project must be worked out.

(4) The specific programs for re-settlement of approximately 7,000 people, whose residences are to be submerged by the Yusufeli reservoir, must be established.

(5) There is no vegetation, aquatic as well as land animals, historical monuments or asset of artistic value in the area to be affected by this Project. The possibility of changes in the ecology and water quality must be studied, however, referring to the effects of existing large reservoirs in Turkey, the effects of this Project related to such issues are expected to be trivial considering the present status of natural environment of this Project.

(6) In order to make the power plants of this Project operational by the year 2000, it is necessary that the construction of Yusufeli Project be started in early 1992, that of Artvin Project in early 1995, and that of the transmission line from the power plants to Hopa Substation in late 1997.

It is also necessary that the transmission system interconnecting Hopa Substation to Ankara and Istanbul be completed by year 2000.

CHAPTER I INTRODUCTION

CHAPTER 1. INTRODUCTION

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CHAPTER 1. INTRODUCTION

A planned economy has been implemented in the Republic of Turkey since 1963, and efforts are being continued to achieve economic growth through industrialization by changing the industrial structure which had been based mainly on agriculture. Securing energy is an indispensable factor for this purpose, and with limited petroleum resources, the development of domestic energy resources has been given very high priority in order to achieve the established target of economic growth.

A growth rate in GNP of 8 percent was the target in the Fourth Five-Year Plan (1979-1983), but the result was far below it. In the current Fifth Five-Year Plan (1985-1989) which started in 1985, the target GNP growth rate is 6.3 percent. The growth rates in GNP from 1979 to 1984 and the growth rates in electric energy supply during those years are as shown below.

	1979	1980	1981	1982	1983	1984
GNP (%)	-0.4	-1.1	4.1	4.6	3.2	5.9
Electric Energy supply growth (%)	5.4	4.5	6.8	7.7	4.4	12.5

This low growth rate in electric energy supply was due to the shortage of capital for investment in economic activity because of the second oil crisis which occurred in 1978 so that supply capability became insufficient in spite of the existence of latent demand, and this was manifested by the load shedding carried out from 1980 to 1983.

As an emergency measure to cope for the time being with the power shortage, the Turkish Government has been importing electric power from Bulgaria since 1975 and from the Soviet Union since 1979. The quantity has increased annually, and in 1984 it was 2,653 GWh, corresponding to 8.7 percent of the total energy production of 30,614 GWh. The growth rate in electric power imports in the most recent 5 years was an annual average of 18 percent, and valuable foreign currency is being used for this, as in the case of oil imports.

The installed electric power capacity of the Republic of Turkey in 1984 was 8,459 MW (3,875 MW hydro, 4,584 MW thermal), while the capacities scheduled to be commissioned around 1986 were 1,067 MW hydro and 2,044 MW thermal, so that around 1986, the total installed capacity is scheduled to become 11,570 MW. However, these projects under construction are at present lagging behind original schedule. As a result of the recovery of the world economy after the second oil crisis there has been an increase in investment in the electric power sector. The Turkish Government, in order to meet the increasing power demand, has been implementing the construction of largescale hydro and thermal projects such as Elbistan Thermal Power Plant (4,200 MW), Karakaya Hydroelectric Power Plant (1,800 MW), Altinkaya Hydroelectric Power Plant (700 MW), and Ataturk Hydroelectric Power Plant (2,400 MW), and these are scheduled to be successively commissioned in the electric power system from 1987 to around 1990. It is thought that the chronic shortage of electric power will be gradually eliminated if these projects are developed as planned.

1.1 Background

As an outlook from a long-range point of view, the Turkish Government has predicted that it will be necessary to additionally construct capacity of 32,000 MW (annual average growth rate 7.3 percent) and electric energy of 190,000 GWh (annual average growth rate 7.7 percent) according to the demand forecast for the 18-year period from 1987 to 2005. Of this amount, it is proposed to develop approximately 26,000 MW and 81,000 GWh, respectively, of hydro power.

It has been published in the Annual Report of 1983 that the energy resources of Turkey are 57 x 10^6 tons of petroleum, 12,900 x 10^6 tons of coal, and 30,800 MW of hydroelectric potential. The production of oil would supply only about 10 to 20 percent of domestic demand. The production of coal is about 20 million tons annually, but there is little hard coal, with most of the production consisting of lignite which is not of very good quality, making it difficult to use this for purposes other than fuel. Therefore, hard coal is being used for industrial purposes and lignite for heating and for thermal power generation.

On the other hand, with regard to hydro, although Turkey is situated in a dry area, since the country as a whole is in the form of a plateau, the hydroelectric potential is fairly large, and from the viewpoint that it is a purely domestic energy resource, the Turkish Government has been actively promoting its development. From the standpoint of effective utilization of domestic energy, the Government plans to continue to aggressively develop hydro in the future to bring the ratio of hydro versus thermal to 50:50 or 55:45. In addition to the large-scale hydros previously mentioned, preparations are underway to start construction of Kayraktepe Hydroelectric Power Plant (420 MW), Ilisu Hydroelectric Power Plant (1,200 MW), Boyabat Hydroelectric Power Plant (510 MW), etc., in the very near future, and plans are ready for development of new sites following these projects. The hydroelectric potential of Turkey is concentrated in the eastern part of the country. Hydroelectric power development at sites near Istanbul and load centers in the west has reached a stage of completion, and development is shifting to the eastern region which is far away from load centers.

It was under such circumstances that the Turkish Government selected the Coruh River for large-scale development of the next generation, and in 1982 prepared a Master Plan for an integrated development scheme for the river in anticipation of its development.

The Coruh River is a swift-flowing river located at the easternmost part of Turkey which has approximately 10 percent (3,000 MW) of the hydroelectric potential in the country. The river basin is surrounded by steep mountains, while the runoff is on the large side compared with other rivers in Turkey, and so the river is ideal for hydroelectric power development.

According to the Master Plan, Yusufeli Hydroelectric Power Plant of a reservoir type and Artvin Hydroelectric Power Plant of regulating reservoir type on the downstream are planned on the middle reaches of the Coruh River, and these two schemes are the key projects of Coruh River integrated development.

In order to realize this hydroelectric power development project, the Turkish Government requested the Japanese Government for technical cooperation to conduct a feasibility study of the Project.

In response to this request the Japanese Government dispatched a Preliminary Study Team headed by Mr. Haruo Suzuki of the Japan International Cooperation Agency (JICA) to Turkey in November 1984 for exchange of opinions with the Turkish Government and to carry out a rough field reconnaissance. Based on the results of the discussions with the Turkish Authorities and the field reconnaissance, a "Scope of Work for the Feasibility Study on Coruh River Hydroelectric Power Development Project in the Republic of Turkey," was agreed upon in November 1984 between EIE of Turkey and JICA.

1.2 Scope of Study and Field Investigation

The objective of the study is to examine the Yusufeli and Artvin hydroelectric power development projects situated at the middle reaches of the Coruh River, which empties into the Black Sea, based on existing data and field investigatons in order to evaluate whether the Project would be feasible from technical and economic points of view, and to compile the results of the study in a report.

The scope of the investigation is to consist of field investigations and study in Turkey, and study in Japan. The work to be performed in Turkey would include field reconnaissances, collection, analyses and evaluation of data, outline study of the power generation scheme, formulation of investigation works plan, and the execution of investigation works.

The investigation works consisted of topographical surveying, geological investigation works and various tests.

Study in Japan consisted of formulating the optimum power development plan for the Project based on existing data, and results of field investigations and investigation works to prepare preliminary designs, cost estimate, and conducted economic and financial analysis, etc.

JICA commenced the work in March 1985 based on the abovementioned "Scope of Works", following which a Survey Team was dispatched to Turkey on May 28, 1985 to carry out field investigations for the Project. The Survey Team engaged in collection and analyses of related data, field reconnaissances, and a rough examination of the

Project with the cooperation of EIE from May 30 to July 23. During this time, an "Inception Report" was submitted to EIE on June 17, 1985.

In succession to the above, the Survey Team carried out in-situ rock tests at the project site until September 5, 1985 with the cooperation of EIE.

On returning to Japan the Survey Team performed studies in the field of power demand forecast, hydrology, geology, materials, optimum development plan, etc. During this time, the First and Second Progress Reports were submitted to EIE in September and December 1985, respectively.

The Survey Team visited Turkey again from January 30 to February 28, 1986, to conduct field reconnaissance once again of the project area and collection of additional data. Following this, discussions were held concerning the optimum development plan with EIE and an Interim Report on the Project was submitted to EIE.

Based on the results of the above field reconnaissance and discussions with EIE, power demand and supply forecast, selection of optimum development plan, preliminary design, construction cost estimation, construction schedule, and financial and economic analyses were conducted in Japan. During this time, a Third Progress Report was submitted to EIE in August 1986.

The results of investigations and studies of the Project were compiled in the "Final Report (Draft)" which was discussed with EIE in November 1986, followed by preparation of the "Final Report" in December 1986.

The members of the Survey Team and the persons of the Turkish Government who cooperated with the investigation are listed below. All members of the Survey Team are engineers and economists of the Electric Power Development Co., Ltd.

(Name)	(Assignment)	(Period)
Mamoru TAKAICHI	Team Leader (Civil Engineer)	May 26 - Jul 26, 1985 Jan 30 - Feb 28, 1986
Kiyoshi KONISHI	Planning (Civil Engineer)	May 28 - Jul 26, 1985 Feb 14 - Feb 28, 1986
Kiyoshi SHIOTA	Design (Civil Engineer)	May 28 - Jul 26, 1985 Jan 30 - Feb 28, 1986
Junichi MIYAKE	Cost Estimating (Civil Engineer)	May 28 - Jul 11, 1985
Takayuki NIIMURA	Hydrology (Civil Engineer)	May 28 - Jul 11, 1985
Yozo FUKUTAKE	Geology (Senior Engineering Geologist)	May 28 - Jul 26, 1985 Jan 30 - Feb 28, 1986
Tadahisa UDOH	Geology (Testing) (Civil Engineer)	Jul 1 - Sep 13, 1985 Jan 30 - Feb 28, 1986
Keiji IGUCHI	Geology (Testing) (Geologist)	Jul 1 - Sep 13, 1985
Yosuke SUZUKI	Electric Power Planning (Electrical Engineer)	May 28 - Jun 26, 1985
Haruyuki OKAMOTO	Power System Planning (Electrical Engineer)	May 28 - Jun 26, 1985
Tateshi MURAI	Economics	May 28 - Jun 26, 1985
Tetsuya HIRAHARA	Economics	May 28 - Jun 26, 1985

TURKEY

EIE:

Mr. Suheyl ELBIR	General Director
Mr. Kemal ARKUN	Assistant General Director
Mr. Vural SELCEN	Assistant General Director

Civil Engineering Group

Mr. Nezih SAYAN	Head of Project Design Department
Mr. Engin ERBERIK	
Mr. Sukru KARABIBER	
Miss Hatice TURAN	

Mr. Yildirim VARLIK

Mr. Necati KUSKONMAZ

Mr. Vokan DIPCIN

Mr. Nedim GONUL

Electrical Engineering Group

Mrs. Senel TEKELI	Assistant Head of Project Design Department
Mr. Mehmet GUNGOR	
Mr. Behzat AKBAYIR	

Geologist Group

Mr. Mehmet TARAKCI	Head of Geology and Driling Department
Mr. Erdal BULUTLAR	
Mr. Yuksel TAN	
Mr. Turgut CANLI	
Mr. Salih GUNAY	
Mr. Mutlu BERIK	
Mr. Osman NARIN	
Mrs. Ulker SOYLEMEZOGLU	
Mr. Necmettin DANAGLU	
Mr. Bayram UYSAL	

Geolophysicist Group

Mr. Osman DEMIRAG

Mr. Veli DEMIROGLU

Mr. Eyyup ACAR

Hydrologist Group

Mr. Mete TURKSOY	Head of Hydrological Survey Department
Mr. H. Yasar KUTOGLU	
Mr. Mehmet TANRIKULU	
Mr. Hayati HANCER	
Mr. Adil ALISIk	

Others

Mr. Yilmaz TURKMENOGLU

DSI:

Mr. Ahmet UNVER — Assistant General Director
Mr. Ozder BILEN
Mr. Hirant MUMCAN
Mr. Erdogan BASMACI
Mr. Namik AKCANBAS

TEK:

Mr. Guner ASAN
Mr. Suat KIZILYALLI

ODTU:

Mr. Mustafa ERDIK

1.3 Information and Data

The project studies were conducted with existing information and data mainly made available by EIE, and information and data obtained through field investigations and investigation works.

Topographic maps, hydrologic data, cost estimate data, power supply and demand data, economic and financial data, etc. which were used in the studies are listed in Appendix 6.

CHAPTER 2 GENERAL SITUATION IN THE REPUBLIC OF TURKEY

CHAPTER 2. GENERAL SITUATION IN THE REPUBLIC OF TURKEY

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CHAPTER 2. GENERAL SITUATION IN THE REPUBLIC OF TURKEY

2.1 Geography

The Republic of Turkey is geographically located between north latitudes 42°06' and 35°51', and east longitudes 44°48' and 25°40', and is situated at the connecting point between the European and Asian continents.

The country is in the shape of a rectangle, 650 km wide and 1,565 km long having a total area of 779,452 km^2. 97% of this area belongs to the Anatolian Peninsula at the westernmost tip of Asia called Asia Minor, with the remaining 3% being the Thrace Region in the south-eastern part of the Balkan Peninsula located at the eastern tip of the European continent.

The land is bounded on the south by the Mediterranean Sea, on the west by the Aegean Sea and Bulgaria and Greece, on the north by the Black Sea, and on the east by the Soviet Union, Iraq, Iran and Syria.

Broadly dividing the land geographically, it consists of the Aegean-Mediterranean Region, Black Sea Coast Region, Eastern and Central Anatolia Region, and the Southern Anatolia Region. 96% of the land belongs to a steppe type climate zone called the Anatolian Plateau, and only 30% of the land is cultivated.

The mean elevation of the land is 1,132 m with no more than 20% of the land being below elevation 500 m. The mean elevation of Ankara, the capital city, is 902 m.

Representative rivers are the Kizilirmak River (1,355 km), the longest in Turkey, the Sakarya River (825 km), the Seyhan River (560 km) and the Yesilirmak River (520 km), besides these, there are the famous Tigris and Euphrates which are international rivers that rise within the boundaries of Turkey.

Lake Van (3,700 km^2) in Eastern Anatolia, and Lake Tuz (1,500 km^2) in Central Anatolia are representative lakes, and both are salt water lakes. Artificial lakes are Lake Keban (675 km^2) on the Euphrates River and Lake Hirfanli (263 km^2) on the Kizilirmak River which are well-known, and both are playing important roles as reservoirs for hydroelectric power generation, namely, as water power energy resources.

Most of the mountain areas are situated in the Eastern Anatolia Region bounded by the Soviet Union and Iran. Mt. Ararat (5,165 m) is the most famous mountain, besides which there are peaks such as Mt. Suphan (4,434 m), Mt. Kackar (3,932 m), and Mt. Erciyes (3,916 m), and this region comprises the greatest hydroelectric potential area of Turkey.

Vegetation differs according to the climate and topographical conditions, but the country can be broadly divided into the following regions.

Black Sea Coast Region	:	Forest zones are distributed at mountain slopes facing the shoreline, with oak, elm and birch being the predominant species.
Aegean-Mediterranean Coast Region	:	Olive, citrus, and pine are the predominant species along the mountain areas.
Anatolian Plateau Area	:	The vegetation consists of natural forage and scattered forests.

2.2 Climate

In spite of the fact that three sides - north, west, south - of Turkey are bonded by sea (Black Sea, Aegean Sea and Mediterranean Sea, total coast-line 8,400 km), the mean elevation of the country is 1,132 m. The climate differs greatly according to region due to the influence of the mountain ranges running parallel to the coast line from north to south.

2.2.1 Temperature

The annual mean temperature in the Black Sea Coast Region is a mild 14°C to 15°C, while in midsummer of July and August, temperatures are from 22°C to 24°C which is relatively comfortable, and in the cold season of January and February the temperature is from 5°C to 7°C and the climate is not very severe.

The annual mean temperature of the Aegean-Mediterranean Region is a warm 18°C to 20°C, a so-called Mediterranean climate. The temperature climbs higher than 27°C in summer, but it is mild from 8°C to 12°C in winter.

On the other hand, annual mean temperatures in inland areas differ greatly between 4°C and 18°C depending on altitude, a continental climate with extremes of hot and cold. In midsummer it becomes burning hot, while in mid-winter warm winds are shut off by mountain ranges running parallel to the coast line and many areas are hit by cold waves of 0°C to -10°C.

2.2.2 Precipitation

Turkey is subject both to a continental type climate characterized by rainy weather throughout the year and also to a subtropical climate distinguished by dry summers. Rainfalls are generally observed on the slopes of the mountains facing the seas. But moving towards the interior areas, the rainfall gradually becomes less. Thus there is a substantial variation in precipitation from region to region.

In the Agean-Mediterranean Region the rainy season continues from autumn to late spring, while in the Black Sea Coast Region there is rainfall throughout the year. The precipitation in the inland areas consists mainly of snowfall in the wintertime succeeded by rainfall in the early spring, with almost no precipitation in the other periods.

The climates of the main cities are shown in Table 2-1.

Table 2-1 Climate in the Main Cities

Selected Cities	Regions	Altitude above Sea (m)	Temperature (°C)			Average Humidity (%)	Average Precipitation (mm)
			Average	Lowest	Highest		
Istanbul	Mar.	39	14.0	-16.1	40.5	75	673.4
Ankara	Cent.A.	902	11.8	-24.9	40.0	60	367.0
Izmir	Aegean	25	17.6	-8.2	42.7	65	700.2
Adana	Medit.	20	18.7	-8.4	45.6	66	646.8
Edirne	Thrace	48	13.5	-22.2	41.5	70	599.3
Bursa	Mar.	100	14.4	-25.7	42.6	69	713.1
Antalya	Medit.	42	18.6	-4.6	44.7	64	1,067.2
Urfa	S.East A.	547	18.1	-12.4	46.5	48	473.1
Zonguldak	W.Black S.	136	13.5	-8.0	40.5	75	1,242.9
Rize	E.Black S.	4	14.2	-7.0	37.9	78	2,357.0
Van	East A.	1,725	8.8	-28.7	37.5	59	384.0
Agri	N.East A.	1,632	6.1	-43.2	38.0	67	528.5
Mugla	Aegean	646	15.0	-12.6	41.2	60	1,220.9

Source: General Directorate of Meteorology

2.3 Population

The total population as of the end of 1984 was 48,300,000, the ratio between urban and rural areas being 46:54.

90% of the people are Turks, with the remainder made up by Kurds, Arabians, Armenians, Greeks and others. Moslems comprise 99% of the population with the remaining 1% being of various Christian denominations.

2.4 Economy

The economy in the Republic of Turkey is a mixed system (established in the early 1930's) where private enterprises coexist with public enterprises set up with state capital. Today, approximately 55% of industrial production is by the public sector.

In 1960 the State Planning Organization was established and a Long-Range Fifteen-Year Economic Development Plan was formulated to start from 1963. Since 1963, a planned economy has been implemented, the objective being to attain an annual average economic growth rate of a 7% level.

This target is to be realized through promoting industrialization and absorbing surplus labor of agriculture into the industrial sector.

At present, the Fifth Five-Year Development Plan (1985-1989) is being implemented. In the Fourth Five-Year Development Plan (1979-1983), it was planned to attain an economic growth of 8% annually by investing 10,595 x 10^9 TL (1983 prices), but the actual performance was as shown in Table 2-2, and the growth rate was approximately 2.0%, considerably below the planned level.

Table 2-2 Growth Rates during Planned Development Period by Sectors

% Increase (at 1968 Factor Prices)

	1st Plan Average (1963-1967)	IInd Plan Average (1968-1972)	IIIrd Plan Average (1973-1977)	1978 Average	IVth Plan Average (1979-1983)
1. Agriculture					
a. Target	4.2	4.1	4.6	4.1	5.3
b. Realisation	3.1	3.5	3.5	2.4	2.2
2. Industry					
a. Target	12.3	12.0	11.2	8.0	9.9
b. Realisation	10.8	7.8	9.8	3.7	1.7
3. Services					
b. Realisation	7.3	7.9	7.9	4.1	2.5
4. Gross Domestic Product					
b. Realisation	6.4	6.8	7.3	3.6	2.3
5. Gross National Product					
a. Target	7.0	7.0	7.9	6.1	8.0
b. Realisation	6.6	7.1	6.5	3.0	2.0

Source: Economic Report (Turkey) 1984
Publication No. 1984/13

In the Fifth Five-Year Development Plan, it is planned to invest a total of 14,413 x 10^9 TL (1983 prices), the breakdown of which is 57% for the public sector, and 43% for the private sector. By category, the investment is to be 27.04% for manufacturing industries, 18.57% for transportation and communications, 15.20% for housing, 11.37% for agriculture, 14.89% for energy, and 12.93% for others, with which it is planned to achieve an annual average growth of 6.3%. The major economic activities during the 5-year period of 1980-1984 (with estimtes partially included) are indicated in Table 2-3.

Table 2–3 Economic Activity

Item	Unit	1980	1981	1982	1983	1984
GNP (Current Price)	10^9TL	4,435.1	6,553.6	8,735.1	11,485.2	17,458.0
Foreign Deficit	10^9TL	N.A.	N.A.	187.5	476.0	611.4
Total Resources	10^9TL	N.A.	N.A.	8,909.3	11,961.0	18,069.8
Growth Rate 1/	%	-1.1	4.1	4.6	3.3	5.9
Total Investment	10^9TL	1,156.6	1,572.6	1,774.6	2,376.0	3,513.0
Fixed Capital Invement	10^9TL	863.6	1,241.4	1,646.9	2,181.0	3,190.4
Stock Changes	10^9TL	293.0	331.2	127.7	195.0	322.6
Total Consumption	10^9TL	N.A.	N.A.	7,134.7	9,585.0	14,556.8
GNP by Origin						
Agriculture	%	22.1	21.8	22.1	21.4	21.0
Industry	%	23.2	25.2	25.6	26.4	27.1
Services	%	54.7	53.0	52.3	52.2	51.9
Per Capita GNP 2/	T.L.	99,805.0	144,467.0	188,613.0	244,276.0	379,973.0

1/ : Producers' valves at 1968 prices
2/ : Current Producers' Prices

Source: The Turkish Economy 85 (TUSIAD)

The rates of increase in wholesale price indices and unemployment rates in the latest 5 years are as follows:

	Wholesale price index (Yearly average, percent change) (%)	Unemployment rate (%)
1980	107.2	14.8
1981	36.8	15.2
1982	25.2	15.6
1983	30.6	16.1
1984	52.0	16.5

The exchange rate between the U.S. dollar and the Turkish Lira had been revised annually or monthly as necessary, but since May 1981, the adjustments have been made daily. The recent record is as shown below.

TL/$ (Year-end)	TL/$ (Year-end)
1976 - 16.50	1981 - 132.30
1977 - 19.25	1982 - 184.90
1978 - 25.00	1983 - 280.00
1979 - 35.00	1984 - 443.30
1980 - 89.25	1985 - 574.00

The recent state of foreign trade of Turkey is as shown in Table 2-4.

Table 2–4 Foreign Trade

10^6 $ (%)

	1980	1981	1982	1983	1984
Exports : Total (FOB)	2,910	4,703	5,746	5,728	7,134
Agricultural Products	1,672 (57.46)	2,219 (47.18)	2,141 (37.26)	1,881 (32.84)	1,749 (24.52)
Processed and Manufactured Products	1,047 (35.98)	2,290 (48.69)	3,430 (59.69)	3,658 (63.86)	5,145 (72.12)
Mining and Quarrying Products	191 (6.56)	194 (4.13)	175 (3.05)	189 (3.30)	240 (3.36)
Imports : Total (CIF)	7,910	8,933	8,843	9,235	10,757
Agricuture and Livestock	50 (0.63)	125 (1.40)	176 (1.99)	138 (1.49)	417 (3.88)
Mining and Quarrying	4,006 (50.64)	4,099 (45.89)	3,960 (44.78)	3,864 (41.84)	3,908 (36.33)
Industrial Products	3,759 (47.52)	4,640 (51.94)	4,658 (52.67)	5,177 (56.06)	6,338 (58.92)

Source: The Turkish Economy 85 (TUSJAD)

Exports in 1984 consisted mostly of textiles, processed foodstuffs, agricultural products such as grain and leaf tobacco, leather goods, and metal products. On the other hand, the principal items of imports were crude oil, machinery, chemical products, and steel. Of the amount of imports, crude oil took up 31%, followed by machinery at 15%.

The main trading partners in 1984 were as follows:

Export

West Germany, Iraq, Iran, Italy, Saudi Arabia

Import

Iran, West Germany, U.S.A., Iraq, Libya

Approximately 52% of both exports and imports are with OECD countries, and almost all of the remainder being barter with the Soviet Union, West European countries and OPEC countries based on bilateral trade agreements.

The balance of trade is constantly that of a deficit, and in 1984, exports amounted to $\$7,134 \times 10^6$ and imports to $\$10,757 \times 10^6$ recording a deficit of approximately $\$3,623 \times 10^6$. The main reason for the deficit was the dependency of import of crude oil and other forms of petroleum, amounting to $\$3,637 \times 10^6$, making up about 34% of total imports.

The Turkish Government is encouraging laborers in the country to emigrate to oil-producing countries and is making efforts to promote tourism to increase foreign exchange income, and the recent balances of emigration and tourism revenues are as follows:

Table 2-5 Emigration and Tourism

	Person/year	Cummulative Total	Home Remittance (10^6\$)	Tourism Revenue (10^6\$)
1980	28,503	914,068	2,071.1	N.A.
1981	58,753	972,821	2,489.7	N.A.
1982	49,388	1,022,209	2,286.7	375.8
1983	52,470	1,074,609	1,583.7	411.0
1984	41,599	1,116,472	1,881.2	547.9

The international balance of trade in 1984 in terms of current balance and overall balance were minus \$1,407 x 10^6 and \$793 x 10^6, respectively (source: Central Bank, tentative figures).

2.5 Energy Resources

Securing energy is an extremely important matter for Turkey which is attempting to transform the industrial structure of the country from mainly agriculture to an industry oriented economy by pursuing an economic development plan spread over a number of years. However, the demand and supply balance of electric power in Turkey has been constantly facing of a shortage in power supply capability, and this situtaion is being tide over by imports of electric power from the Soviet Union and Bulgaria. Therefore, development of electric power is a problem of urgent nature for the country. The present consumption of energy in the country is as shown in Table 2-6.

Table 2-6 Preliminary Energy Consumption (Petroleum Equivalent)

Unit: 1,000 tons

Kind	1980	1981	1982	1983	1984
Coal	2,806	2,518	2,509	2,928	3,172
Lignite	4,260	4,650	4,877	5,310	5,910
Asphaltite	-	-	-	-	-
Petroleum Products	14,885	15,465	15,871	16,063	16,750
Hydraulic	2,576	2,837	3,014	3,216	3,631
Electricity Imports	261	336	404	610	450
Total Commercial Energy	24,788	25,806	26,675	28,127	29,928
Wood	4,300	4,300	4,300	4,300	4,300
Dung	2,380	2,400	2,400	2,400	2,400
Grand Total	31,468	32,506	33,375	34,827	36,628

Note: 1984 estimate
Source: Economic Report (Turkey) 1984,
Publication No. 1984/13

The electric power supply facilities as of 1984 was 8,459 MW (30,613 GWh) and the ratio of hydroelectric power generating facilities (3,875 MW) to thermal power generating facilities (4,584 MW) was 46% : 54%.

The economically developable hydroelectric potential of Turkey is estimated at 30,800 MW, and only about 13% of this had been developed as of 1984, and therefore this resource is anticipated for development in the future. Other domestic energy resources of Turkey are petroleum (estimated reserves 57 x 10^6 ton), hard coal, soft coal,and peat (estimated reserves 12.9 x 10^9 ton), and uranium. In 1984, although on a small scale (15 MW), geothermal power generation was started, while research was begun on the utilization of solar energy. According to TEK Annual Report - 1984, the first unit of nuclear power, 1,000 MW, is schedule to be commissioned in 1992.

2.6 Transportation and Communications

The means of transportation available in Turkey are highways, railways, watercraft, aircraft,and pipelines. Roads, combining national and provincial highways, were of a total length of approximately 61,000 km (1980), of which 89% was paved.

Highways play the most important role in the transportation system, and in 1980 accounted for 94% of passenger travel and 72% of freight transportation. The number of vehicles registered was approximately 1,200,000 (1980), 55% of which consisted of passenger cars.

The total length of railways is 10,083 km, of which trunk lines comprised 8,336 km (including 329 km of electrified lines), and branch lines 1,747 km (including 72 km electrified).

Turkey is a peninsula surrounded by the Black Sea, the Aegean Sea, and the Mediterranean Sea, so that ports and harbors have been developed from historical ages, and there are now 10 seaports for international trade and 65 others as well. Istanbul is an important port city which straddles two continents.

Airports include the three international airports of Istanbul, Ankara, and Izmir, besides which there are 10 others at major cities in the country and scheduled flights are operated.

The means of communications in Turkey are mail, telegraph, and telephone. The number of post offices as of 1980 were 949 main stations, 2,102 branch stations, and 7,284 agents. The telephone is not yet popularly utilized and mail is the most important means of communication.

Broadcasts of radio and television cover the entire country although the rates of receiving set ownership are still low.

CHAPTER 3 GENERAL CONDITION IN PROJECT AREA AND SURROUNDINGS

CHAPTER 3. GENERAL CONDITION IN PROJECT AREA AND SURROUNDINGS

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CHAPTER 3. GENERAL CONDITION IN PROJECT AREA AND SURROUNDINGS

3.1 General Condition in Surrounding of Project Area

3.1.1 General Condition

The Coruh River Basin in which the project area is located encompases an area from 39°55' to 41°32' north latitude and 20°40' to 42°39' east longitude, and is situated in the northeastern part of Turkey close to the border with the U.S.S.R.

The Coruh River Basin is surrounded by the mountain peaks of Tatos (3,937 m) and Soganli (2,856 m) to the north and Kop (2,953 m), Mescit (3,255 m), and Kargapazari (3,288 m) to the south, and comprises a highland with much undulation.

The mainstream Coruh River rises from the Mescit Mountain Range (highest peak 3,255 m), flows west, and changes its course to the east from the vicinity of Bayburt. In the vicinity Yusufeli at the midstream part, it changes its course roughly to the northeast, enters Soviet territory approximately 20 km upstream from the river mouth and empties into the Black Sea. The length and catchment area of the Coruh River in Turkish territory are approximately 390 km and 19,750 km^2 (approximately 2.53 percent of entire Turkey), respectively.

The Coruh River Basin is generally of continental climate at the midstream and upstream of the river, and Black Sea climate at the downstream area. Annual precipitation is from 300 to 500 mm in the midstream and upstream areas and 1,000 to 1,500 mm in the downstream area. The annual mean, annual maximum, and annual minimum, air temperatures in the basin are 8.1°C, 43°C and -31.3°C, respectively.

The Coruh River Bain drains the following five provinces with areas and population (as of 1980) listed below.

	Area (km^2)	Population	Capita/km^2
Artvin	7,436	228,997	31
Erzurum	25,066	801,809	32
Gumushane	10,227	275,191	27
Kars	18,557	700,238	38
Erzincan	11,903	282,022	24

There are ten counties, Artvin, Ardanuc, Borcka, Savsat, Yusufeli, Ispir, Oltu, Olur, Tortum, and Bayburt, the total population of which (as of 1980) was 447,866, and the population density is 27 per square kilometer. The population of urban and rural districts is 78,029 and 369,837, respectively.

The people living in the basin are mainly engaged in agriculture and animal husbandry. At the downstream and midstream areas of the Coruh River, farmland comprises only 6 percent of the entire area and grape and several kinds of other fruits are being produced. At the Bayburt Plain in the upstream area of the Coruh River, there is farmland that has been developed and irrigation is being carried out.

The agricultural products of the Coruh River Basin as a whole consist mainly of wheat, barley, rye, corn, potato, etc., besides which there are also millet, rice, beans, tobacco, beet, fruits, etc.

Industry consists of mining, dressing of minerals and lumber mills in the vicinity of Artvin.

Copper is being mined and refined at Goktas which is close the city of Artvin. Chrome, coal, iron, and copper are mined near Bayburt and Moden. Lignite has been discovered in the vicinity of Ispir, and salt, coal, and chrome at Oltu and Tortum, and these are being mined.

The following small-scale factories exist in the basin.

Artvin	Fiberboard factory
Borcka	Lumber mill
Goktas	Dressing facilities for copper ore and smelting, and sulphuric acid factory
Muratli	Tea factory
Bayburt	Brick plant Flour mill Milk, butter, cheese plant

Domestic water for the main cities and towns in the basin such as Artvin, Borcka, Yusufeli, Aidonus, Savsat, Oltu, Tortum, Ispir, and Bayburt is supplied completely by the City Bank and the General Directorate of Roads, Water, Electricity (YSE). Practically all of the supply facilities for domestic water to villages are also provided by YSE.

National highways (2 routes) paved with asphalt run through the basin. These are the Trabzon-Bayburt-Erzurum highway (Route A) and the Trabzon-Hopa-Artvin-Erzurum highway (Route B). Route B is branched at the confluence of the Tortum and Oltu Rivers and passes through Oltu and Narman and another route runs along Lake Tortum and the Tortum River. Erzurum has access to air and railway travel, and Trabzon to air travel.

Although outside the river basin, there are port facilities at Hopa at the Black Sea coast 35 km from Borcka.