THE REPUBLIC OF TURKEY

FEASIBILITY REPORT ON BOYAKAT-KEPEZ DAM AND HYDROELECTRIC POWER PLANT DEVELOPMENT PROJECT

March 1979

JAPAN INTERNATIONAL COOPERATION AGENCY

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DEVELOPMENT PROJECT

March 1979

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

The Government of Japan, in response to a request of the Government of the Republic of Turkey, agreed to conduct a feasibility study on the Boyabat-Kepez Dam and Hydroelectric Power Plant Development Project and entrusted the Japan International Cooperation Agency (JICA) to carry out this study.

JICA, recognizing the importance of this project, dispatched to Turkey a 6-man survey team headed by Mr. Nobuaki Harada (Electric Power Development Co., Ltd.) for 35 days from September 9 to October 13, 1978.

The team conducted a field survey and an economic feasibility study on the Boyabat-Kepez Dam and Hydroelectric Power Plant Development Project and has now completed this report.

I hope that this report will be found useful for the electric power development and the economic and social development of the Republic of Turkey and contribute to the promotion of friendly and cooperative relations between the Republic of Turkey and Japan.

I wish to express my sincere thanks to the persons concerned of the Republic of Turkey for their kind cooperation extended to the team.

March, 1979

Shinsaku Hogen

President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Mr. Shinsaku Hogen
President
Japan International Cooperation Agency

Dear Sir:

We are pleased to submit the Report on the Feasibility Study of Boyabat-Kepez Dam and Hydroelectric Power Plant Development Project in the Republic of Turkey.

The survey team organized for the study of the Project and composed of six members, headed by Mr. Nobuaki Harada, visited the Republic of Turkey and made a field survey for thirty-five days from September 9 to October 13, 1978.

During the stay in the Republic of Turkey, the Team collected available data and information for the study and investigated the topography, geology, materials and hydrology at and around the proposed sites.

After return to Japan, the Team made a study of the demand forecast, hydrologic analysis, geological analysis, power generation plan, preliminary design of civil structures, estimation of construction cost and economic analysis, and prepared the report on the feasibility study of the Project on the basis of the results of the field survey and data collected.

It is our ardent wish that the Report will contribute to the further progress of the electric power development of the Republic of Turkey in the near future.

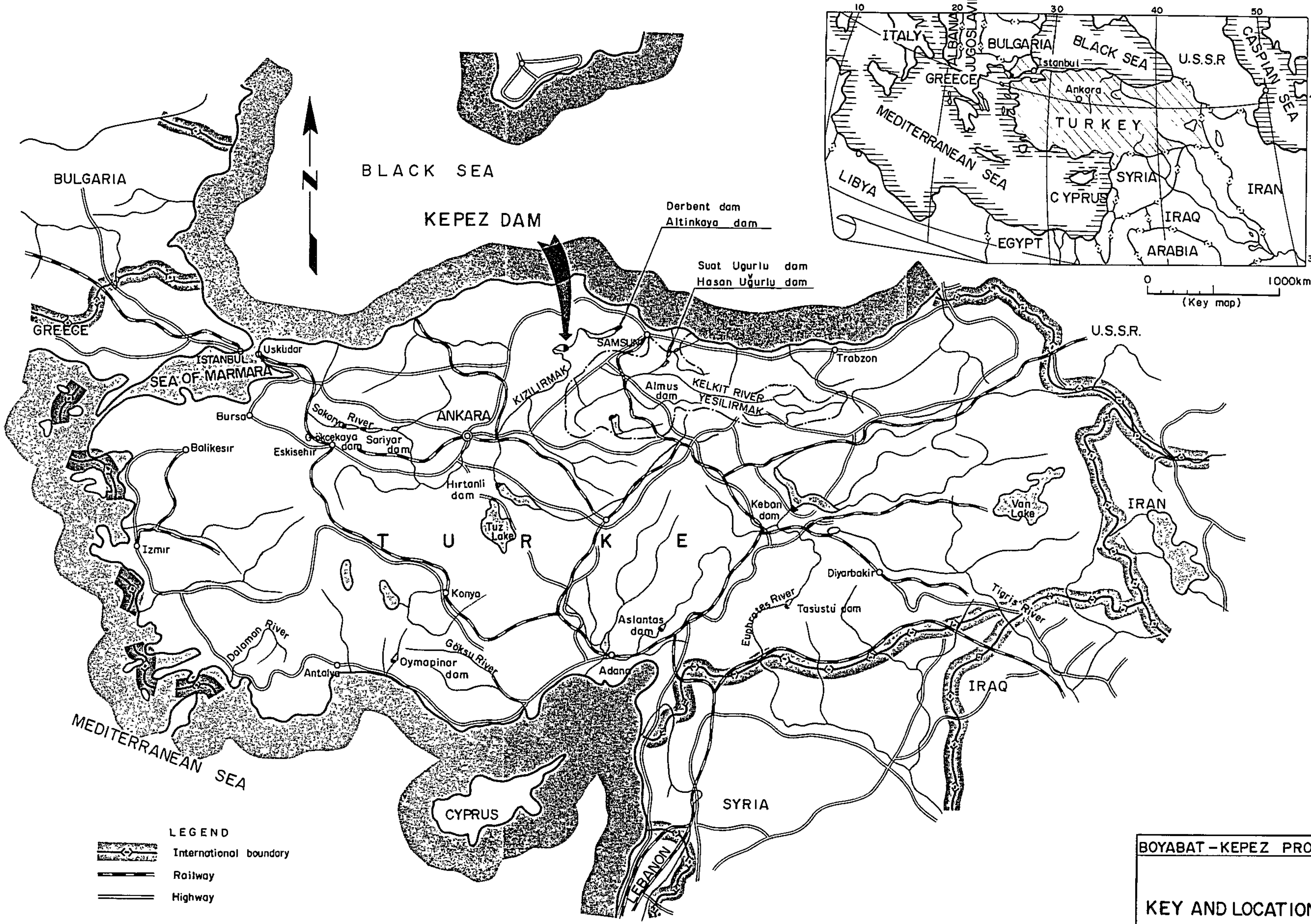
On the occasion of submitting the Report, I sincerely express my profound gratitude to all persons concerned for their generous assistance and cooperation in performing the study.

March, 1979

Yours respectfully,

Nobuaki Harada

Nobuaki Harada
Team Leader of Japanese Survey
Team for Boyabat-Kepez Dam
and Hydroelectric Power Plant
Development Project



BOYABAT-KEPEZ PROJECT

KEY AND LOCATION MAP

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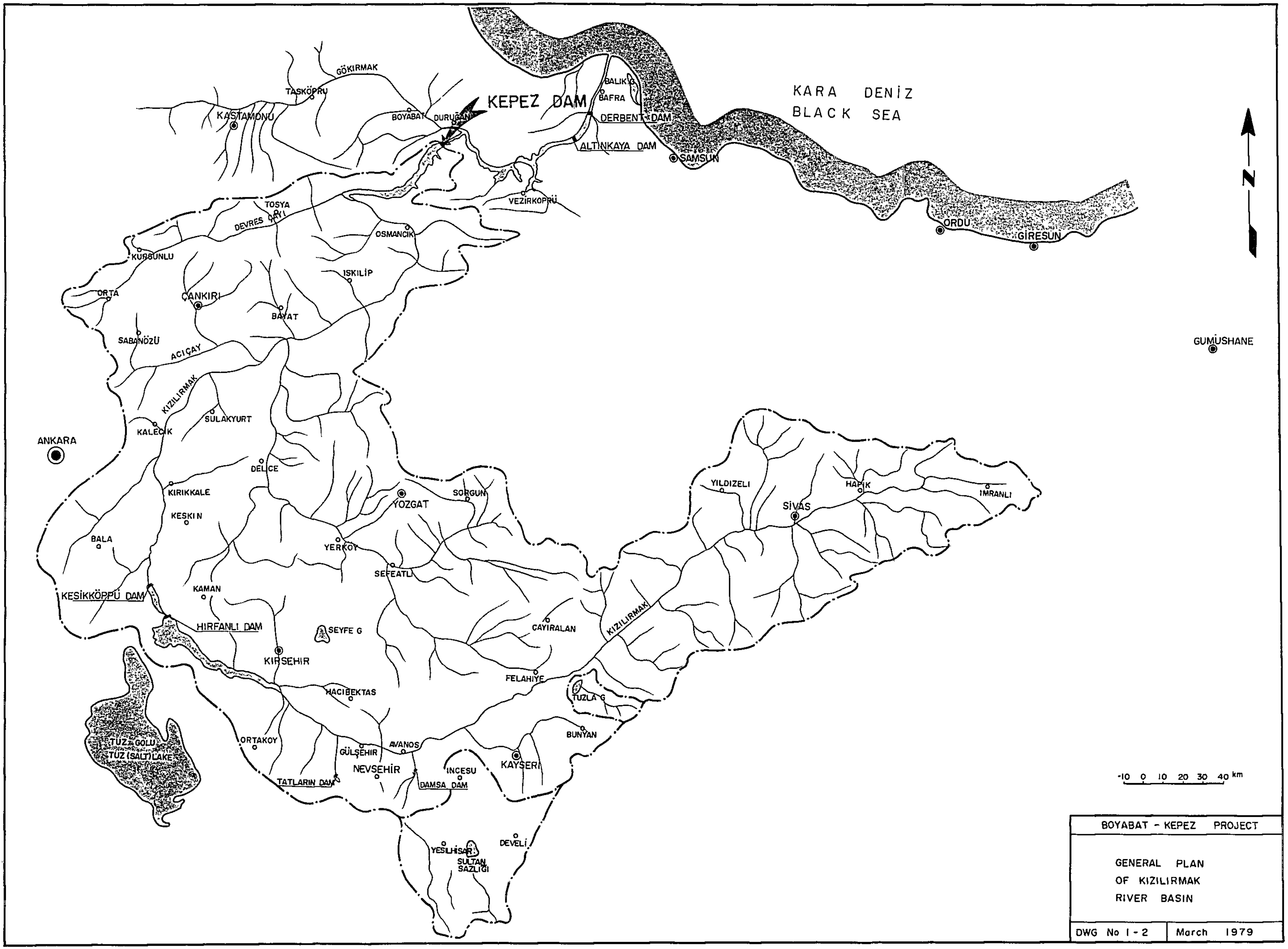

BOYABAT - KEPEZ PROJECT

GENERAL PLAN OF KIZILIRMAK RIVER BASIN

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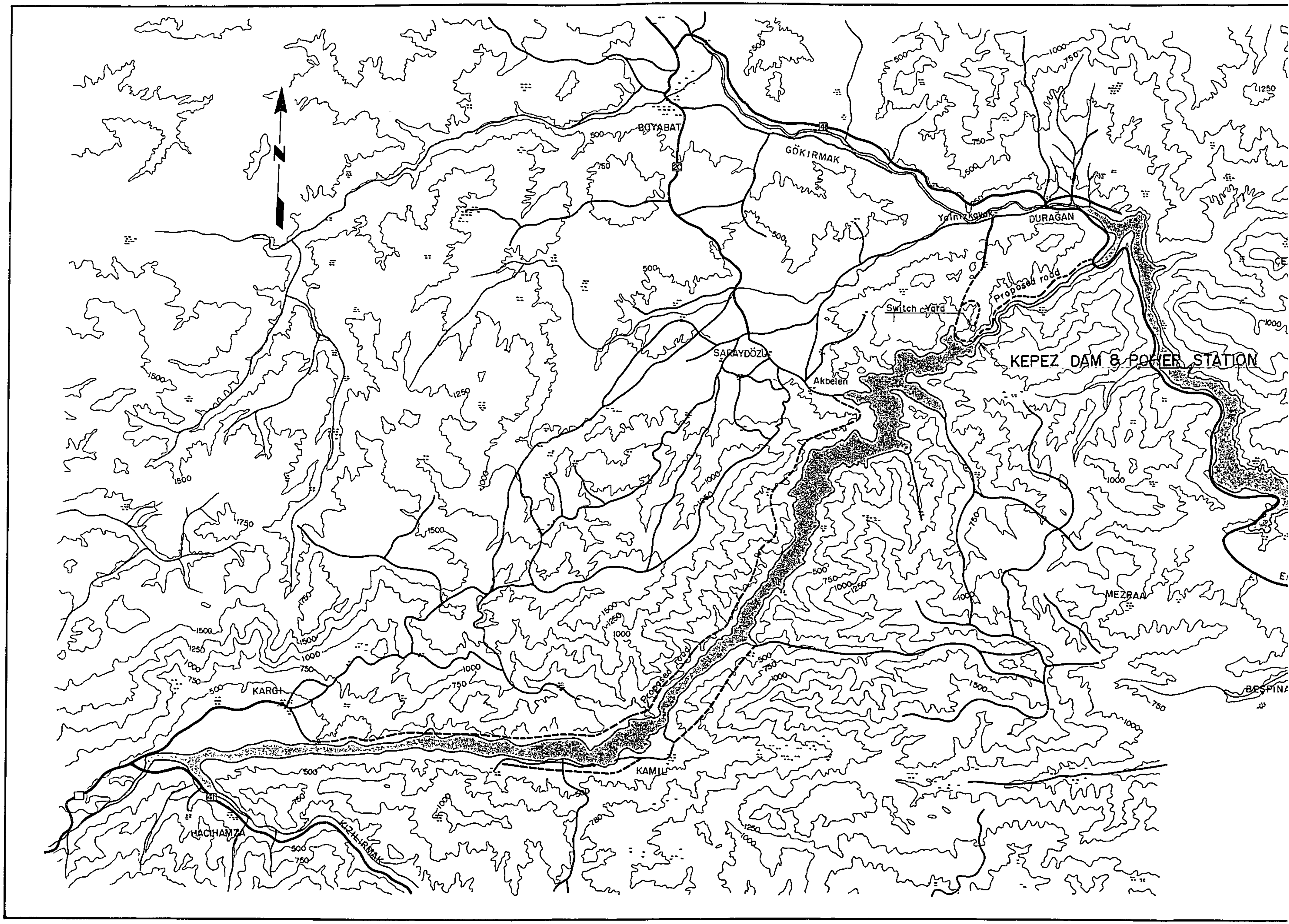

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KEPEZ DAM & POWER STATION
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Proposed road
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KIZILIRMAK
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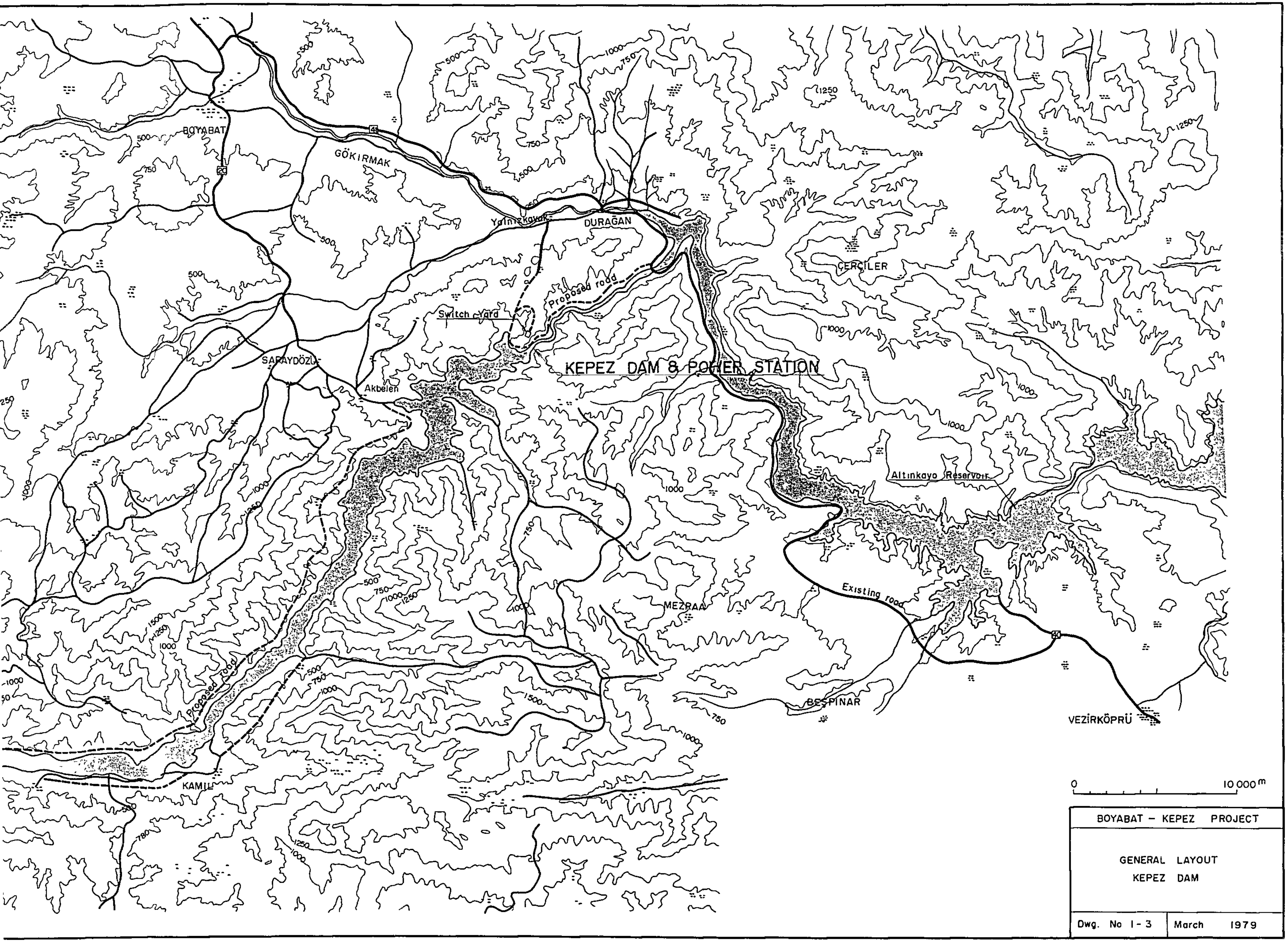
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Akbelen
Altınkaya Reservoir
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BEŞPINAR
VEZİRKÖPRÜ
KAMIL
Proposed road
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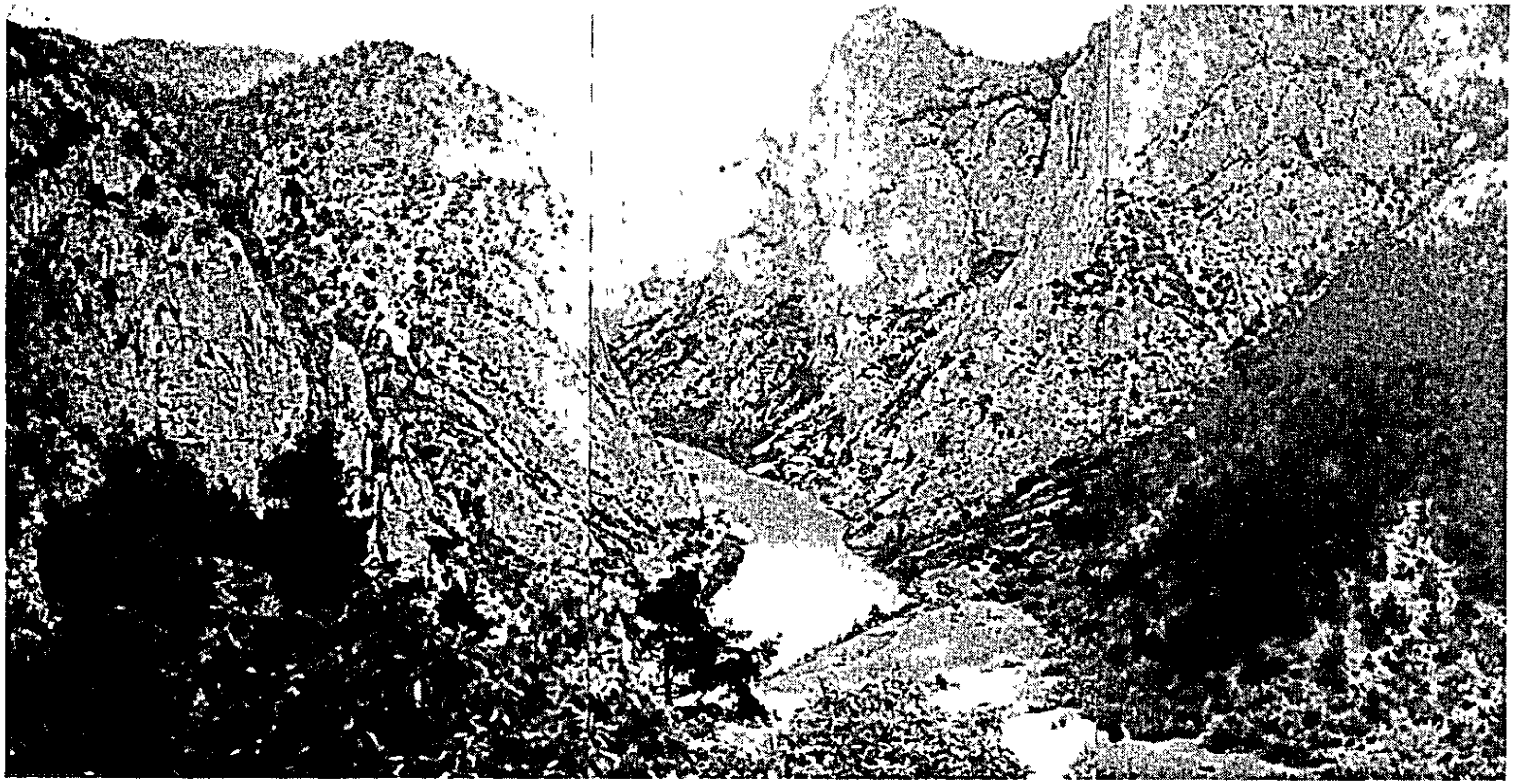
BOYABAT – KEPEZ PROJECT
GENERAL LAYOUT
KEPEZ DAM
Dwg. No I-3
March 1979

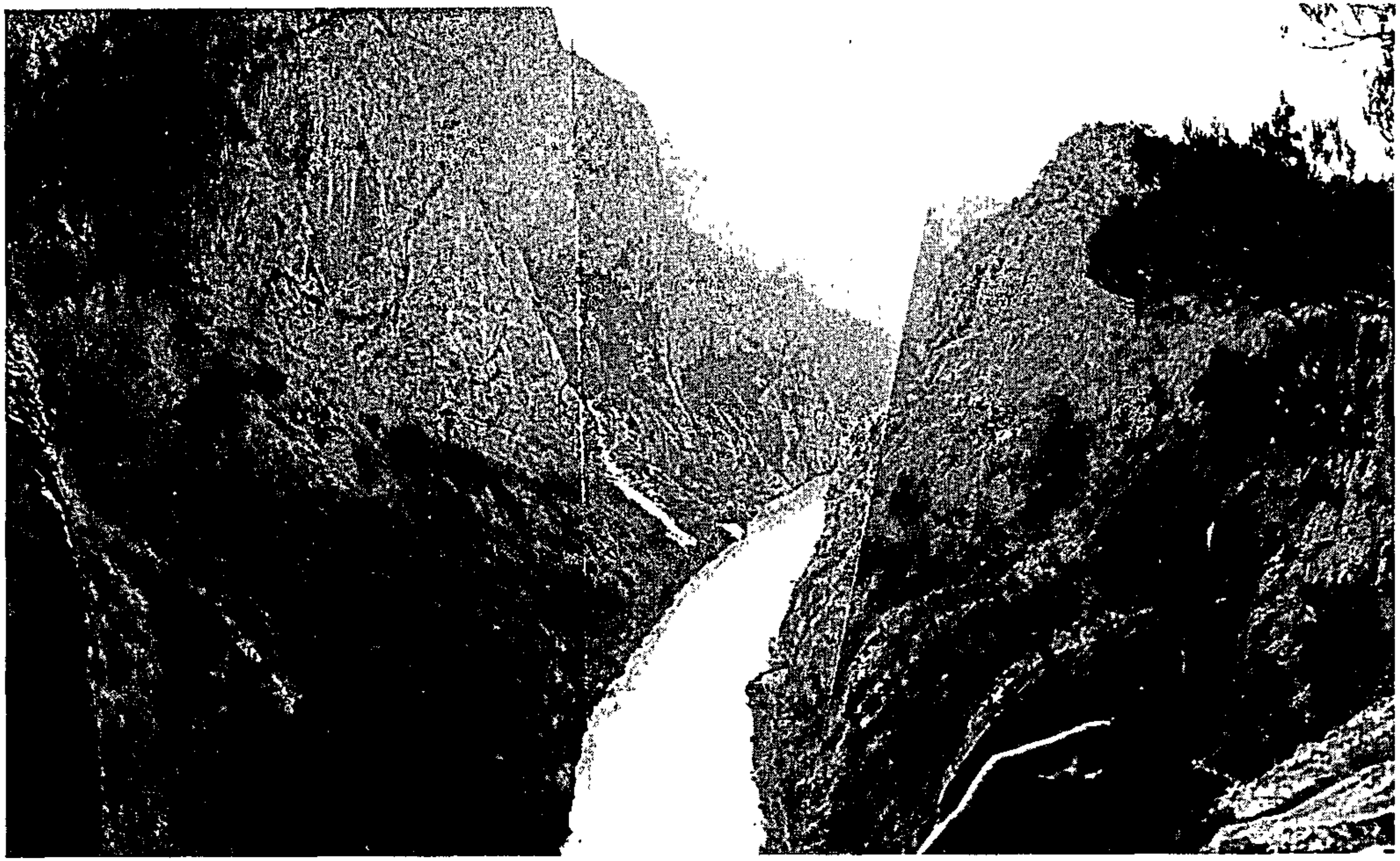
Kepez Dam Site

– Looking Downstream –



Kepez Dam Site

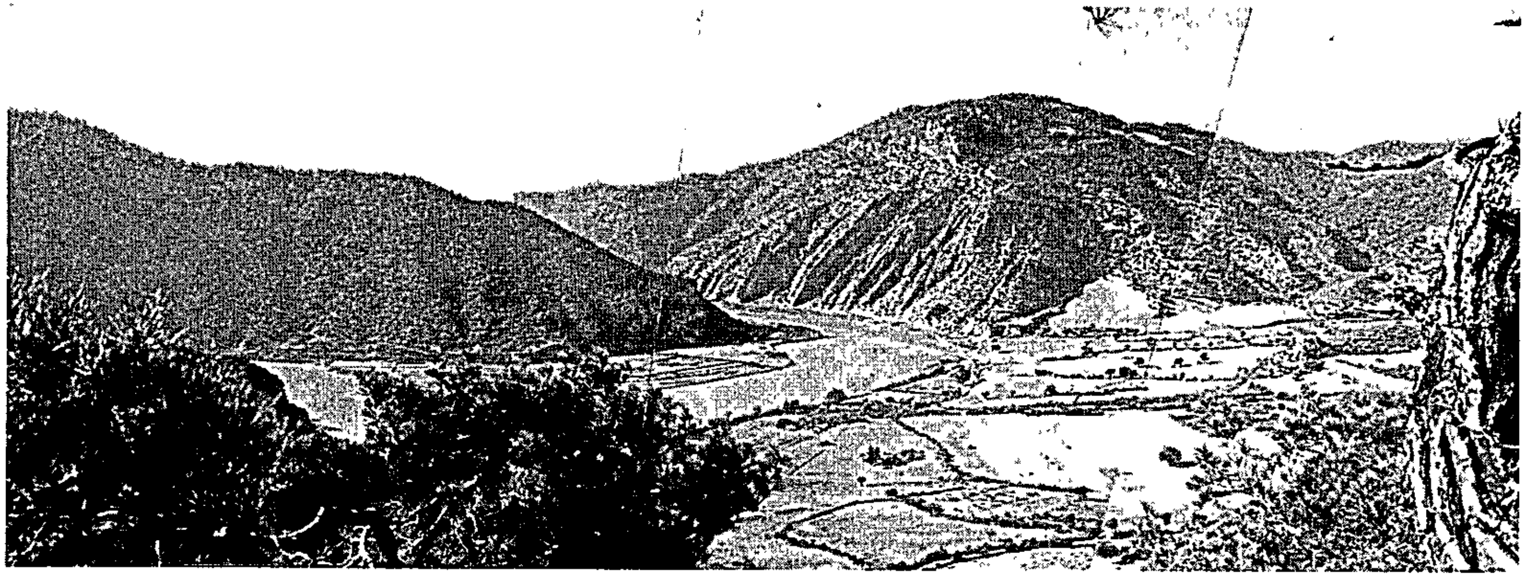
– Looking Upstream –



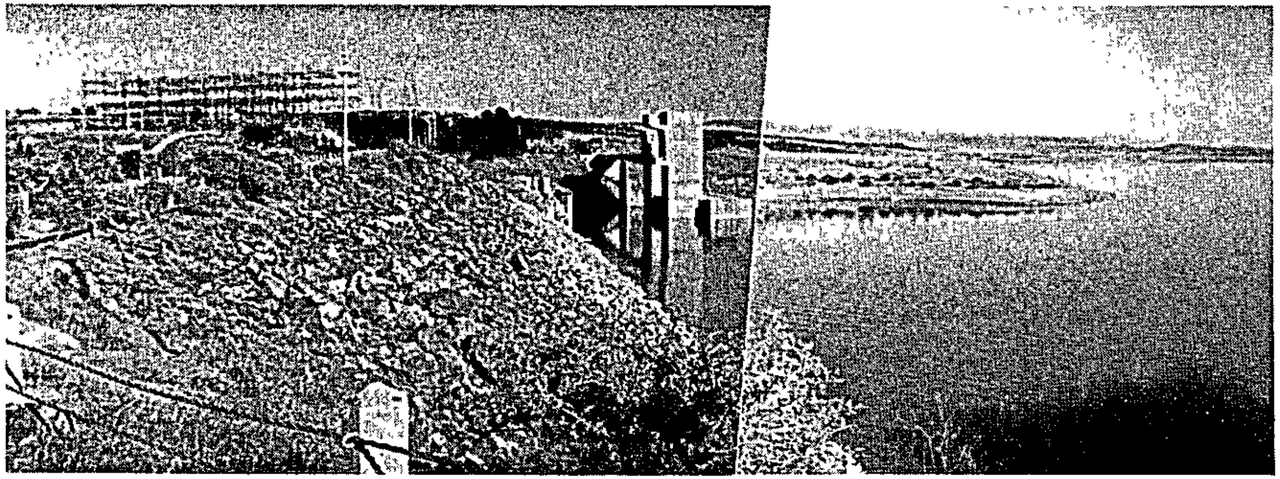
Site for Switch Yard

Boyabat Dam Site

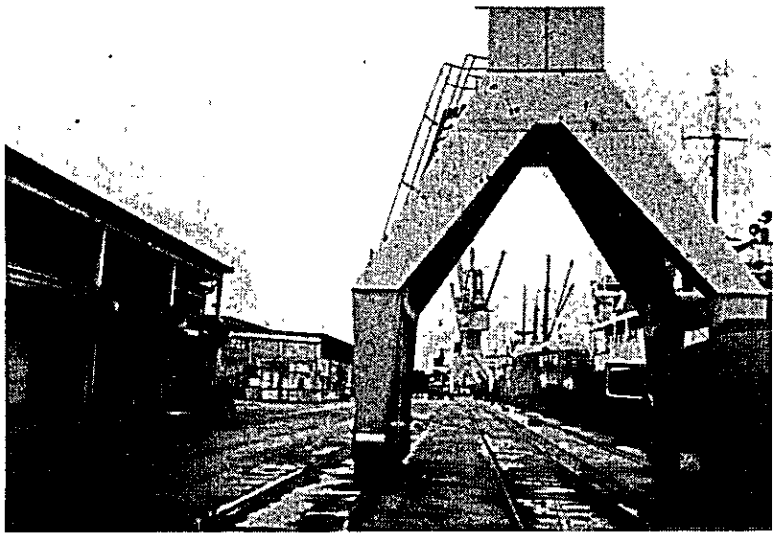
– Looking Upstream –



Hirfanlı Dam and Reservoir



Samsun Port



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BOYABAT HYDROELECTRIC POWER DEVELOPMENT PROJECT

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INTRODUCTION

INTRODUCTION

The oil crisis of 1973 has caused great change in the energy policies of the countries in the world, and the petroleum prices have been increased continuously since then, while with the various estimates of natural resources, the situation regarding the energy problem is still quite unstable.

The effect of the jump in petroleum prices on the Republic of Turkey which is poor in petroleum resources has been great and the stagnation of the global economy since the oil crisis has inflicted a severe blow to the economic activity of this country which has been attempting to push forward with industrialization.

Since 1963, the Republic of Turkey has been implementing a planned economy, and its goal is economic growth through industrializing the economic structure which is mainly agricultural. The securing of energy is an indispensable factor in promotion of this industrialization, and for this country with poor petroleum resources, development of domestic energy resources to conserve imported energy has been taken up as an urgent problem, and these energy resources, particularly hydroelectric power, are being vigorously developed.

Electric power demand in the Republic of Turkey in recent years has been increasing at an average annual growth rate of 13 %. With regard to hydroelectric power generation, it is estimated that the hydroelectric power resources which can be economically developed amount to 30,000 MW (100,000 GWh), with only 6 % of the potential hydroelectric power presently developed.

In the Fourth Five-Year Economic Plan which started from 1978, the GNP growth rate of 8 % is to be attained, and for this purpose the average annual growth rate 13 % of electric energy demand is looked forward to. It is planned for this growth in demand to supply with hydro and thermal power, and with regard to hydro, development of large-capacity reservoir-type power stations is expected.

With such a situation as the background, the Government of the Republic of Turkey requested the Government of Japan in 1978 to carry out a feasibility study in order to expedite the Kızılırmak River Boyabat-Kepez Dam and Hydroelectric Power Plant Development Project. In response to this request, the Government of Japan commissioned the Japan International Cooperation Agency (JICA) to carry out a survey of the Project.

JICA sent the survey team listed below and carried out field investigations for thirty-five days from September 9 to October 13, 1978.

Nobuaki Harada,	Team Leader	Civil Engineer	EPDC
Hideyuki Koine		Electrical Engineer	EPDC
Terumi Ushijima		Civil Engineer	EPDC
Teruo Tahara		Geologist	EPDC
Kiyoshi Konishi		Civil Engineer	EPDC
Mitsuru Suemori		Coordinator	JICA

During the period of field investigations, a large number of engineers of State Hydraulic Works (DSİ) Headquarters and the DSİ VII Regional Department, and many engineers concerned with the Project in the Power Resources Surveying Administration (EİE) and the Turkish Electricity Authority (TEK) cooperated in providing and sorting data, and in carrying out field investigations.

The survey team on returning to Japan carried out a feasibility study of the Project from October 1978 to March 1979 upon which this Report was prepared.

During the process of preparing the Report on this Project, Mr. Ruştu Günner and Mr. Neşet Aydurak of the DSI VII Regional Department arrived in Japan on February 8, 1979 as coordinators and stayed here until February 27, 1979. Subsequently, Mr. Nobuaki Harada of the team leader visited the organizations concerned with the Project in the Republic of Turkey from February 20 to March 4, 1979 and explained a draft report for final arrangement.

The information obtained in field investigations is summarized in the Appendix.

Synopsis

Item	Unit	Description
Location		On the Kızılırmak River
Catchment Area	km^2	64,724
Annual Inflow	10^6m^3	4,806
Design Flood	m^3/sec	9,300
Reservoir		
High Water Level	m	330.50
Normal Water Level	m	330.00
Reservoir Area	km^2	65.39
Gross Storage Capacity	10^6m^3	3,557
Effective Storage Capacity	10^6m^3	1,410
Diversion Tunnel		
Diameter	m	7.80
Length	m	900 + 980 = 1,880
Dam		
Type	-	Concrete Gravity Type
Elevation of Crest	m	335.00
Height	m	195.00
Length of Crest	m	265.00
Volume	10^3m^3	2,060
Spillway		
Type	-	Center Overflow with Radial Gates
Capacity	-	9,300 m^3/s at High Water Level
Number of Gates	-	8
Size of Gate	m	(B × H) 10 × 14
Intake		
Type	-	Attached to the Dam
Control Gate	-	Roller Gate
Penstock		
Type		Embedded in Dam Concrete
Length	m	171.00
Diameter	m	6.50 - 5.00

Item	Unit	Description
Powerhouse		
Type	-	Semi-underground Type
Power Generation Facilities		
Number of Units	unit	3
Unit Capacity	kW	170,000
Turbine		
Number	unit	3
Type	-	Vertical Shaft Francis Turbine
Normal Effective Head	m	125.50
Maximum Discharge	m^3/sec	157.00
Output	kW	176,000
Rated Speed	rpm	167
Generator		
Number	unit	3
Type	-	Vertical Shaft Synchronous Generator
Rated Output	kVA	190,000
Rated Voltage	kV	16.5
Rated Power Factor	%	90 (lagging)
Rated Frequency	Hz	50
Rated Speed	rpm	167
Main Transformer		
Number	unit	3
Type	-	3-phase, Indoor Type
Rated Capacity	kVA	190,000
Rated Voltage	kV	16.5/380
Rated Frequency	Hz	50
Switchyard		
Nominal Voltage	kV	380
Type of Circuit Breaker	-	SF_6 Circuit Breaker
Transmission Line		
Number of Circuit	unit	3
Nominal Voltage	kV	380

Item	Unit	Description
Construction Period	month	82
Annual Energy Production		
Total Energy	GWh	1,468
Firm Energy	GWh	925
Secondary Energy	GWh	543
Project Cost		
Investment (9.5% interest rate)	10^6TL	14,124
Surplus Benefit and Benefit-Cost Ratio		
Annual Benefit (B)	10^6TL	1,944
Annual Cost (C)	10^6TL	1,624
Surplus Benefit (B-C)	10^6TL	320
Benefit-Cost Ratio (B/C)	-	1.197
Internal Rate of Return	%	10.9

PART I

CONCLUSION AND RECOMMENDATION

PART I

CONCLUSION AND RECOMMENDATION

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The Boyabat-Kepez Dam and Hydroelectric Power Plant Development Project is located on the down stream part of the Kızılırmak River, the largest river of the Republic of Turkey, which rises in the north-eastern Anatolian Plateau, flows through the Central Anatolian Plateau and flows into the Black Sea.

There has been two sites, Boyabat and Kepez, as dam sites for this Project. It has been requested that appropriate dam site, dam type and height, and installed capacity should be decided. As results of comparison study, Kepez was selected.

Kepez Hydroelectric Power Development Project will consist of a dam of 195 m height on the Kızılırmak River and a power station of maximum output of 510 MW and annual energy of 1,470 GWh, which will be set up immediately downstream of the dam.

As results of investigation and study regarding the Project, the obtained conclusions and recommendations are as follows.

CHAPTER 1

CONCLUSIONS

CHAPTER 1 CONCLUSIONS

1.1 Growth in electric power demand in the Republic of Turkey has been prominent lately, and in the recent several years the average annual growth rate has approached to 13%. This has been due to the rapid industrialization and rise in national living standards through implementation of the First to Third Five-Year Economic Plans initiated in 1963. The electricity demand of the Republic of Turkey in 1977 was 3,400 MW, 20,600 GWh at the sending end and supply capability was inadequate.

Accoding to the Fourth Five-Year Economic Plan started in 1978, the future growth in electricity demand will be remarkable with an average annual growth rate of 13 % up to 1980, with 10,000 MW, 56,000 GWh at the sending end or 2.7 times that of 1977 forecast for 1985, and 17,200 MW, 96,000 GWh at the sending end estimated for 1990. The Republic of Turkey, in order to meet this electricity demand, is presently proceeding with construction of Elbistan Thermal Power Station and the large-scale hydroelectric power stations such as Hasan Uğurlu and Karakaya, while preparations are going on for near start of construction of reservoir-type hydroelectric power stations such as Altınkaya and Kılıçkaya. However, with the strong rise in electricity demand, the supply capability of these power stations will not be enough to satisfy requirements.

On the other hand, due to the stagnation of the national economy as a result of the oil crisis, the progress in construction and planning of the power stations mentioned above has been delayed, and it is unpredictable whether supply capability can be secured, taking present circumstances into consideration.

1.2 The Kepez Hydroelectric Power Development Project is judged as results of study to be feasible both technically and economically.

1.3 With regard to the timing of commissioning this Project in the power system to cope with the rise in electricity demand, it is considered to be appropriate to commence the operation in 1991, assuming the planned electricity demand and supply program will be progressed as scheduled. Furthermore, it is fully expected to promote to develop the Kepez power Station as the development site to follow the Altınkaya power station, taking the local characteristics into consideration.

1.4 Since the Kepez site topographically is a narrow gorge with steep cliffs at both banks, dam types other than concrete will not be suitable. A center overflow type spillway and a powerhouse immediately downstream of the dam are judged to be economically advantageous. Adopting an arch dam is not technically and economically advantageous in consideration of the layout of structures other than dam.

Therefore, the dam types for comparison would be the gravity type and the gravity arch type and as indicated in the table below there is little difference in construction costs. However, in the case of a gravity arch type, the designs of structures such as the spillway, powerhouse, etc. will become complex because of the steep topography and construction will naturally be more difficult than for a gravity type. Therefore, it is judged in this feasibility study that a gravity type will be more advantageous.

Table I-1-1 Comparison of Dam Types

Item	Unit	Gravity Type	Gravity Arch Type
Dam			
Crest Elevation	m	335.00	335.00
Dam Height	m	195.00	195.00
Crest Length	m	265.00	297.00
Concrete Volume	10^6m^3	2.06	1.78
Construction Cost	10^6TL	14,124	14,120

1.5 The Boyabat site is located 6 km upstream from the Kepez site, and topographically in sharp contrast with the Kepez site since the gorge is widened out at the dam site and the river-bed width is as much as 270 m. Considering this topographical condition, and the geological conditions as well, it is judged that dam types other than rockfill would not be economical.

1.6 A comparison of Boyabat and Kepez Projects will be indicated in the table below. In the case of the former the dam volume will be as much as 20 million m^3 and the site is topographically ideal for the layout of structures, but is judged to be uneconomical.

1.7 The conclusions regarding geology and construction materials about Kepez site are given in Part III, Chapter 4.

1.8 Regarding watertightness of foundation rock of the Kepez dam, it is described in 1.7 mentioned above, and the foundation treatment will be excuted for reducing leakage through foundation by grouting the zone from the ground surface to a depth of 100 m including the faults F-1 to F-7, and the zone along the F-5 fault to deep underground. As previously stated, it cannot be imagined that the amount of leakage from deep underground zone will be great, while the zone is at the depth that stability of the dam will not be affected so that foundation treatment around the zone is not judged to be necessary, but it is desirable for a final judgment on the necessity for foundation treatment of this deep underground zone to be made based on the results of further investigations.

Table I-1-2 Comparison of Kepez and Boyabat Projects

Item	Unit	Boyabat Project	Kepez Project
Reservoir			
Normal Water Level	m	330.00	330.00
Effective Storage Capacity	$10^6 m^3$	1,410	1,410
Available Depth	m	28.80	25.00
Dam			
Type		Rockfill	Concrete Gravity
Crest Elevation	m	335.00	335.00
Crest Length	m	670.00	265.00
Dam Height	m	195.00	195.00
Dam Volume	$10^3 m^3$	20,600	2,060
Generating Plan			
Maximum Discharge	m^3/sec	471	471
Effective Head	m	112.9	125.5
Number of Unit	Unit	3	3
Installed Capacity	MW	459	510
Annual Energy Production			
Firm Energy	GWh	823.6	925.4
Secondary Energy	GWh	517.9	543.0
Total Energy	GWh	1,341.5	1,468.4
Construction Cost	$10^6 TL$	19,874	14,124
Economic Evaluation			
Annual Cost (C)	$10^6 TL$	2,286	1,624
Annual Benefit (B)	$10^6 TL$	1,756	1,944
Surplus Benefit (B-C)	$10^6 TL$	- 530	320
Benefit Cost Ratio (B/C)		0.768	1.197

1. 9 It is estimated that 510 MW with 3 units is appropriate as the installed capacity of this Project, and the electricity produced is to be transmitted to the Western Region of the Republic of Turkey via Çankırı Switchyard and Ereğli Substation by means of three circuits of 380-kV transmission lines running out to two directions.

1. 10 The total investment cost for development of this Project is estimated to be 14. 1 billion TL of which the domestic currency portion will be 6. 8 billion TL, and the foreign currency portion 7. 3 billion TL. Benefit-cost ratio, and surplus benefit for the 50-year period analysis are about 1. 2 and 320 million TL, respectively. The internal rate of return will be 10. 9 % and the generating cost 1. 1 TL/kWh at the sending end.

CHAPTER 2

RECOMMENDATIONS

CHAPTER 2 RECOMMENDATIONS

2.1 It is recommended that the Government of the Republic of Turkey immediately proceeds with the supplementary investigations indicated below.

1) Supplementary drill holes, exploratory adits and water pressure tests at the dam site (see III.4.6.2).

2) Supplementary field and laboratory investigations for concrete aggregates (see III.4.6.2).

2.2 The power transmission plan for this Project is described in III. 6.1.3, but the final design of the Altınkaya-Çankırı Line being planned by TEK will be completed in 1980. In design of the above-mentioned line, consideration sound be given to π - connection for the double circuits which come from the Kepez Project

2.3 Based on the results of the investigations mentioned above, this Feasibility Study should be re-examined, supplemented and improved at the time of preparation of the final design, and a report for the purpose of fund procurement and documents for letting out to contract should be prepared.

PART II

GENERAL SITUATION IN THE REPUBLIC OF TURKEY

PART II

GENERAL SITUATION IN THE REPUBLIC OF TURKEY

CHAPTER 1 GENERAL SITUATION

CHAPTER 2 PRESENT STATE OF ELECTRIC ENTERPRISES

CHAPTER 1

GENERAL SITUATION

CHAPTER 1 GENERAL SITUATION

LIST OF TABLES

CHAPTER 1 GENERAL SITUATION

1.1 GEOGRAPHICAL FEATURES

The Republic of Turkey is situated at the junction of the European and Asian continents with boundaries at 42° 06' and 35° 51' north latitude, and 44°48' and 25°40' west longitude and the national territory is rectangular with a width of 650 km and length of 1,570 km for an area of 779,500 km^2. Of the land of this country, 97 % comprises the Anatolian Peninsula, the westernmost tip of the Asian continent called Asia Minor, and the remaining 3% is the region of Thrace at the southeastern part of the Balkan Peninsula situated at the eastern tip of the European continent. The land is bounded by the Mediterranean Sea on the south, the Aegean Sea on the west and the Black Sea on the north for a coast line totalling 8,400 km. It is also adjacent to Bulgaria and Greece on the west, and the USSR, Iran, Iraq and Syria to the east with borders totalling 2,750 km in length. Roughly dividing the national territory geographically, it is made up of the Aegean-Mediterranean and Black Sea coastal regions and the Eastern, Central and Southern Anatolia regions. 96 % of the land is a steppe area called the Anatolian Plateau, and only 30 % is cultivated land. The mean elevation is 1,132 m and no more than one fifth of the land is under 500 m in elevation.

Large rivers are the Kızılırmak River (1,335 km), the foremost in Turkey on which the Kepez Project site is situated, the Sakarya River (825 km), the Seyhan River (560 km), and the Yesilırmak River (520 km), while the famous international rivers, the Tigris and the Euphrates, also spring in the Republic of Turkey. Of natural lakes, Lake Van (3,700 km^2) in Eastern Anatolia and Lake Tuz (1,500 km^2)in Central Anatolia are large. Of artificial lakes, Lake Keban (675 km^2) on the Euphrates River and Lake Hirfanlı (265 km^2) on the Kızılırmak River are well known, both playing important roles as energy resources being reservoirs for hydro-electric power generation. Tall mountains abound in Eastern Anatolia, among which Mt. Ararat (5,165 m) is the most famous, while others are Mt. Suphan (4,434 m), Mt. Kackar (3,932 m) and Mt. Erciyes (3,916 m).

Vegetation differs according to climate and topographical conditions, but may be roughly divided into the followings:

Black Sea Coastal Region:

A forest area is distributed on the mountain slopes facing the coast line, and oak, elm and beech trees are abundant.

Aegean-Mediterranean Coastal Region:

Olive, citrus and pine trees are abundant in the hill area.

Anatolian Plateau Regions:

The regions comprise natural pasturage with scattered forests.

1.2 CLIMATE

In spite of the fact that the north and south sides of the Republic of Turkey are bounded by seas, the climate differs greatly depending on the region because of the high mean elevation of the land at 1,132 m and the influences of the mountainous areas running parallel to the coast lines.

1.2.1 Temperature

The annual mean temperature of the Black Sea Coastal Region is mild at 14 to 15°C, being 22 to 24°C in the midsummer months of July and August to be relatively bearable, while the coldest season of January and February is not very severe at 5 to 7°C. The annual mean temperature of the Aegean-Mediterranean Coastal Region is warm at 18 to 20°C to indicate a so-called Mediterranean climate with 27°C and higher reached in the summer, while winters are temperate at 8 to 12°C. As for the inland regions, the annual mean temperatures vary greatly depending on altitude to be featured by a continental climate with a large difference between hot and cold. It becomes searing hot in midsummer, while in the coldest season warm winds are blocked by the mountainous areas along the coast and many areas suffer cold waves of 0 to -10°C.

1.2.2 Precipitation

With regard to precipitation the year may be roughly divided into a continental climate of little rainfall and a subtropical climate of dry summer. In general, there is much precipitation in the mountainous areas along the sea coast with precipitation decreasing more the farther inland, although there are large differences between areas. In the Aegean-Mediterranean Coastal Region, it is the rainy season from autumn to late spring, while rainfall is seen in the Black Sea Coastal Region throughout the year. In the inland area precipitation consists mostly of snowfall in the winter season followed by rainfall in early spring, and other than these seasons there is practically no precipitation.

The climates of the main cities are indicated in Table II-1-1.

Table II-1-1 Climate in the Main Cities

Selected Cities	Regions	Altitude Above Sea (meters)	Av. T. (cent.)	Lowest T. (cent.)	Highest T. (cent.)	Average Humidity (%)	Average Precipitation (milimeters)
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
Edime	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	18.7	-4.6	44.6	64	1,068.2
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
Agrı	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

1.3 POPULATION

The population is 42,100,000 (1977) with the ratio between urban and rural populations being 40 to 60, and concentration of the population in cities is becoming more prominent from year to year. Large urban populations are the 2,530,000 of Istanbul and the 1,700,000 of Ankara, the capital. It is reported that the annual average population growth rate is 2.5%. The population by industry is 58% in agriculture, 14 % in services, and 13 % in mining and manufacturing, so that the Republic of Turkey may be said to be an agricultural country. The people are 90 % Turke, with the remainder consisting of Kurds, Arabs, Armenians, Greeks and others. Of the population, 99 % are Muslims, while the remaining 1 % is mainly Christian.

1.4 NATIONAL ECONOMY

The feature of the economy of the Republic of Turkey is that the form of a mixed economy is taken centered around public enterprises established through state investment with in private enterprises existing alongside. State Planning Organization was created in 1960 and a planned economy has been implemented since 1963, the aim of which is to increase the share of the industrial sector in the economic which is mainly agricultural, thereby achieving an annual economic growth rate in the 7% level to absorb the surplus labor force from the agricultural sector into the industrial sector.

The First Five-Year Economic Plan was launched in 1963 and 1978 corresponds to the first year of the Fourth Five-Year Economic Plan. During the Third Five-Year Economic Plan an investment of $41 billion was made (26% in manufacturing, 18% in housing, 22 % in transportation and communications, 12% in agriculture, 7% in energy, and 15% in others) aiming for economic growth of 7.9% annually, but the actual performance is considered to have been about 1 % lower as indicated in Table II-1-2. Further, in the Fourth Five-Year Economic Plan (1978-1982), a scheme for attaining an annual average GNP growth rate of 8% is being contemplated through investment of a total of $63 billion (27.7% in manufacturing, 16.0% in transportation and communications, 14.0% in housing, 12.2% in agriculture, 10.6% in energy, and 18.9% in others).

Table II-1-2 Targets and Peformances of Long-Range Plans (Growth Rate)

Unit: %

	1st (1963-1967)		2nd (1968-1972)		3rd (1973-1977)	
	Target	Performance	Target	Performance	Target	Performance
Agriculture	4.2	3.7	4.1	3.6	3.7	3.1
Industry	12.3	10.6	12.0	9.9	11.2	10.4
Construction	10.7	8.0	7.2	5.0	11.9	9.0
Transportation & Communications	10.5	7.8	7.2	8.8	8.2	9.9
Housing	-	3.5	5.9	6.8	5.0	6.5
Services	6.2	7.5	6.3	7.3	7.1	8.2
GNP	7.0	6.7	7.0	7.1	7.9	6.9

Source : State Planning Organization

The major economic indices (partially including estimates) for the three-year period of 1975 to 1977 are given in Table II-1-3.

Table II-1-3 Economic Activity

Item	Unit	1975	1976	1977
GNP (current)	$\$10^9$	21.43	26.80	32.70
Total Resources	"	22.54	28.32	34.69
External Deficit	"	1.11	1.52	1.99
Growth Rate	%	8.0	7.6	5.0
Total Investment	$\$10^9$	4.91	6.24	8.25
Total Consumption	"	17.63	22.08	26.44
GNP by Origin				
Agriculture	%	21.9	21.9	20.9
Industry	"	19.7	20.2	20.7
Services	"	58.4	57.4	58.4
Income per Capita	$/Capita	884	986	1,016

Note: Exchange rate 25 TL/$ Source : State Institute of Statistics

On examination of wholesale price indices (100 in 1963), they were 343.2 for 1975, 396.6 for 1976 and 494.4 for 1977, corresponding to annual increases of 10.1%, 15.6% and 24.7%, respectively. The exchange rate against the dollar was revised 15 times from 1973 up to the present, with the current buying rate 25 TL/$, selling rate 25.5 TL/$, interest rate 9.0%, and the net reserves of foreign currency according to data of the Central Bank have reached a deficit of $\$3.5 \times 10^9$. The foreign trade structure of the Republic of Turkey follows a pattern of export of agricultural products and import of capital goods and raw materials. In effect, 61% of exports consist of agricultural products (tobacco, cotton, hazel nut, etc.), 33% of industrial products (spun cotton, leather, olive oil, etc.), the remaining 6% of mining products (chrome ore, etc.), while 77% of imports consist of industrial products (machinery, chemical products, steel, electrical products, etc.), 22% of mining products (oil, etc.), with the remaining 1% agricultural products. The uses of imported items are proportioned 44% for capital goods, 53% for raw materials and 3% for consumption goods. Further, 44% of exports and 38% of imports are to and from European Community countries.

The exports of the Republic of Turkey in 1977 amounted to $\$1.75 \times 10^9$ and imports $\$5.80 \times 10^9$, with import of petroleum reaching $\$1.00 \times 10^9$ to result in a deficit of $\$4.05 \times 10^9$ in the balance of trade.

1.5 ENERGY RESOURCES

Electric power at present is in a state of shortage of supply capability with power being received from Bulgaria, while it is also planned for power to be received from the USSR in the future. Because of such a situation, development of electric power is a matter of great urgency in proceeding with industrialization. The present ratios of energy resources consumption, as indicated in Table II-1-4, show that 44% of total consumption is of petroleum.

Table II-1-4 Energy Resources in National Consumption

Unit: %

Energy Resource	1976
Petroleum products	43.8
Wood	13.9
Coal	13.3
Animal and plant residues	12.0
Lignite	9.7
Hydraulic power	6.6

Source : Ministry of Energy

The electric power supply facilities as of 1977 totaled 4,700 MW (20,600 GWh) with the ratio of composition between hydraulic and thermal 40% : 60%, the electric energy consumption per capita being 490 kWh. It is forecast that power demand will grow at a rate of 13% from now on. It is estimated that the hydroelectric potential possible to be developed economically is 30,000 MW (100,000 GWh) with only 6% presently developed, and this is the reason why future development is looked forward to.

With regard to petroleum, 80% of the total consumption of 13.8×10^6 tons is presently being imported. It is estimated there are reserves of 57×10^6 tons of petroleum, 1.3×10^9 tons of hard coal, 5.6×10^9 tons of soft coal, 6.0×10^9 tons of peat and oil shale, and 45×10^6 tons of uranium ore. It is planned for 600 MW of nuclear energy to be developed in 1985, and 1,000 MW in 1991.

In any event, the Republic of Turkey was severely hit by the energy crisis since it is a petroleum importing country. Because of this, in order to stimulate economic activity, the necessity for development of energy resources suited to regional conditions is being stressed, and development of domestic fossil fuel resources, specially coal, is being planned. Also, in addition to fossil fuels the development and effective utilization of local energy resources such as hydroelectric power, geothermal power, etc. are said to be of importance.

1.6 TRANSPORTATION AND COMMUNICATIONS

Domestic transportation relies mostly on motor traffic. Of the 59,000 km of roads including state and provincial roads, 38% consists of paved highways with the remainder being crushed stone macadam and stabilized soil roads. The number of vehicles in 1977 was 522,000. The total length of railways is 8,100 km with 99% not electrified.

Telephone and broadcasting services are state-operated with broadcasting covering the entire national territory. The rates of pervasion of telephones, radio sets and television sets in 1976 were 2%, 10% and 4%, respectively.

CHAPTER 2

PRESENT STATE OF ELECTRIC ENTERPRISE

CHAPTER 2 PRESENT STATE OF ELECTRIC ENTERPRISE

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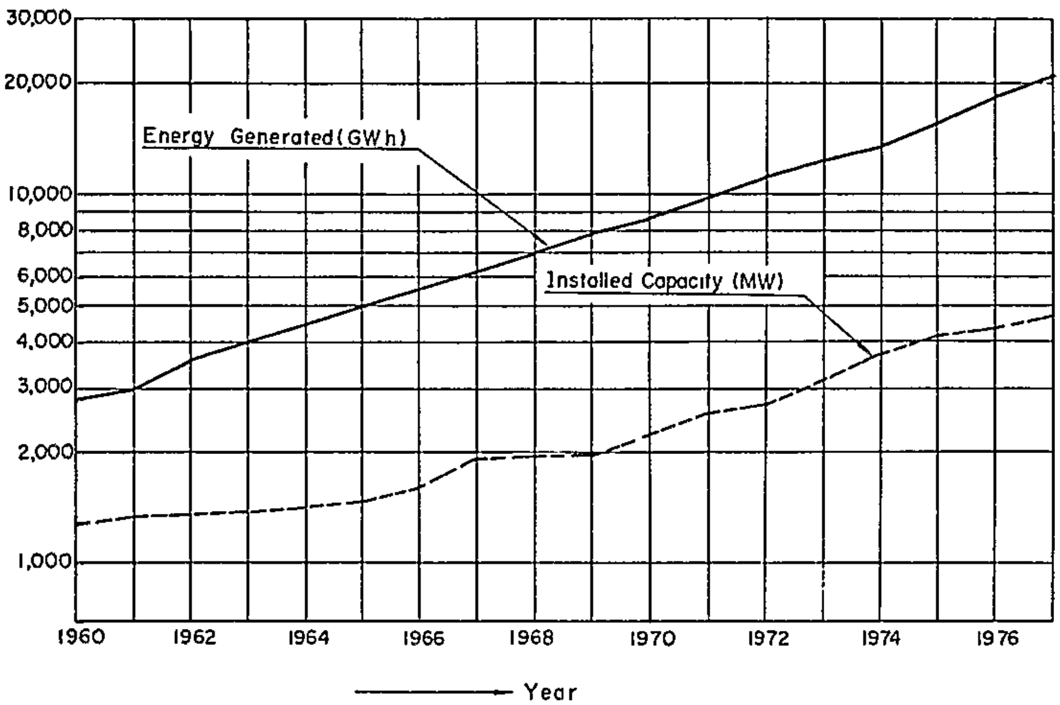
CHAPTER 2 PRESENT STATE OF ELECTRIC ENTERPRISE

2.1 ELECTRIC POWER SITUATION

The trends in installed capacity and gross energy generated in the Republic of Turkey are indicated in Fig. II-2-1. The installed capacity as of 1977 was a total of 4,700 MW, with 60% of the facilities consisting of thermal and 40% of hydraulic. The total annual electric energy production is 20,600 GWh, of which 42% is due to hydroelectric power generation.

Fig. II-2-1 Installed Capacity and Energy Generated



The per capita energy production is 490 kWh. It cannot be said that the per capita consumption level is on the high side, but the growth rate in energy production is high, with both 5-year and 10-year averages exceeding 12%. It is surmised that such a trend is due to the First, Second and Third Economic Development Plans started in 1963, and the increase in the electrification rate in the country. Such rapid increase in electric energy consumption has resulted in shortage of supply capacity, and the Republic of Turkey has been forced to import approximately 500 GWh from Bulgaria. According to the power demand forecast made by TEK, it is estimated that there will be an annual average growth rate of 12% or more during the next ten-year period, and in order to cope with this growth in demand, a plan for expanding electric power development facilities is being implemented. According to the above plan, it is aimed for installed capacity to be increased to 6 times the present capacity by 1992. The plan emphasizes hydraulic power development, and it may be noted that it is targeted for hydraulic power generation in 1992 to be raised to 60% of power generation. Large-scale power stations are scheduled to be commissioned starting with Keban Hydro (1,354 MW), Karakaya Hydro (1,800 MW) and Hasan Uğurlu Hydro (500 MW), followed by Elbistan Lignite Thermal Power Station of 4,660 MW, and these are planned to be completed successively from 1979 to 1985. In 1986, it is planned for the first nuclear power station (600 MW) to go into operation. In recent years, however, since promising supply capabilities sufficient to satisfy the growth in demand have not been provided, there is a possibility that during the several years from now, the electric power shortage will become even worse.

The ratios of energy consumptions by customer category in 1977 were 20% for general household and commercial uses, 75% for industrial and agricultural uses, and 5% for others. These ratios have not changed very much during the past 10 years.

Practically almost the transmission system of the Republic of Turkey has been interconnected, with about 5% of the whole remaining in the form of isolated systems. The major transmission network is composed of 380 kV transmission lines (2,200 km) and 154 kV transmission lines (9,600 km). Voltages of 66 kV and 34.5 kV are adopted for local transmission networks. The introduction of the 380 kV system to the major network has been going on since 1972, with the power transmission system being actively strengthened since then, and evaluations and examinations are being made by TEK with regard to adoption of a power transmission system of 800 kV class. The distribution network under 34.5 kV is approximately 40,000 km in total length, and although this is being expanded annually, no more than 70% of the whole national territory is covered by the distribution network, and there is a considerable portion of unelectrified villages in agricultural areas in the provinces

The electricity tariffs in the Republic of Turkey as of August 1978 were based on a dual system of (1) and (2). All consumers had the privilege of selecting either the (1) tariff or (2) tariff.

(1) Double Term Tariff System
   (a) Power Base Tariff: 83 TL/kW per month
   (b) Energy Base Tariff: 0.61 TL/kWh

(2) Single Term Tariff System: 1.031 TL/kWh

2.2 ELECTRICAL ENTREPRENEURS

The electrical industry of the Republic of Turkey is entirely operated in the form of state ownership with electric power administration under the jurisdiction of the Ministry of Energy and Natural Resources. Organs concerned with electric power are EİE (Power Resources Surveying Administration), DSİ (General Directorate of State Hydraulic Works), and TEK (Turkish Electricity Authority).

EİE is an organ for planning and investigating electric power development, and in consideration of future power demand and supply, it makes plans on development sites, scales and development timings.

DSİ is an organ established in 1953 and has the main purposes of construction and operation of facilities for flood control, irrigation and drainage, and construction of hydroelectric power stations. DSİ has 28 regional departments throughout the country and a total number of 14,000 employees, and with regard to hydroelectric power generation projects, there are cases in which DSİ carries them out independently and cases in which DSİ participates with EİE from the investigation stage.

TEK is an electric power supplying organ for construction, maintenance and operation of thermal power stations, nuclear power stations and transmission lines, and maintenance and operation of hydroelectric power stations constructed by DSİ, and has a total of 5,300 employees. There are approximately 50 major power stations directly operated by TEK, and 80% of all of the power generating capacity of the Republic of Turkey is operated by TEK. The remaining 20% comprise municipal power stations or plants operated by private enterprises.

Power distribution is carried out in three types of areas, that is, areas directly handled by TEK, areas handled by municipal organizations supplied with power by TEK, and some communities supplied by Electricity and Gas Services. Since the service areas of these three types overlap at places, there is an initiative being taken for distribution work to be unified.

2.3 PRESENT STATE OF ELECTRIC POWER SUPPLY FACILITIES

The major power stations in the Republic of Turkey are as listed in Table II-2-1. The annual trends of installed power generating capacity are as indicated in Table II-2-2, and capacity has increased by 2.4 times during the past 10 years. Of the installed capacity, the variation in the proportion made up by hydroelectric power generation is indicated in Fig. II-2-2. The ratio of hydroelectric power generation has indicated a gradual trend of increase to reach 40% (1,873 MW) of the total facilities in 1977.

Fig. II-2-2 Percentage of Hydraulic Power Stations in Total Capacity

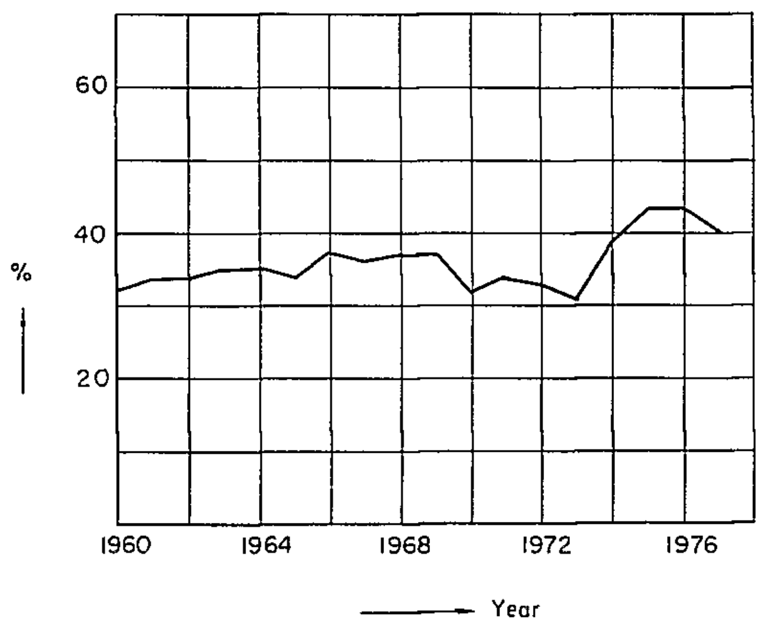


Table II-2-1 Major Power Stations in Operation

Name	Thermal Power Stations		Name	Hydraulic Power Stations		
	Installed Capacity (MW)	Energy Generated(GWh)		Installed Capacity (MW)	Energy Generated (GWh)	
					Average	Firm
Izmir	40	130				
Silahtar	122	450	Almus	27	80	40
Catalagzi	129	800	Cag - Cag	14.4	42	42
Soma	44	300	Demirkopru	69	190	100
Tuncbilek	129	830	Dogankent 1-3	24.6	128	115
Anbarli	630	4,500	Goksu	10.6	65	55
Hopa	50	350	Gokcekaya	186	650	215
Bornova GT.	45	115	Hirfanlı	96	300	180
Seydisehir	120	320	Hazar 1-2	30.1	188	158
Seyitomer	300	1,800	Ikizdere	15.1	100	80
Aliaga GT.	120	320	Kesikkopru	76	180	110
Hazar GT.	30	80	Kemer	48	135	65
Mersin	106	700	Kovada 1-2	59.6	261	190
Karabuk	20	60	Sariyar	160	580	330
Ego	26.6	40	Tortum	26	85	68
Erdemir	20	130	Keban 1-4	630	4,600	4,600
Seka - Izmit	11	31	Cildir	15.4	30	30
Seka - Dalaman	26.2	65	Seyhan	60	350	243
3 ncuDemircelik	60	300	Kadincik 1-2	126	622	390
Tpao Batman	15	75	Kepez	26.4	160	130

Table II-2-2 Installed Generating Capacity

Unit: MW

Year	Operated by TEK			Operated by Others			Total		
	Thermal	Hydraulic	Total	Thermal	Hydraulic	Total	Thermal	Hydraulic	Total
1960	237	331	568	623	81	704	860	412	1,272
1961	237	348	585	642	97	739	879	445	1,324
1962	237	348	585	664	122	786	901	470	1,371
1963	237	352	589	666	126	792	903	478	1,381
1964	237	353	590	684	144	828	921	497	1,418
1965	302	360	662	683	145	828	985	505	1,490
1966	302	471	773	726	145	871	1,028	616	1,644
1967	522	557	1,079	735	145	880	1,257	702	1,959
1968	522	577	1,099	722	146	868	1,244	723	1,967
1969	522	582	1,104	721	142	863	1,243	724	1,967
1970	905	582	1,487	605	143	748	1,510	725	2,235
1971	1,095	669	1,764	611	203	814	1,706	872	2,578
1972	1,188	690	1,878	631	202	833	1,819	892	2,711
1973	1,568	782	2,350	639	203	842	2,207	985	3,192
1974	1,643	1,191	2,834	640	258	898	2,283	1,449	3,732
1975	1,708	1,521	3,229	699	259	958	2,407	1,780	4,187
1976	1,771	1,614	3,385	720	259	979	2,491	1,873	4,364
1977	2,071	1,614	3,685	783	259	1,042	2,854	1,873	4,727

There are approximately 160 major substations of 30 kV or higher throughout the country, the total capacity of 380 kV and 154 kV class transformers reaching 7,000 MVA.

Although the voltages of major transmission lines in the Republic of Turkey are 380 kV and 154 kV as previously described, there is a partial adoption of a voltage of 220 kV for the tie-line with Bulgaria. A list of the major transmission lines is indicated in Table II-2-3.

The Keban-Golbasi and Golbasi-Umraniye lines are main transmission lines running through the central part of Turkey, and are the main arteries connecting the power consumption areas in the west and the power resources areas in the east, and the total of the distances of the two amount to 900 km.

The annual trends in lengths of transmission lines and distribution lines are given in Table II-2-4.

Table II-2-3 Major Transmission Lines in Operation

Name	Nominal Voltage (kV)	Length (km)	Conductor (MCM)
Keban-Golbasi	380	546	2 x 954 (2 circuits)
Golbasi-Gokcekaya	380	167	2 x 954
Gokcekaya-Umraniye	380	216	2 x 954
Golbasi-Umraniye	380	355	2 x 954
Gokcekaya-Seyitomer	380	112	2 x 954
Seyitomer-Isiklar	380	265	2 x 954
Seyitomer-Seydisehir	380	295	2 x 954
Babaeski-Dogu Meric (Bulgaria)	220	77	2 x 954

Table II-2-4 Transmission and Distribution Lines

Unit: km

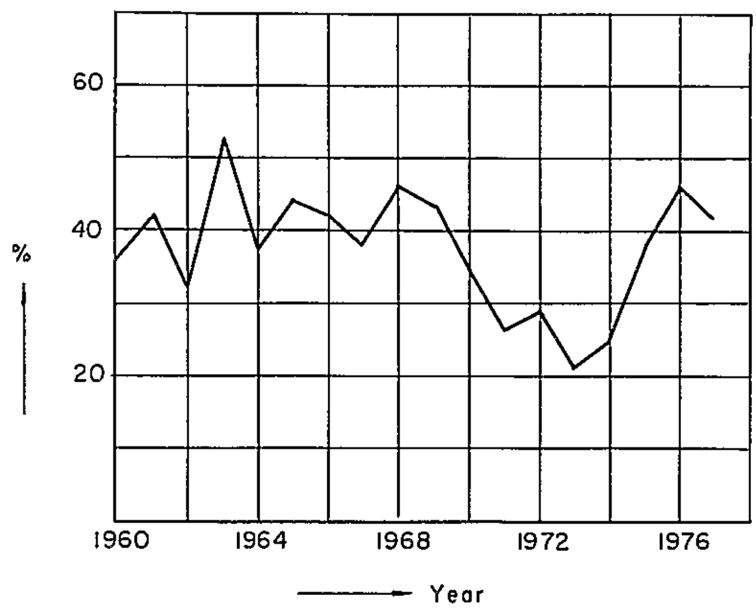
Year	Nominal Voltage					Total
	380 kV & 220 kV	154 kV	66 kV	34.5 kV	Less than 34.5 kV	
1962	-	2,166	1,024	350	1,582	5,622
1967	-	4,129	1,870	2,869	3,202	12,070
1972	355	6,010	2,426	10,848	34,023	53,662
1973	355	6,464	2,437	11,716	34,471	55,443
1974	1,835	8,758	2,430	13,164	38,042	64,229
1975	2,156	9,620	2,430	14,141	39,961	68,309

2.4 PRESENT STATE OF DEMAND AND SUPPLY OF ELECTRIC POWER

The trend in gross energy generated in the Republic of Turkey is indicated in Table II-2-5. The average growth rate in energy generated in the past 10 years was 12.7% and the amount of energy generated 3.3 times that of 10 years ago.

The proportion made up by hydraulic power is shown in Fig. II-2-3, and in 1977 hydraulic energy comprised 42% of the total energy generated.

Fig. II-2-3 Percentage of Hydraulic Energy in Gross Energy Generated



The trends in monthly maximum demands are indicated in Table II-2-6. December corresponds to the critical path during the year, but there is not very much difference from the maximum demands of other months, and the power demand of the month with the smallest maximum demand is in the range of 80% to 95% of that of December. The annual growth rate in maximum demand was an average of 12.3% in the 10-year period, indicating the same level as the growth rate in energy generated. A typical daily demand curve is indicated in Fig. II-2-4.

The trends in the annual demand and supply balances of the power system of TEK are indicated in Table II-2-7. The electric energy generated in June 1978 classified according to energy source is shown in Table II-2-8. The demand and supply balance sheet of TEK for 1977 shows that 3% of the entire electric energy supplied was imported from Bulgaria with 2% supplied by other companies. The network loss rate is under 5% showing that a world level is being maintained.

Fig. II-2-4 Typical Daily Demand Curve

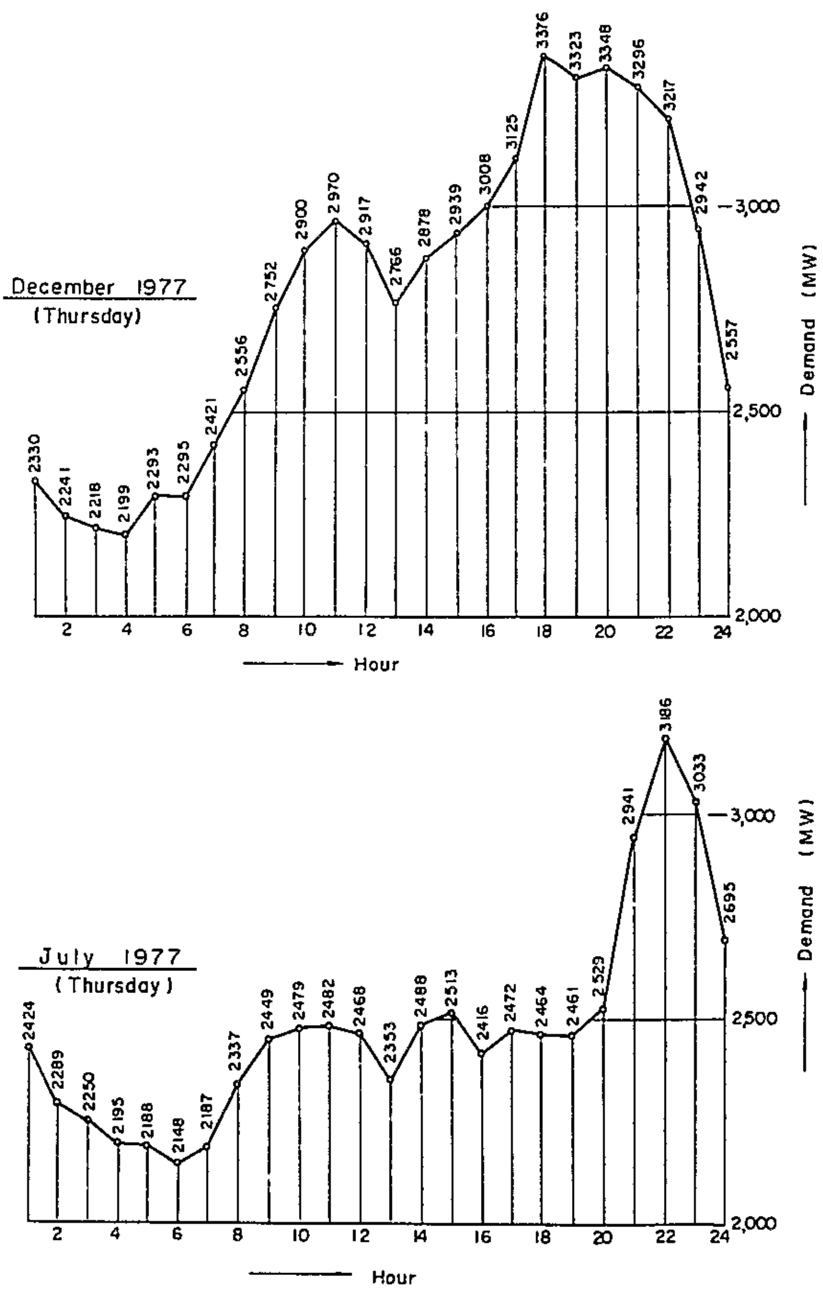


Table II-2-5 Gross Energy Generated

Unit: GWh

Year	Furnished by TEK			Furnished by Others			Total		
	Thermal	Hydraulic	Total	Thermal	Hydraulic	Total	Thermal	Hydraulic	Total
1960	920	751	1,671	894	250	1,144	1,814	1,001	2,815
1961	974	997	1,971	772	268	1,040	1,746	1,265	3,011
1962	1,280	809	2,089	1,156	315	1,471	2,436	1,124	3,560
1963	849	1,740	2,589	1,030	364	1,394	1,879	2,104	3,983
1964	1,451	1,236	2,687	1,352	412	1,764	2,803	1,648	4,451
1965	1,442	1,682	3,124	1,332	497	1,829	2,774	2,179	4,953
1966	1,746	1,771	3,517	1,467	567	2,034	3,213	2,338	5,551
1967	2,453	1,787	4,240	1,382	595	1,977	3,835	2,382	6,217
1968	2,485	2,535	5,020	1,276	640	1,916	3,761	3,175	6,936
1969	2,841	2,749	5,590	1,552	696	2,248	4,393	3,445	7,838
1970	3,915	2,358	6,273	1,675	675	2,350	5,590	3,033	8,623
1971	5,890	1,912	7,802	1,281	698	1,979	7,171	2,610	9,781
1972	6,833	2,291	9,124	1,205	913	2,118	8,038	3,204	11,242
1973	8,223	2,035	10,258	1,599	568	2,167	9,822	2,603	12,425
1974	8,585	2,604	11,189	1,536	752	2,288	10,121	3,356	13,477
1975	8,201	4,644	12,845	1,518	1,260	2,778	9,719	5,904	15,623
1976	8,254	7,200	15,454	1,654	1,175	2,829	9,908	8,375	18,283
1977	9,804	7,433	17,237	2,168	1,160	3,328	11,972	8,593	20,565

Table II-2-6 Monthly Maximum Demand

Unit: MW

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1966	790	791	806	776	771	763	737	763	814	863	908	928
1967	903	909	917	893	895	873	840	843	944	1,018	1,027	1,058
1968	1,026	1,006	1,014	988	977	977	963	987	1,054	1,145	1,134	1,179
1969	1,170	1,147	1,122	1,108	1,102	1,091	1,098	1,112	1,178	1,248	1,285	1,287
1970	1,296	1,292	1,272	1,268	1,250	1,256	1,260	1,258	1,357	1,442	1,434	1,508
1971	1,520	1,503	1,540	1,504	1,466	1,467	1,478	1,502	1,521	1,621	1,740	1,787
1972	1,758	1,713	1,702	1,683	1,696	1,645	1,668	1,687	1,747	1,842	1,904	1,951
1973	1,947	1,891	1,930	1,892	1,861	1,838	1,815	1,864	1,914	1,986	2,064	2,139
1974	2,087	2,069	2,052	2,014	2,037	2,059	2,034	2,078	2,215	2,269	2,490	2,511
1975	2,352	2,284	2,321	2,321	2,268	2,248	2,281	2,342	2,484	2,550	2,703	2,782
1976	2,783	2,808	2,839	2,775	2,709	2,712	2,759	2,850	2,959	3,095	3,217	3,223
1977	3,216	3,305	3,282	3,317	3,226	3,186	3,186	3,182	3,306	3,350	3,370	3,376

Table II-2-7 TEK's Energy Balance

Year	1972	1973	1974	1975	1976	1977
Gross Generated by TEK (GWh)	9,124	10,258	11,189	12,845	15,454	17,230
Consumed for Station Service (GWh)	484	509	521	681	780	969
Net Generated (GWh)	8,640	9,749	10,668	12,164	14,674	16,261
Consumed for Compensator (GWh)	23	23	22	15	16	16
Imported from Bulgaria (GWh)	-	-	-	96	332	492
Supplied by Others (GWh)	372	438	1,252	544	398	317
Energy Furnished (GWh)	8,989	10,164	11,898	12,789	15,388	17,054
Network Losses (GWh)	482	600	588	606	748	841
(%)	5.4	5.9	4.9	4.7	4.9	4.9
Net Consumption (GWh)	8,507	9,564	11,310	12,183	14,640	16,213

Table II-2-8 Distribution of Electrical Energy Generated (June 1978)

Energy Source	Energy Generated GWh	%
Thermal Power Stations	1,047.3	60.7
Oil	506.6	29.3
Coal	103.9	6
Lignite	343.6	20
Diesel Engine & Gas Turbine	93.2	5.4
Hydraulic Power Stations	678.2	39.3
Storage Type	503.1	29.2
Run-off Type & Natural Lake Type	175.1	10.1
Total	1,725.5	100

PART III

KEPEZ HYDROELECTRIC POWER DEVELOPMENT PROJECT

PART III

KEPEZ HYDROELECTRIC POWER DEVELOPMENT PROJECT

CHAPTER 1

DEMAND AND SUPPLY FORECAST

CHAPTER 1. DEMAND AND SUPPLY FORECAST

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CHAPTER 1. DEMAND AND SUPPLY FORECAST

1.1 DEMAND FORECAST

Electric power demand forecasts are roughly divided into long-range or short-range forecasts depending on the number of years considered. Even if the construction of the Kepez Project were to be completed within the shortest length of time, a minimum of 10 years from now will be required including the preparatory period, and operation will become possible only at the end of the 1980s or the beginning of the 1990s. Consequently, in this Report, a long-range forecast up to the year 2002 is made by which the trend of power demand around the time of commissioning can be considered. The contents of this article consist of three items, that is, the outline of the demand forecast made by TEK in 1977, the long-range forecast made by a macro-method, and the results of study.

1.1.1 Demand Forecast by TEK

This paragraph is an abridgement of the report "Electrical Energy and Power Estimates of Turkey (1978-2000): Edited by TEK Planning and Coordination Department" published by TEK in December 1977, and the results of the estimates. According to this report, the period considered in the demand forecast is a long term of 23 years from 1978 to 2000. This term is divided into two periods, the first of which is from 1978 to 1981 for which the method of aggregating energy consumption based on consumers is adopted. The second period is from 1982 to 2000 with calculations made based on gross energy generation. The processes or contents of the above estimates in somewhat more concrete terms are the following:

(1) Estimations for First Period (1978-1981)

As previously mentioned, after the electric energy of this period is estimated on the basis of consumers, with the consumers classified according to a number of groups depending on region or character, the energy consumption by group is forecast. Regarding the energy of large-scale consumption groups, estimates are made based on policies set up by government organs or expansion plans of individual enterprises, while for groups about which it is difficult to obtain information of high accuracy, figures deduced from past records and trends are applied. The sum of the energy consumptions of the various groups is the energy consumption for that year, and the energy consumed for station service and network losses added to this amount is the gross energy generation. For the energy consumed for station service and network losses a total of 8% is taken into account. This figure was seen to vary from 8% to 9% in the past, but it is forecast that it will become stabilized at around 8% with addition of modern power stations and a 380 kV transmission system. The classification of groups and the methods of estimation is indicated below.

(a) Cities: trend values
(b) Villages: trend values
(c) Medium and small enterprises: trend values

(d) Large enterprises: planned values
(e) Public organs: planned values
(f) Irrigation facilities: planned values
(g) Power station construction: planned values

(2) Estimations for Second Period (1982-2000)

Since adequate data on industrial development after 1981 are especially meager, a method using gross energy generation obtained from trends is adopted in estimations for this period. In this method, a equation is derived from data on gross energy generation for the 19-year period from 1963 to 1981 based on actual records and forecast values calculated for the First Period. The equation most suitable for this 19-year period is the cubic equation below, and this equation is used for demand forecast from 1982 to 2000.

$$Y = 4.7X^3 + 104X^2 + 1,340X + 11,000$$

where Y : annual gross energy generated (GWh)
X : year of estimation with 1972 as zero starting year

(3) Estimation of Maximum Demand

The load factor is forecast to be 64% from past performances, and the maximum demand for each year is calculated by the equation below.

$$Pmax = \frac{E_g}{Lf \times 8,760}$$

where

Pmax : maximum demand (MW)
E_g : annual gross energy generated (MWh)
Lf : load factor = 0.64

(4) Results by TEK

The results of demand forecast by the processes described above are indicated in Table III-1-1.

Table III-1-1 Results of Demand Forecast by TEK

Year	Gross Energy Generated (GWh)	Maximum Demand (MW)
1978	24,400	4,350
1979	27,600	4,920
1980	30,900	5,510
1981	34,300	6,120
1982	39,500	7,040
1983	44,600	7,960
1984	50,200	8,950
1985	56,300	10,040
1986	63,000	11,240
1987	70,400	12,560

Year	Gross Energy Generated (GWh)	Maximum Demand (MW)
1988	78,300	13,960
1989	86,900	15,500
1990	96,200	17,160
1991	106,200	18,940
1992	117,000	20,870
1993	128,500	22,940
1994	140,900	25,130
1995	154,000	27,470
1996	168,000	29,970
1997	182,900	32,620
1998	198,800	35,460
1999	215,500	38,440
2000	233,200	41,600

Dividing the term from 1963 to 2000 into 5-year periods, the average growth rates in energy generation of these periods are indicated in Table III-1-2.

Table III-1-2 Average Growth Rate of Energy Generated

Period (Year)	Growth Rate (%)
1962 - 1967	11.8
1967 - 1972	12.6
1972 - 1977	13.7
1962 - 1977	12.7
1977 - 1982	13.0
1982 - 1987	12.3
1992 - 1997	10.7
1977 - 1997	11.3

As is clearly seen in this table, the growth is slowed from 1977, but with energy increasing at this degree of speed the kWh per capita will reach 3,110 kWh in the year 2000. The transitions in kWh per capita during the forecast periods are estimated in Table III-1-3, and an annual 2.5% is adopted as the increase rate of population which is the basis of calculation.

Table III-1-3 Energy Generated per Capita

Planned Period	Energy Generated (GWh)	Population (10^3)	kWh	Growth Rate (%)
End of 1982	39,500	47,600	830	10.3
End of 1987	70,400	53,900	1,306	9.5
End of 1992	117,000	61,000	1,918	8.0
End of 1997	182,900	69,000	2,650	6.7

1.1.2 Demand Forecast by Macro-Method

The demand forecast by TEK described in 1.1.1 may be said to be a composite of micro and macro techniques when the entire forecast period is looked at. In effect, in the estimation for the near term a microscopic technique of aggregating the energy consumption based on consumers is adopted, while in estimation for the subsequent long term, a macroscopic concept is adopted, that of determining the trend curve of gross energy generated on the basis of not only actual performances but forecast values for the near term.

A forecast by a macroscopic technique was attempted with the view of finding out what kind of difference in trend is produced between the above-mentioned forecast results and those of a macroscopic technique.

(1) Demand Forecast Based on GNP

It has been established statistically that there is a correlation between the energy demand and the national economy of a country. Particularly, it has been clarified that a fairly regular correlation index exists between GNP per capita and kWh per capita. There are many cases of demand forecasts made by macroscopic techniques utilizing this correlation. A long-range forecast of energy demand has been made, in the Republic of Turkey using this macroscopic method based on GNP. The indices, basic conditions, etc. used in the study were the following:

(a) Guiding Principle of Study and Statistical Indices:
"New-Method Long Range or Very Long Range Demand Forecast of Energy Including Electricity Viewd from Worldwide Standpoint, Edited by EPDC"
(b) Period of Forecast: 25 years (1978 - 2002)
(c) Estimation Conditions: (see Table II-1-4)
  (i) GNP per Capita (1968 Price): $ 540 (1977)
  (ii) Growth Rate of GNP per Capita: 4.2% (5-year average, 1973 - 1977)
  (iii) kWh per Capita: 490 kWh(1977)
  (iv) Population: 42,078,000 (1977)
  (v) Increase Rate of Population: 2.5%

As indicated in the above Estimation conditions, this long-range forecast has the actual value of GNP per capita in 1977 as its starting point. It was assumed that the correlation between GNP per capita and its growth rate would show the trend indicated in Fig. III-1-1, while the correlation between GNP per capita and kWh per capita would show the trend indicated in Fig. III-1-2.

(2) Results by Macro-Method

The annual gross energy generated obtained from the above graphs and table is indicated in Table III-1-5. The forecasts of maximum demands were calculated from gross energy generated, on the basis of the load factor of 64% predicted by TEK.

Table III-1-4 Basic Data for Demand Forecast

	GNP (Constant Price in 1968)			Energy Generated		Population	Per Capita			
							GNP		Energy Generated	
Year	TL (billion)	US$ (million)	Growth Rate(%)	GWh	Growth Rate(%)	(Thousand)	US$	Growth Rate(%)	kWh	Growth Rate(%)
1962	76.6	8,480	6.2	3,560	18.2	28,933	290		120	
1963		9,040		3,983	11.9	29,655	300	3.4	130	8.3
1964		9,630		4,451	11.7	30,394	320	6.7	150	15.4
1965		10,270		4,953	11.3	31,391	330	3.1	160	6.7
1966		10,940		5,551	12.1	31,934	340	3.1	170	6.3
1967		11,660		6,217	12.0	32,750	360	5.9	190	11.8
Average			6.6		11.8	(2.5%)		4.4		9.6
1968	112.5	12,440	6.7	6,936	11.6	33,585	370	2.8	210	10.5
1969		13,370		7,838	13.0	34,442	390	5.4	230	9.5
1970		14,320		8,623	10.0	35,605	400	2.6	240	4.3
1971		15,340		9,781	13.4	36,215	420	5.0	270	12.5
1972	148.5	16,430	7.4	11,242	14.9	37,132	440	4.8	300	11.1
Average			7.1		12.6	(2.5%)		4.1		9.6
1973	156.5	17,310	5.4	12,425	10.5	38,072	450	2.3	330	10.0
1974	168.0	18,580	7.4	13,477	8.5	39,036	480	6.7	350	6.1
1975	181.5	20,080	8.0	15,623	15.9	40,348	500	4.2	390	11.4
1976	195.3	21,600	7.6	18,283	17.0	41,039	530	6.0	450	15.4
1977	205.1	22,690	5.0	20,565	12.5	42,078	540	1.9	490	8.9
Average			6.7		12.8	(2.5%)		4.2		10.3

Source of GNP(TL) and Growth Rate: ALMANAC TURKEY 1978

Fig. III-1-1 Correlation Between per Capita GNP and Growth Rate

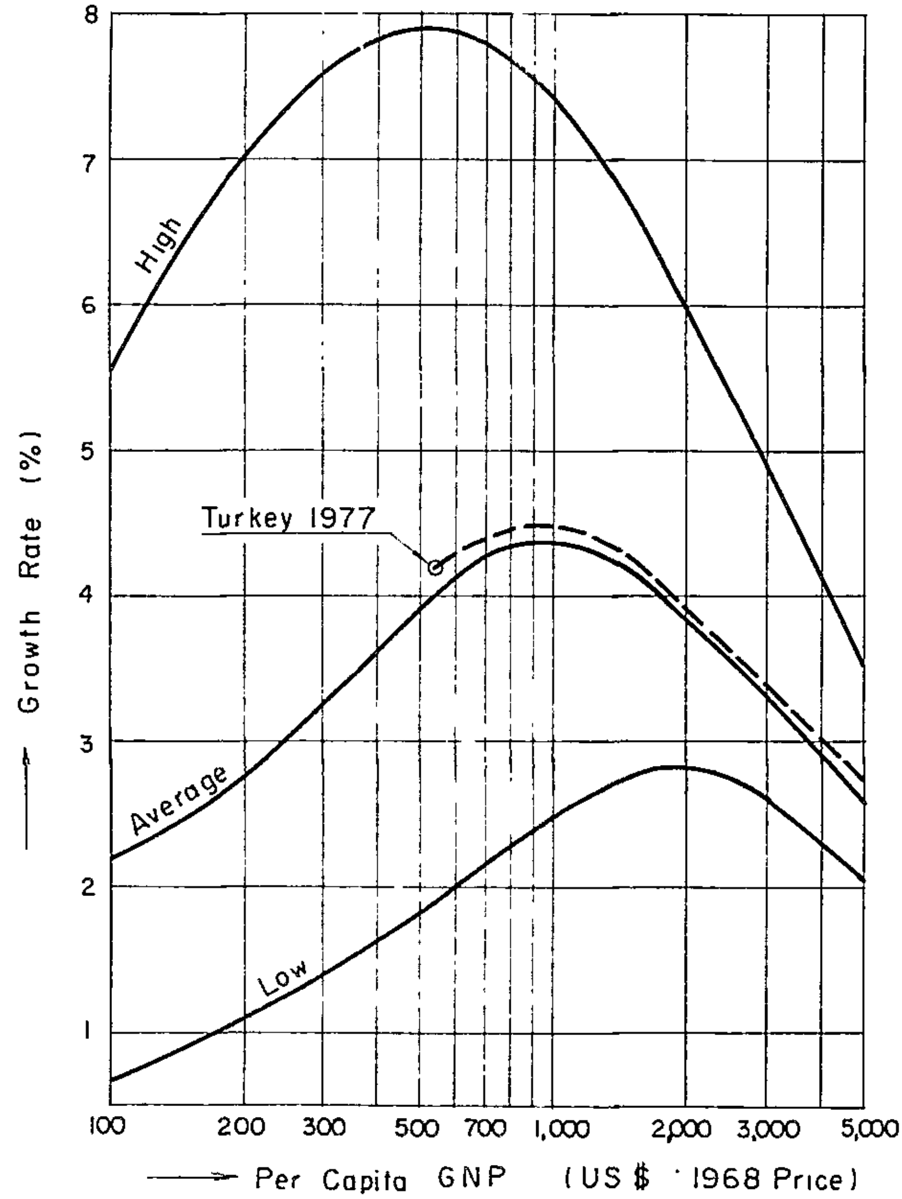


Fig. III-1-2 Correlation Between per Capita GNP and per Capita Energy

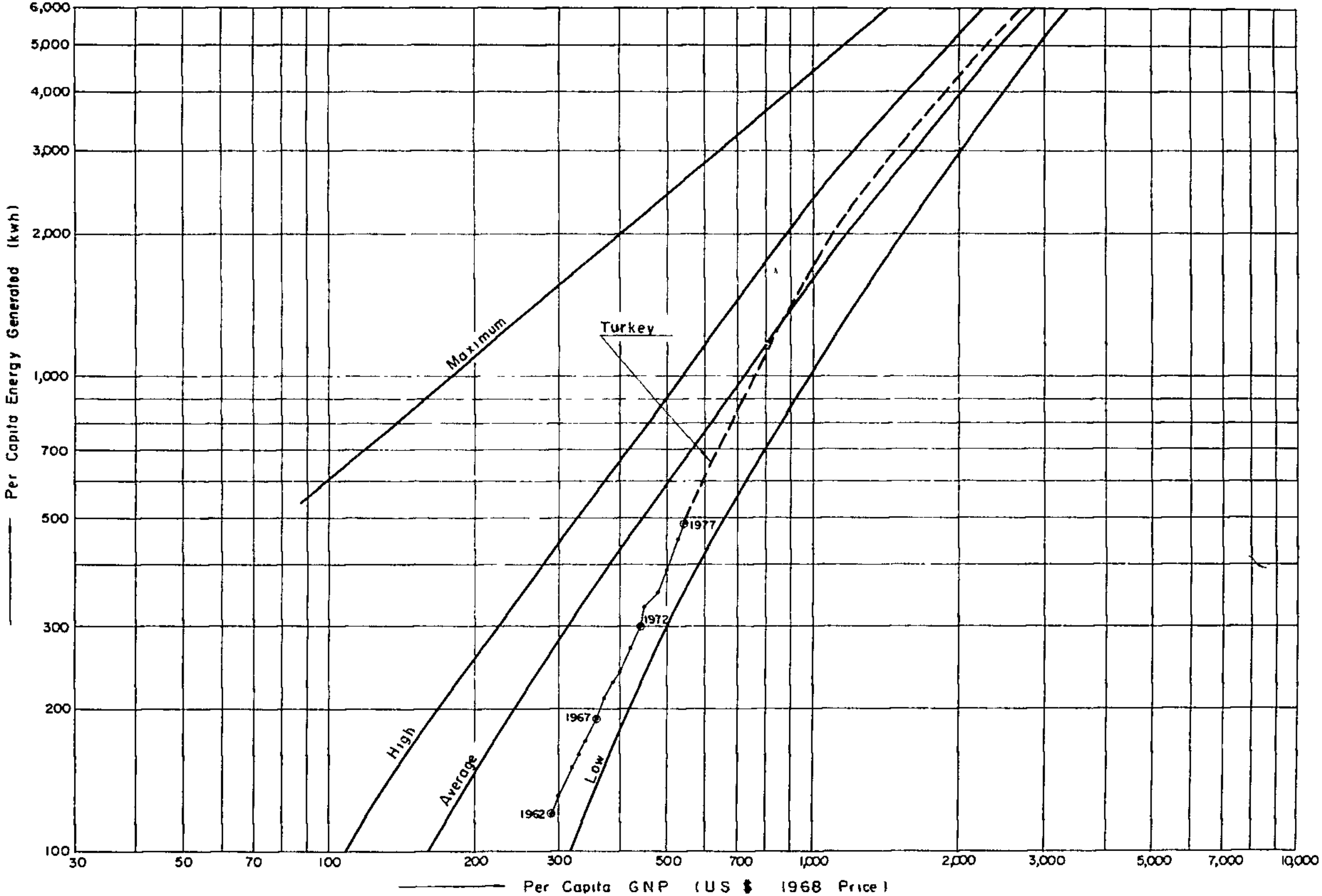


Table III-1-5 Results of Demand Forecast by Macro-Method

Year	Per Capita GNP		Per Capita kWh		Population	Gross Energy Generated		Maximum Demand
	Growth Rate (%)	US$ (1968 Price)	kWh	Growth Rate(%)	(10^3)	GWh	Growth Rate(%)	(MW)
1977	4.2	540	490	10.3	42,078	20,565	12.8	3,376
1978	4.2	563	530		43,130	22,900		4,100
1979	4.25	587	580		44,210	25,600		4,600
1980	4.25	612	630		45,310	28,500		5,100
1981	4.3	638	700		46,440	32,500		5,800
1982	4.3	665	760		47,600	36,200		6,500
Average	4.25			9.2	(2.5%)		12.0	
1983	4.35	694	840		48,800	41,000		7,300
1984	4.35	724	930		50,030	46,500		8,300
1985	4.4	756	1,000	51,2	51,290	51,300		9,200
1986	4.4	789	1,100		52,580	57,800		10,300
1987	4.45	824	1,250		53,900	67,400		12,000
Average	4.4			10.5	(2.5%)		13.2	
1988	4.45	861	1,380		55,250	76,300		13,600
1989	4.5	900	1,500		56,630	84,900		15,100
1990	4.5	940	1,650		58,050	95,800		17,100
1991	4.5	982	1,750		59,510	104,100		18,600
1992	4.5	1,026	1,900		61,000	115,900		20,700
Average	4.5			8.7	(2.5%)		11.5	
1993	4.45	1,072	1,980		62,520	123,800		22,100
1994	4.45	1,120	2,120		64,080	134,600		24,000
1995	4.45	1,170	2,200		65,680	144,500		25,800
1996	4.45	1,222	2,300		67,320	154,800		27,600
1997	4.4	1,276	2,490		69,000	171,800		30,600
Average	4.45			5.6	(2.5%)		8.2	
1998	4.4	1,332	2,600		70,720	183,900		32,800
1999	4.35	1,390	2,750		72,490	199,300		35,500
2000	4.3	1,450	2,900		74,300	215,500		38,400
2001	4.3	1,512	3,100		76,150	236,100		42,100
2002	4.25	1,576	3,200		78,050	250,000		44,600
Average	4.3			5.5	(2.5%)		8.1	

1.1.3 Results of Study

A comparison of the results of forecasts by TEK and by the macro-method is given in Table III-1-6 and Fig. III-1-3.

Table III-1-6 Comparison of Demand Forecasts

Period (Year)	By TEK GWh: (a)	By TEK Growth Rate(%)	By Macro-method GWh: (b)	By Macro-method Growth Rate(%)	Difference (c): (a)-(b)	Difference %: (c)/(a)
End of 1977	21,400*	13.7*	20,565**	12.8**	835	3.9
End of 1982	39,500	13.0	36,200	12.0	3,300	8.4
End of 1987	70,400	12.3	67,400	13.2	3,000	4.3
End of 1992	117,000	10.7	115,900	11.5	1,100	0.9
End of 1997	182,900	9.3	171,800	8.2	11,100	6.1
End of 2000	233,200		215,500		17,700	7.6
1977 - 2000		10.9		10.8		

Note: *) Estimated **) Recorded

As is clear in the table and graph, the annual gross energy generated by the macroscopic method is lower than the results by TEK, and there is a difference of 8.4% for the year 1982 with the largest difference in percentage. This difference between the two is due to the difference in the energy demands for 1977 which are the initial conditions for the respective forecasts; this difference comes from the fact that TEK used an estimated value, while the macro-method used the recorded value. However, the growth rates in both cases do not show much difference. Seeing that the average rate for the 23-year period up to the year 2000 is 10.9% for TEK and 10.8% by the macro-method, the two methods may be judged to be quite the same in regard to the growth rates.

Further, it is to be noticed that there is a general difference in trends between the two procedures. In the case of the macro-method, as far-off years are approached, slowing of growth rate of energy generated becomes increasingly prominent. This phenomenon is caused by the fact that the Correlation Between per Capita GNP and Growth Rate, and the Correlation Between per Capita GNP and per Capita Energy as indicated in Figs. III-1-1 and III-1-2, were based on the present and past conditions in the Republic of Turkey, with the worldwide trends as indices, and the following characteristic of the latter correlation has been taken into account.

The fact is that the ratio between the growth rate of GNP per capita and the growth rate of kWh per capita, that is, the elasticity coefficient, shows a very high level in the Republic of Turkey. This signifies that the growth rate of electric energy consumption is at a higher level than the rate of economic growth, and it is the result of the several economic development plans implemented in the past. Taking also the Fourth Five-Year Plan just starting into consideration, it is forecast that for some time to come kWh per capita will be raised at a steeper rate than GNP per capita. Since it is forecast that after attaining a certain level the growth rate of kWh per capita will gradually be decreased to the worldwide growth rate, as indicated in Fig. III-1-2, the macro-method shows a greater saturated trend in the growth rate of kWh per capita.

The above saturated trend in the growth rate by the macro-method becomes more prominent after approximately 2000. But the purpose of this Report is not to discuss such a far-off matter, and it may be concluded that not a very large difference exists between the two methods in the period up to the year 2000.

1.2 DEMAND AND SUPPLY BALANCE

1.2.1 Planning for Supply

The potential of hydroelectric power resources in the Republic of Turkey is said to be 455,000 GWh annually, of which the annual totals of the hydraulic energies of developable sites which will pay economically are indicated in Table III-1-7, and as of the present the evaluation figures are 68,480 GWh of firm energy and 100,564 GWh of average energy.

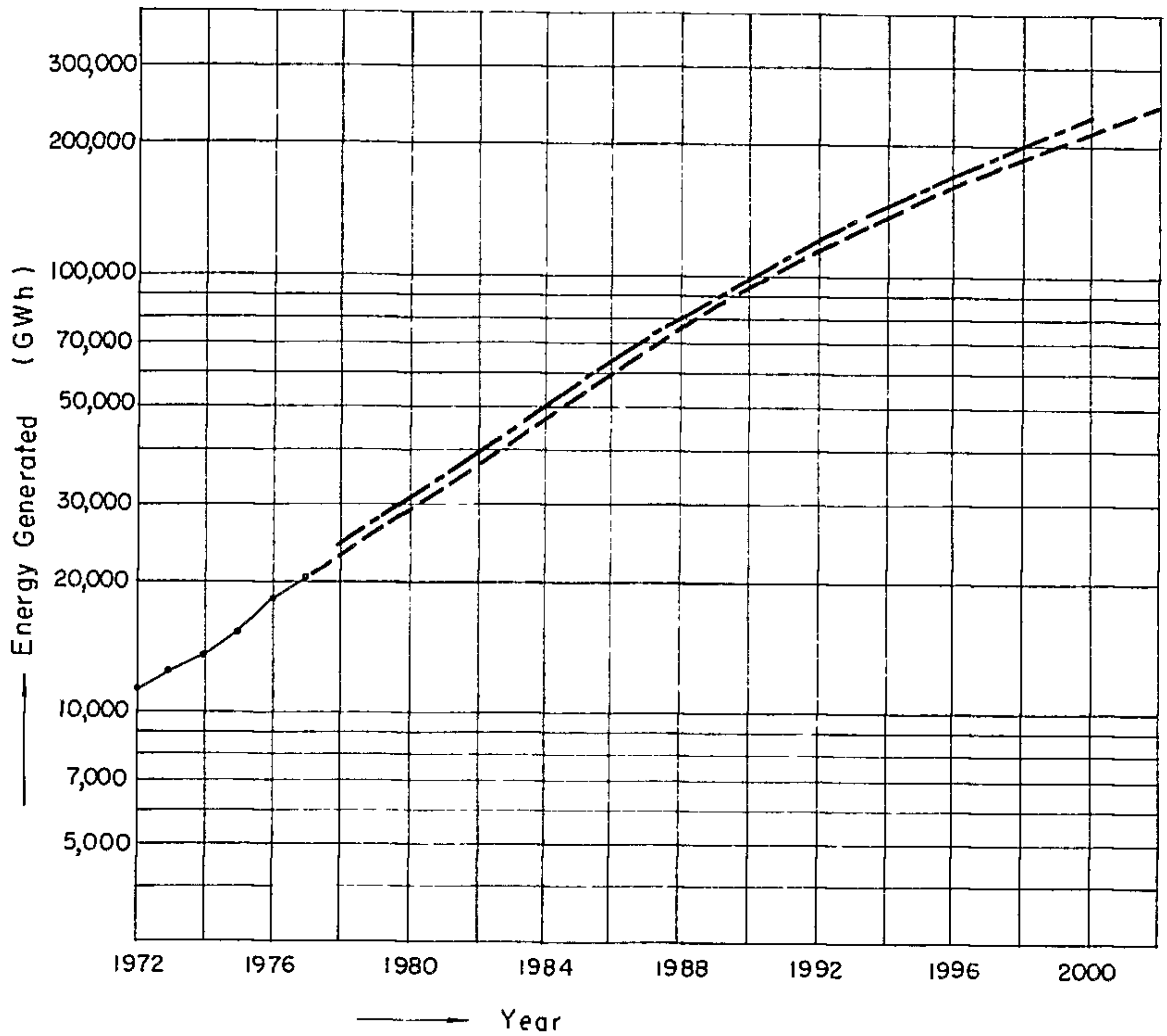
Table III-1-7 Total of Hydraulic Power Station Projects in Turkey

State of Project	Number of Project	Capacity (MW)			Energy Generated (GWh)	
		Installed	Average	Continuous	Average	Firm
In Operation	54	1,873 (6.1%)	1,040	850	9,054 (9%)	7,595 (10.8%)
Under Construction	17	4,038 (13.2%)	1,640	1,053	14,364 (14.3%)	9,281 (13.5%)
Final Design	21	4,515 (14.8%)	1,875	1,396	16,427 (16.3%)	12,227 (17.9%)
In Planning Stage	38	6,043 (19.8%)	1,907	1,273	16,709 (16.7%)	11,155 (16.3%
In Master Plan Stage	186	14,124 (46.1%)	5,024	3,277	44,010 (43.7%)	28,422 (41.5%)
Total	316	30,593 (100%)	11,486	7,816	100,564 (100%)	68,480 (100%)

The electric power development plans from 1978 to 1992 are indicated in Tables III-1-8 and III-1-9. According to the plans, the total installed capacity in 1992 is to be expanded to 6.6 times that at present, with total output to be 31,405 MW. The plans also call for the annual firm energy to be increased to 118,341 GWh, 6 times that at present.

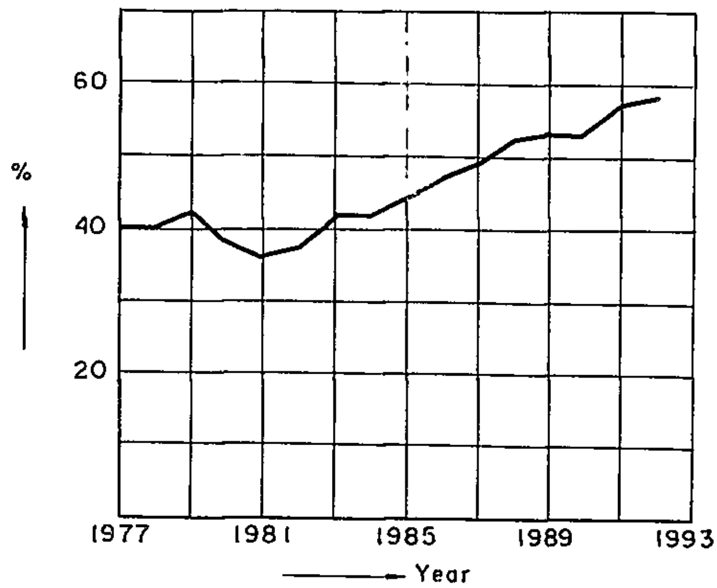
With regard to expansion of hydroelectric facilities, it is planned to be an installed capacity in 1992 approximately 10 times that at present. The result, as indicated in Fig. III-1-4, will be that the hydroelectric capacity will account for just under 60% of total capacity.

Fig. III-1-3 Comparison of Demand Forecasts: Energy



Note :
Forecast by TEK —·—·—
Forecast by Macro-Method — — — —

Fig. III-1-4 Ratio of Hydraulic Power Stations in Total Installed Capacity (Forecast)



As a result, the effective utilization of hydraulic energy will be improved year by year as indicated in Fig. II-1-5, and it is planned to develop, by 1992, up to 60% of the energy possessed by developable sites. The major hydroelectric power stations presently being constructed are listed in Table III-1-10.

Fig. III-1-5 State of Development of Hydraulic Energy (Forecast)

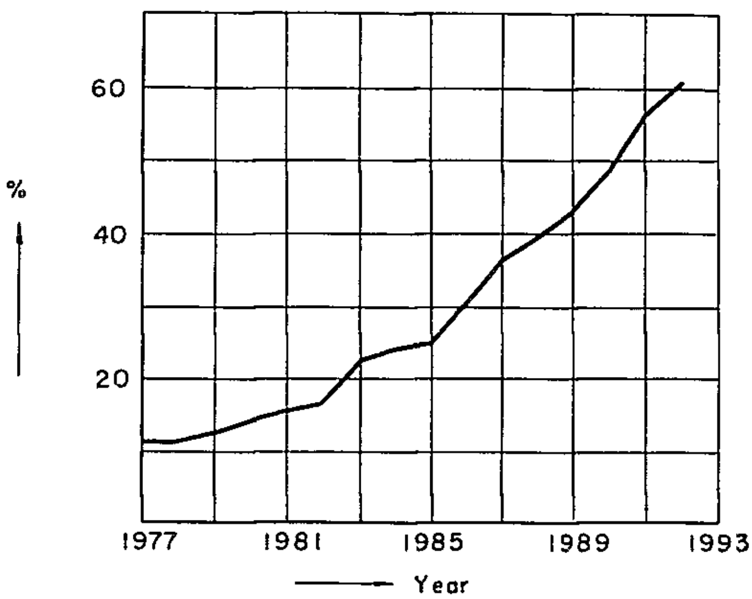


Table III-1-8 Construction Schedule of Power Stations in Turkey

Unit : MW

Year	Installed Capacity					Average Capacity		Continuous	
	Thermal		Hydraulic		Total:	Hydraulic:	Total:	Hydraulic:	Total:
	New Plant	Total: (1)	New Plant	Total: (2)	(1)+(2)	(3)	(1)+(3)	(4)	(1)+(4)
Esisting		2,854		1,873	4,727	1,040	3,894	850	3,704
1978	-	2,854	8	1,881	4,735	1,040	3,894	850	3,704
1979	75	2,929	250	2,131	5,060	1,140	4,069	940	3,869
1980	1,090	4,019	375	2,488	6,507	1,340	5,359	1,080	5,099
1981	1,630	5,649	633	3,121	8,770	1,530	7,179	1,170	6,819
1982	940	6,589	678	3,799	10,388	1,780	8,369	1,260	7,849
1983	-	6,589	850	4,649	11,238	2,270	8,859	1,710	8,299
1984	1,050	7,639	600	5,249	12,888	2,590	10,229	1,840	9,479
1985	-	7,639	788	6,037	13,676	2,750	10,389	1,890	9,529
1986	1,200	8,839	1,802	7,839	16,678	3,310	12,149	2,390	11,229
1987	600	9,439	1,180	9,019	18,458	3,830		2,870	12,309
1988	-	9,439	1,170	10,189	19,628	4,310	13,749	3,060	12,499
1989	750	10,189	1,200	11,389	21,578	4,730	14,919	3,320	13,509
1990	2,050	12,239	2,351	13,740	25,979	5,390	17,629	3,810	16,049
1991	-	12,239	2,644	16,384	28,623	6,210	18,449	4,390	16,629
1992	1,000	13,239	1,782	18,166	31,405	6,820	20,059	4,730	17,969
Total (Additional)	10,385		16,293		26,678				

Table III-1-9 Production Schedule of Available Energy Generated

Unit : GWh

Year	by Thermal: (1)	by Hydraulic		Total	
		Firm: (2)	Average: (3)	Firm: (1)+(2)	Average: (1)+(3)
Existing	11,972 (Recroded)	7,595	9,054	19,567	21,026
1978	11,972	7,595	9,078	19,567	21,026
1979	12,142	8,415	9,978	20,557	22,120
1980	18,592	9,597	11,615	28,189	30,207
1981	28,192	10,399	13,278	38,591	41,470
1982	33,742	11,153	15,467	44,895	49,207
1983	33,742	15,095	19,726	48,837	53,468
1984	40,042	16,213	22,499	56,255	62,541
1985	40,042	16,605	23,852	56,647	63,894
1986	48,142	20,868	28,701	69,010	76,843
1987	52,042	25,113	33,207	77,155	85,249
1988	52,042	26,791	37,459	78,833	89,501
1989	56,842	29,156	41,138	85,998	97,980
1990	69,892	33,498	46,925	103,390	116,817
1991	69,892	38,505	54,118	108,397	124,010
1992	76,892	41,449	59,493	118,341	136,385
Total (Additional)	64,920	33,854	50,493	98,774	115,359

Table III-1-10 Major Hydraulic Power Stations under Construction

	Installed Capacity (MW)	Energy Generated (GWh)		Year of Commissioning
		Average	Firm	
Karakaya (#1-6)	1,800	7,354	6,060	1985-1987
Keban (#1-8)	1,354	6,287	4,906	1974-1981
Oymanpinar (#1-4)	540	1,620	412	1982-1983
Hasan Ugurlu (#1-4)	500	1,217	820	1979-1983
Aslantas	138	569	360	1981
Kokluce	90	584	576	1980
Adiguzel	60	280	150	1981
Suat Ugurlu	46	273	206	1980
Dogankent B	40	157	-	1979
Karacaoren 1	30	142	84	1985

1.2.2 Demand and Supply Balance

From the forecast results according to the macro-method and the supply plan described in 1.2.1, the balance sheet predicted for electric energy up to 1992 will be indicated in Table III-1-11. The general trends of demand and supply balance are graphically indicated in Figs. III-1-6 and III-1-7.

As is clearly seen in the table and graphs, the shortage of energy from 1978 to 1980 will be especially prominent, and the electric power situation will be fairly tight. And from 1981 to around 1987, if the present development plans are smoothly pushed forward, it will be possible for electric power to be supplied stably, with a fair amount of allowance. Further, after 1987, the demand and supply balance will become to harmonious one.

DSI has forecast the year of commissioning of the Kepez Project to be in 1991, and it is judged appropriate to start this Project at that time, from the standpoint of the balance of demand and supply.

Table III-1-11 Energy Balance Estimated

Year	Energy Demand Estimated: (1)	Available Energy Supplied		Allowance			
		Firm: (2)	Average: (3)	Firm		Average	
				GWh: (4) (2)-(1)	% (4)/(1)	GWh: (5) (3)-(1)	% (5)/(1)
	(GWh)	(GWh)	(GWh)				
1977	20,565 (Recorded)	19,567	21,026	-998	-4.9	461	2.2
1978	22,900	19,567	21,026	3,333	14.6	-1,874	-8.2
1979	25,600	20,557	22,120	-5,043	-19.7	-3,480	-13.6
1980	28,500	28,189	30,207	-311	-1.1	1,707	6
1981	32,500	38,591	41,470	6,091	18.7	8,970	27.6
1982	36,200	44,895	49,207	8,695	24	13,007	35.9
1983	41,000	48,837	53,468	7,837	19.1	12,468	30.4
1984	46,500	56,255	62,541	9,755	21	16,041	34.5
1985	51,300	56,647	63,894	5,347	10.4	12,594	24.5
1986	57,800	69,010	76,843	11,210	19.4	19,043	32.9
1987	67,400	77,155	85,249	9,755	14.5	17,849	26.5
1988	76,300	78,833	89,501	2,533	3.3	13,201	17.3
1989	84,900	85,998	97,980	1,098	1.3	13,080	15.4
1990	95,800	103,390	116,817	7,590	7.9	21,017	21.9
1991	104,100	108,397	124,010	4,297	4.1	19,910	19.1
1992	115,900	118,341	136,385	2,441	2.1	20,485	17.7

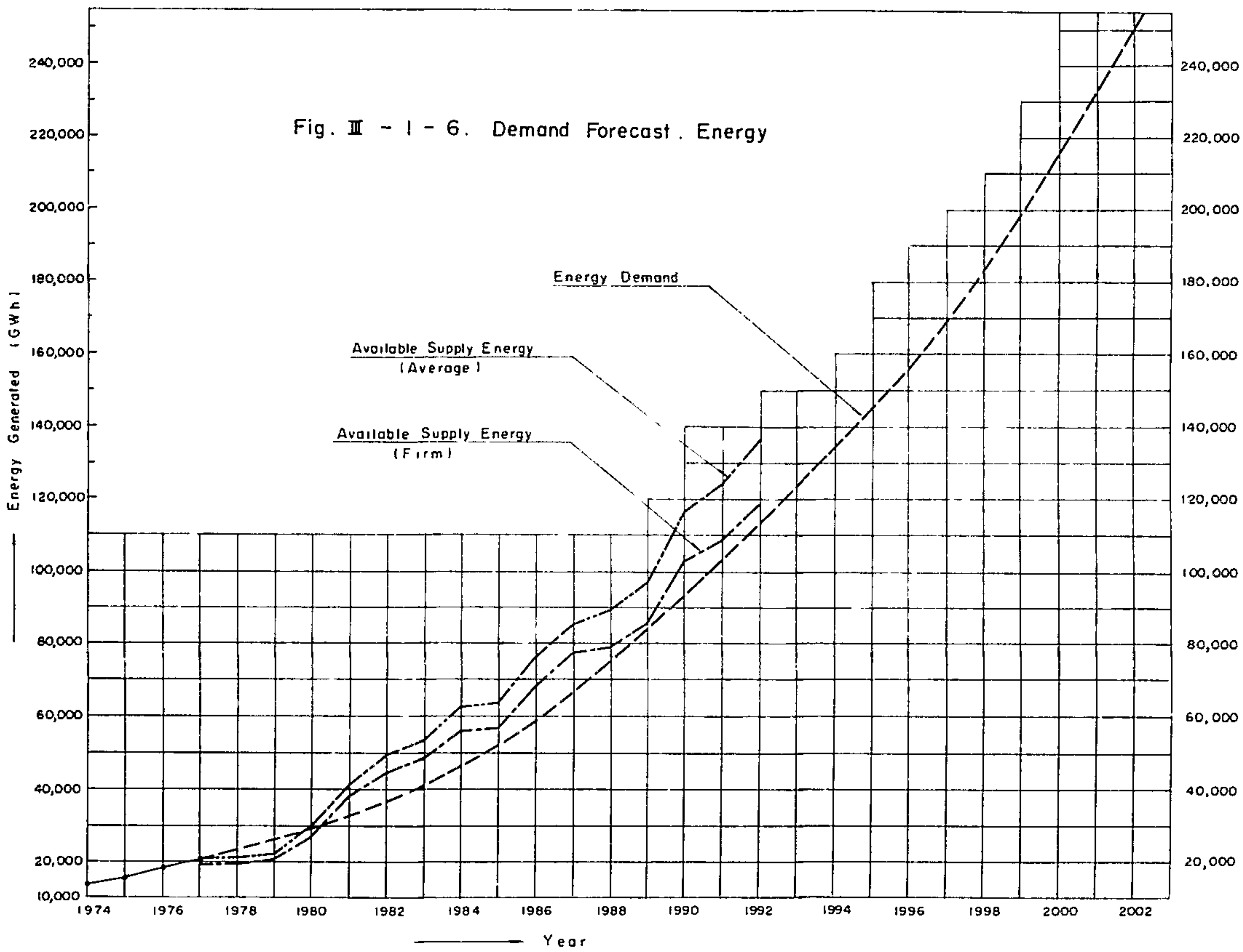


Fig. III - 1 - 6. Demand Forecast. Energy

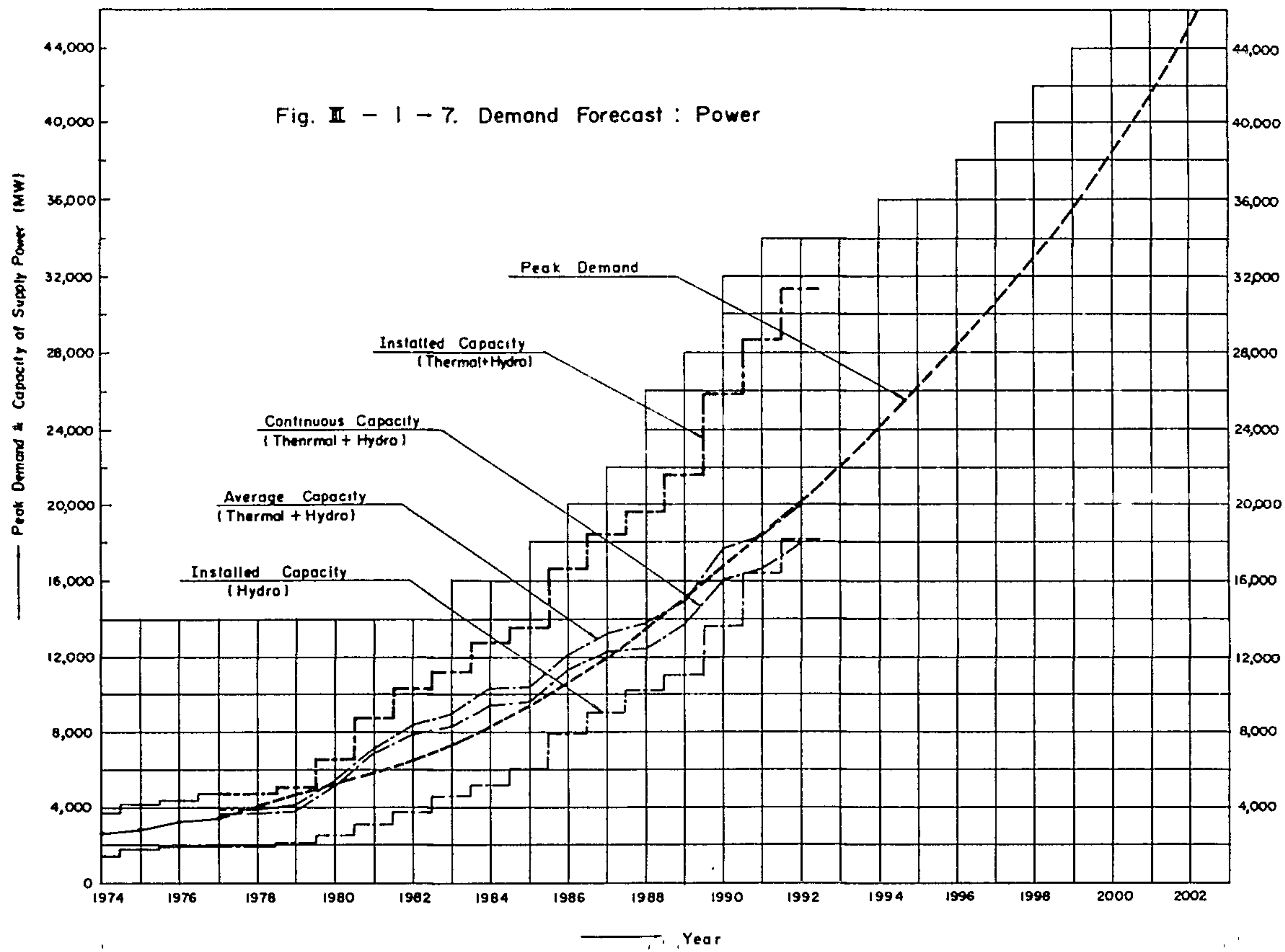


Fig. III - 1 - 7. Demand Forecast : Power

CHAPTER 2

DEVELOPMENT PROJECT

CHAPTER 2 DEVELOPMENT PROJECT

LIST OF FIGURE

CHAPTER 2 DEVELOPMENT PROJECT

2.1 OUTLINE OF KIZILIRMAK RIVER BASIN

The Kızılırmak River is the largest river in the Republic of Turkey which flows through Central Anatolia and flows into the Black Sea. The fountainhead of the Kızılırmak River is on Mt. Kızul (El. 2,160 m) 140 km east of the city of Sivas, the river is 1,355 km in length, and has a catchment area of 77,000 km^2 corresponding to 1/10 of the national territory.

The Kızılırmak River flows down through the Central Anatolian Plateau changing its course from west to southwest, and at a point 20 km north of the city of Nevsehir changes its course again in a northwest direction and flows into Hirfanlı Reservoir. Upon generation of maximum output of 96 MW at Hirfanlı Power Station with maximum available discharge of 196.5 m^3/sec and effective head of 60 m, the river flows down further changing its course north to northeast and then enters a gorge in the mountainous area running parallel to the Black Sea coast. The project site is situated where the river enters the gorge. The end of the backwater of Altınkaya Reservoir presently being prepared for start of construction is at this site.

After passing beyond Altınkaya Dam the gorge suddenly widens and the river gently flows through the broad Bafra Plain to pour into the Black Sea.

The mean elevation of the river basin of this Project is 1,100 m, and the annual mean temperature and precipitation are 11°C and 400 mm, respectively. Consequently, the river basin is mostly in the form of steppe with little vegetation, and the average inflow at the project site is 152 m^3/sec (0.24 m^3/sec per 100 km^2).

2.2 PRESENT STATE OF KIZILIRMAK RIVER DEVELOPMENT

It is said that the hydroelectric potential of the Kızılırmak River is 6,300 GWh, but only Hirfanlı Dam and Power Station and Kesikköprü Power Station with total output of 172 MW (annual energy generated 500 GWh) is presently developed, so that it may be said the river is still undeveloped.

Preparations are now going on for construction of the Altınkaya Project 65 km upstream from the mouth of the river. When the Altınkaya Project and this Project have been completed, 60% of the potential will have been developed.

The hydroelectric power development projects on the Kızılırmak River according to the master plan are the 24 sites with annual energy production of 6,300 GWh as shown in Fig. III-2-1.

2.3 OUTLINE OF DEVELOPMENT PROJECT

2.3.1 Outline of Development Project Site

The Kepez project site is located at the boundary between the Central Anatolia Region and the Black Sea Coastal Region and is 270 km northwest of Ankara and 125 km upstream from the mouth of the river. Further, from the fact that this project site is at the end of the backwater of Altınkaya Reservoir, it may be said to be an ideal site from the viewpoint of effective utilization of the river.

The major industry in the project area is agriculture, and with the town of Durağan as the center, crops such as wheat, tobacco and sugar beet are cultivated in the plain area while a feature is that rice fields are spread out on both banks of the Kızılırmak River.

Accessibility to the project site is extremely good and the main equipment can be brought in via the port of Samsun. The road connecting Samsun Port and the porject site is a national highway of 170 km passing through the town of Havza to Durağan. The stretch of 30 km from Durağan to the project site is connected by a provincial-class road.

The annual mean temperature at the project site is 13°C (maximum 40°C, minimum -16°C), with annual precipitation low at 400 mm, and the climate is that of a Central Anatolian Plateau type.

The river gradient near the project site is gentle at 1:350 with the width of the river suddenly expanding immediately upstream of the dam site, and the site is an ideal one for a reservoir-type power station with good water storage efficiency of 55×10^6 m^3 per meter of storage depth, while the downstream of the dam site is a gorge with both banks comprising steep cliffs.

The annual average inflow at the dam site is 152 m^3/sec, with 67% of the annual inflow concentrated in the 4-month period of snowmelt in March and the following wet season of April to June, while the inflow is decreased to 30% of the annual average inflow in the dry season of August, September and October. Because of this, it may be said the matter of great importance in the hydro-electric development scheme is to store and regulate the inflow of large seasonal variation in the reservoir aiming to average out the available discharge.

The suspended load contained in the inflow is an annual average of 6,600 ppm, this suspended load consisting of sand, silt and clay are produced through erosion of the ground surface during rainfall, landslides, and erosion of deposits at both sides of rivers by river waters.

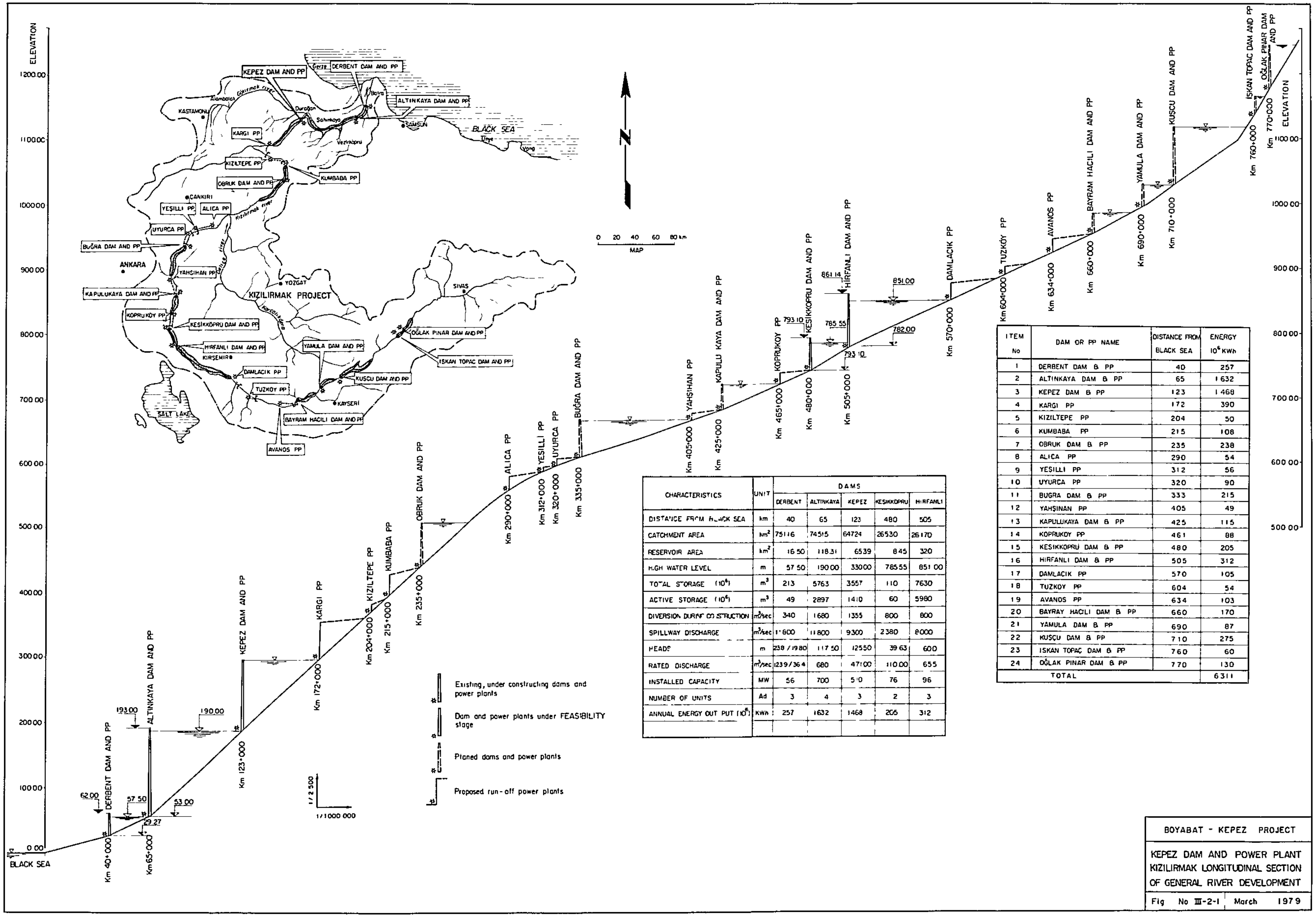
The geology of the surroundings of the reservoir shows distributions of Paleozoic and partially Mesozoic crystalline shist, limestone, Mesozoic diabase, and Cenozoic sedimentary rocks. The surroundings of the reservoir are made up mostly by crystalline schist with limestone intercalated in the forms of blocks and lenses. The bedrock at the dam site consists of limestone intercalated in the form of a block in the crystalline schist.

Items requiring compensation may be broadly divided into rice fields spread out at both banks of the river, scattered dwellings, and roads connecting these dwellings, and if the normal water level were to be increased above 330 m, submergence of rice fields distributed widely near the end of the backwater of the reservoir will occur and the compensation cost will be increased.

2.3.2 Outline of Kepez Hydroelectric Development Project

The hydroelectric power development project consists of constructing a concrete gravity-type dam of height of 195 m on the Kızılırmak River at a location where the Anatolian Plateau and the Black Sea Coastal Region join each other, regulating stored river water with an effective storage capacity of $1,410 \times 10^6$ m^3, and using this stored and regulated water for generation of a maximum output of 510 MW and annual energy production of 1,470 GWh with maximum available discharge of 471 m^3/sec and effective head of 125.5 m. The water utilized for power generation will directly flow into Altınkaya Reservoir and will again be used for power generation of a maximum output of 700 MW at Altınkaya Power Station.

The electric power generated at Kepez Power Station is to be stepped up to 380 kV by main transformers, conducted to a switchyard, and transmitted to Çankırı Switchyard and Ereğli Substation by a three-circuit transmission line.



CHARACTERISTICS	UNIT	DAMS				
		DERBENT	ALTINKAYA	KEPEZ	KESIKKOPRU	HIRFANLI
DISTANCE FROM BLACK SEA	km	40	65	123	480	505
CATCHMENT AREA	km^2	75116	74515	64724	26530	26170
RESERVOIR AREA	km^2	16 50	118.31	65 39	8 45	320
HIGH WATER LEVEL	m	57 50	190 00	330 00	785 55	851 00
TOTAL STORAGE (10^6)	m^3	213	5763	3557	110	7630
ACTIVE STORAGE (10^6)	m^3	49	2897	1410	60	5980
DIVERSION DURING CONSTRUCTION	m^3/sec	340	1680	1355	800	800
SPILLWAY DISCHARGE	m^3/sec	11800	11800	9300	2380	8000
HEADS	m	238 / 19 80	117 50	125 50	39 63	600
RATED DISCHARGE	m^3/sec	1239 / 36 4	680	471 00	110 00	655
INSTALLED CAPACITY	MW	56	700	510	76	96
NUMBER OF UNITS	Ad	3	4	3	2	3
ANNUAL ENERGY OUT PUT (10^6)	KWh	257	1632	1468	205	312

ITEM No	DAM OR PP NAME	DISTANCE FROM BLACK SEA	ENERGY 10^6 KWh
1	DERBENT DAM & PP	40	257
2	ALTINKAYA DAM & PP	65	1632
3	KEPEZ DAM & PP	123	1468
4	KARGI PP	172	390
5	KIZILTEPE PP	204	50
6	KUMBABA PP	215	108
7	OBRUK DAM & PP	235	238
8	ALICA PP	290	54
9	YESILLI PP	312	56
10	UYURCA PP	320	90
11	BUGRA DAM & PP	333	215
12	YAHŞINAN PP	405	49
13	KAPULUKAYA DAM & PP	425	115
14	KOPRUKOY PP	461	88
15	KESIKKOPRU DAM & PP	480	205
16	HIRFANLI DAM & PP	505	312
17	DAMLACIK PP	570	105
18	TUZKOY PP	604	54
19	AVANOS PP	634	103
20	BAYRAY HACILI DAM & PP	660	170
21	YAMULA DAM & PP	690	87
22	KUŞÇU DAM & PP	710	275
23	ISKAN TOPAÇ DAM & PP	760	60
24	OĞLAK PINAR DAM & PP	770	130
TOTAL			6311

BOYABAT - KEPEZ PROJECT

KEPEZ DAM AND POWER PLANT
KIZILIRMAK LONGITUDINAL SECTION
OF GENERAL RIVER DEVELOPMENT

Fig No III-2-1 | March 1979

CHAPTER 3

HYDROLOGY

CHAPTER 3 HYDROLOGY

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CHAPTER 3 HYDROLOGY

3.1 OUTLINE OF WEATHER CONDITIONS AND HYDROLOGIC CONDITIONS

The Kepez Hydroelectric Power Development Project site is situated at the boundary between the Central Anatolia and the Black Sea Coastal Region. The catchment area is 65,000 km^2 with the greater part consisting of steppes with annual precipitation of 400 mm, and mean temperature of about 11°C.

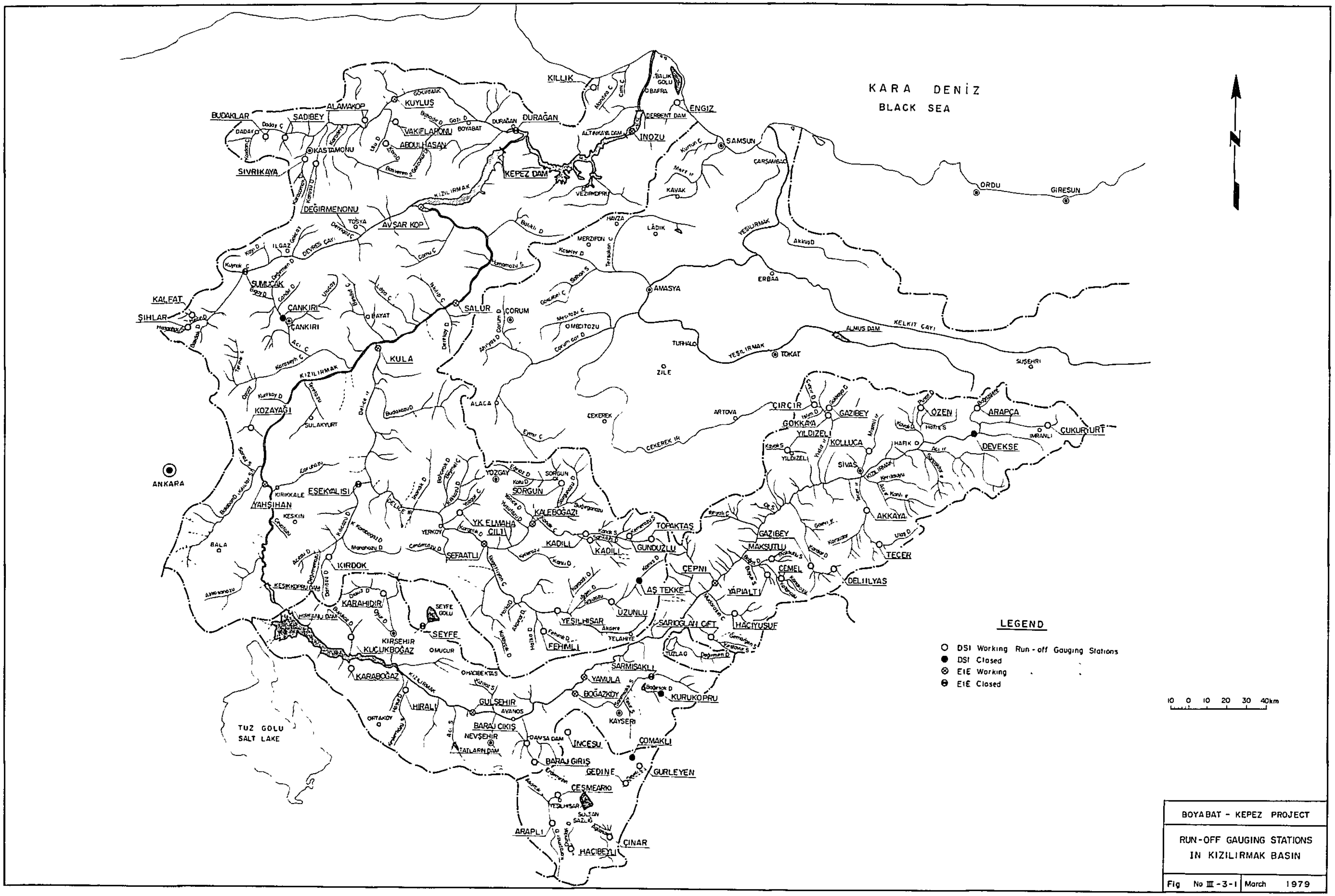
The annual run-off at the project site is 4.81 x 10^9 m^3, the specific run-off per 100 km^2 being very small at 0.24 m^3/sec. The annual precipitation is 400 mm, the mean temperature 13°C, and the number of days of precipitation about 120 days annually.

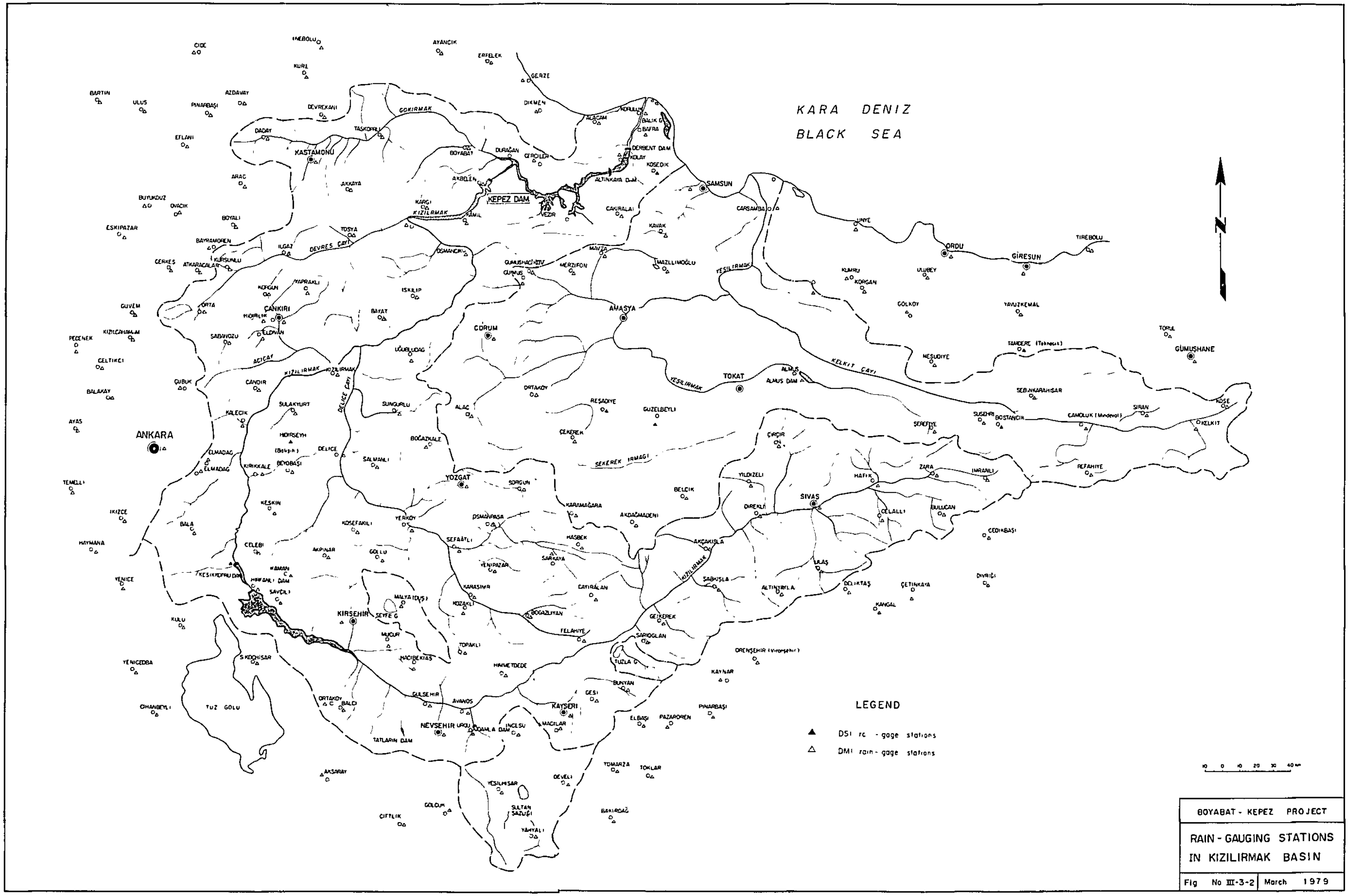
3.2 RUN-OFF GAUGING STATIONS AND METEOROLOGICAL GAUGING STATIONS

There are numerous run-off gauging stations in the Kızılırmak River Basin including tributaries. The locations are as shown in Fig. III-3-1.

Further, there are approximately 120 meteorological gauging stations in the Kızılırmak River Basin. Among these, the major stations at Sivas, Kayseri, Kırsehir, Çankırı and Kastamonu are taking measurements of precipitation, temperature, atmospheric pressure, humidity, cloudiness, wind, evaporation, and ground temperature. At 13 stations headed by Boyabat, Kargı and Osmancık, precipitation, temperature, humidity, cloudiness, wind, and atmospheric pressure are being measured, while the many other stations are measuring precipitation.

The locations of the meteorological gauging stations are as indicated in Fig. III-3-2.


KARA DENİZ
BLACK SEA
ANKARA
TUZ GOLU
SALT LAKE
KIZILIRMAK
YEŞILIRMAK
KELKIT ÇAYI
LEGEND
DSI Working Run-off Gauging Stations
DSI Closed
EIE Working
EIE Closed
10 0 10 20 30 40km
BOYABAT - KEPEZ PROJECT
RUN-OFF GAUGING STATIONS
IN KIZILIRMAK BASIN
Fig No III-3-1 March 1979



KARA DENIZ
BLACK SEA
LEGEND
DSI rc - gage stations
DMI rain - gage stations
BOYABAT - KEPEZ PROJECT
RAIN - GAUGING STATIONS IN KIZILIRMAK BASIN
Fig No III-3-2 March 1979