THE REPUBLIC OF TURKEY

FEASIBILITY REPORT
ON
BESKONAK HYDROELECTRIC POWER DEVELOPMENT PROJECT

Volume 1

November 1983

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the Republic of Turkey, the Government of Japan decided to conduct a survey on the Beskonak Hydroelectric Power Development Project and entrusted the survey to the Japan International Cooperation Agency (JICA). The JICA sent to Turkey a survey team headed by Mr. S. Yuzawa in February - March and October 1982.

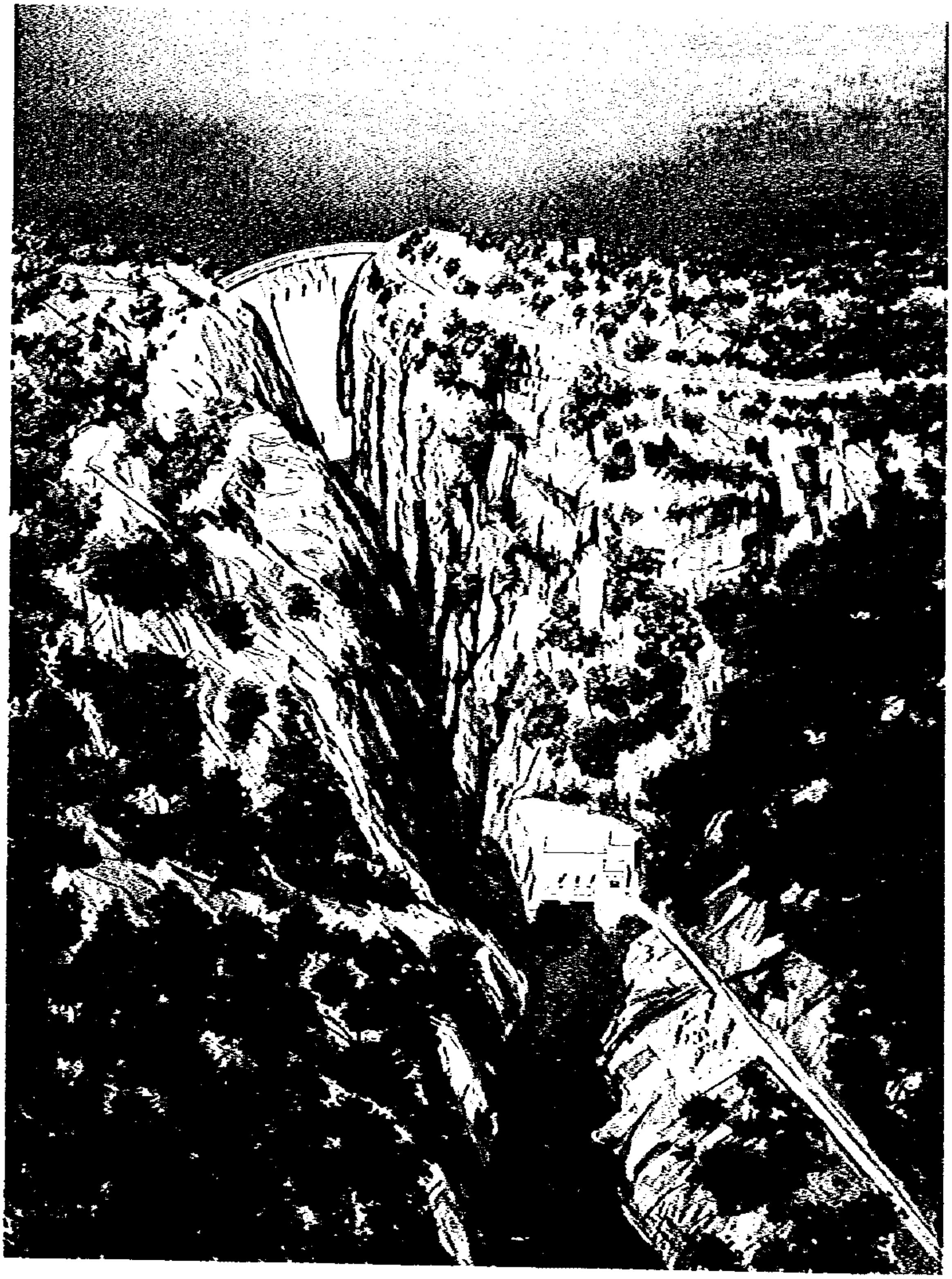
The team exchanged views with the officials concerned of the Government of Turkey and conducted a field survey in Beskonak Project area near Antalya. After the team returned to Japan, further studies were made and the present report has been prepared.

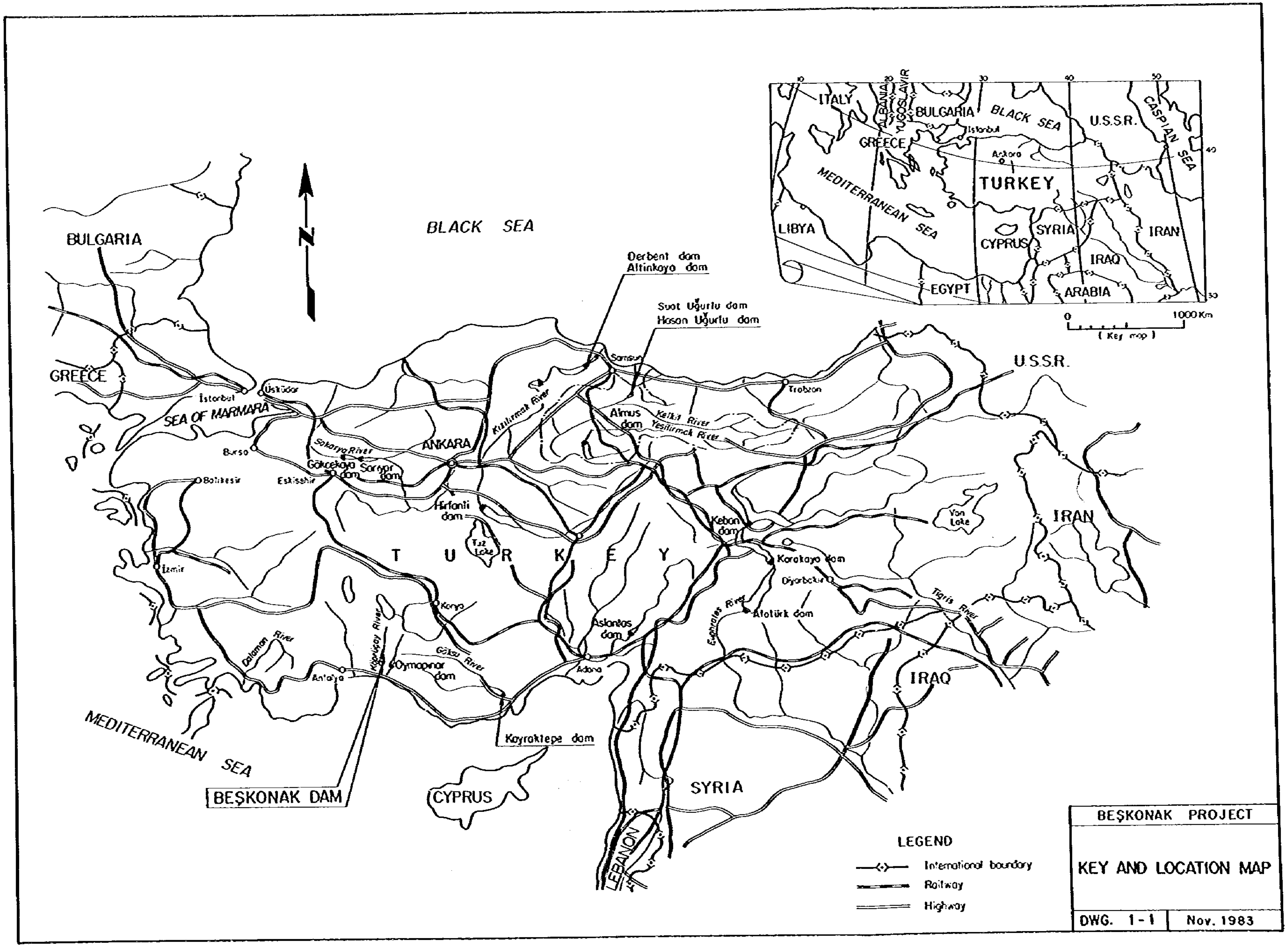
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

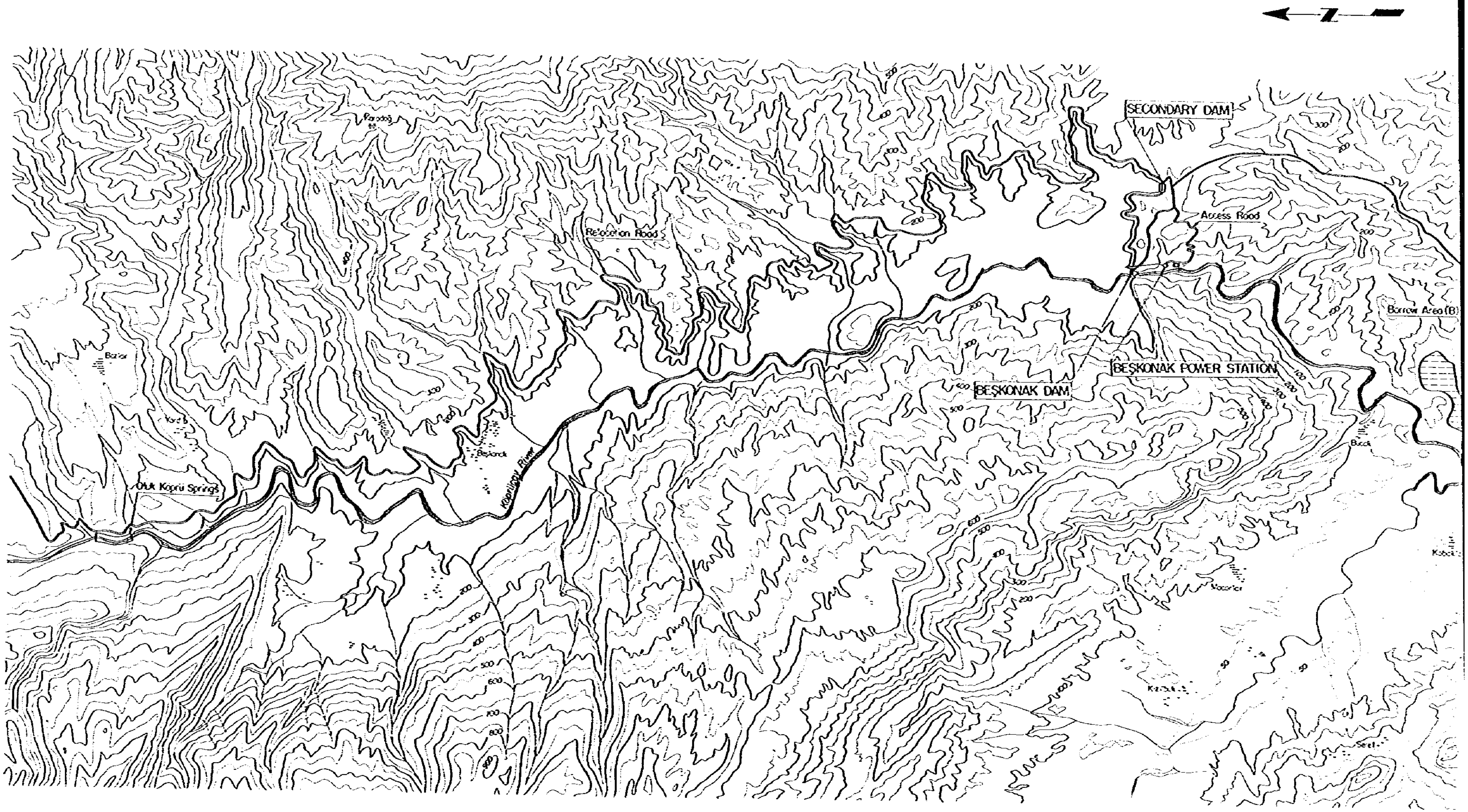
I wish to express my deep appreciation to the officials concerned of the Government of the Republic of Turkey for their close cooperation extended to the team.

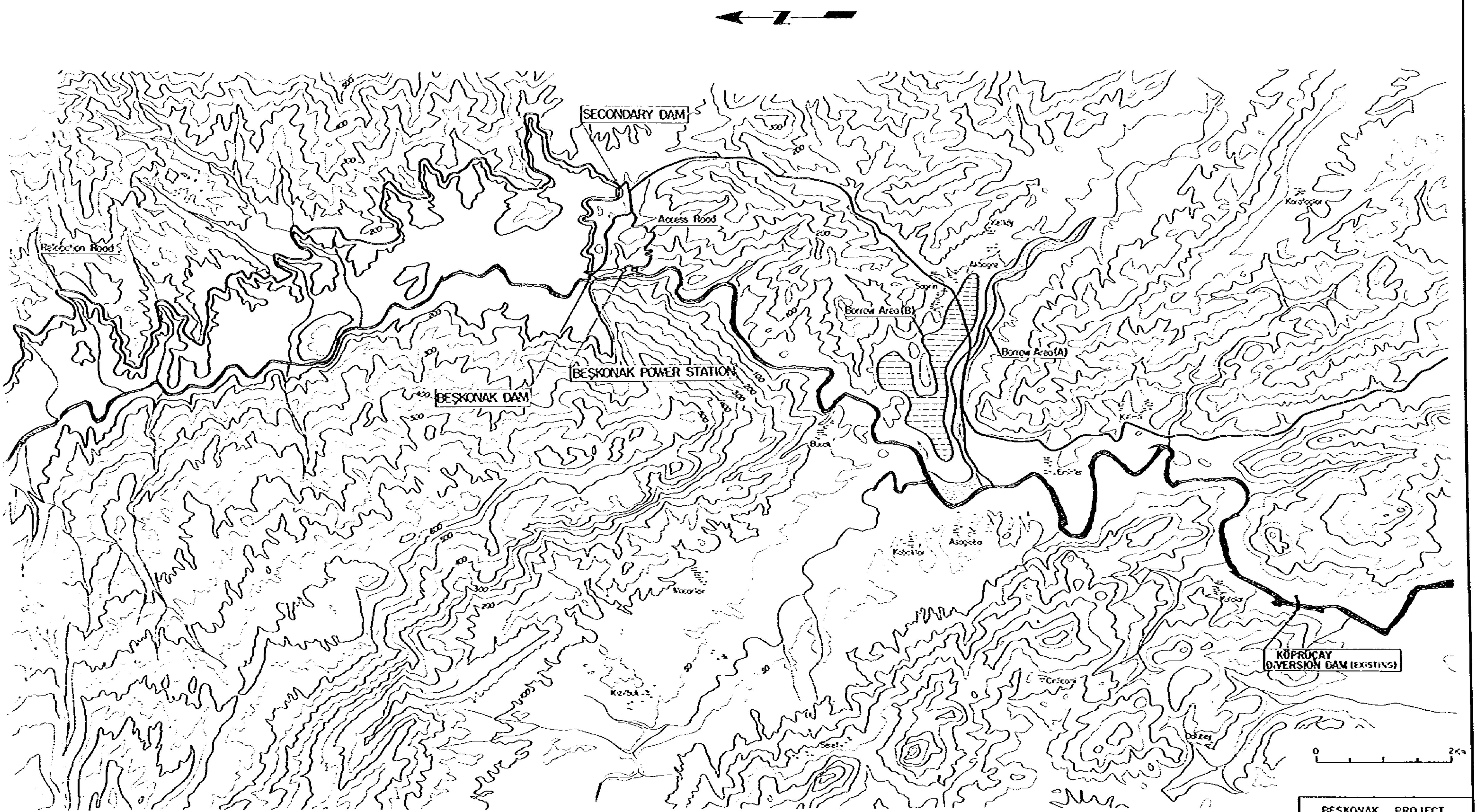
Tokyo, November 1983

Keisuke Arita
President
Japan International Cooperation Agency




BLACK SEA
BULGARIA
GREECE
SEA OF MARMARA
MEDITERRANEAN SEA
CYPRUS
SYRIA
LEBANON
IRAQ
IRAN
U.S.S.R.
T U R K E Y
ANKARA
İstanbul
Üsküdar
Bursa
Balıkesir
Eskişehir
İzmir
Antalya
Konya
Adana
Samsun
Trabzon
Diyarbakır
Van Lake
Tuz Lake
Derbent dam
Altinkaya dam
Suat Uğurlu dam
Hasan Uğurlu dam
Almus dam
Kelkit River
Yeşilırmak River
Kızılırmak River
Sakarya River
Gökçekaya dam
Sarıyar dam
Hirfanlı dam
Keban dam
Karakaya dam
Atatürk dam
Euphrates River
Tigris River
Aslantaş dam
Göksu River
Oymapınar dam
Köprüçay River
Dalaman River
Kayraktepe dam
BEŞKONAK DAM
ITALY
ALBANIA
YUGOSLAVIA
BULGARIA
GREECE
Istanbul
Ankara
TURKEY
BLACK SEA
U.S.S.R.
CASPIAN SEA
MEDITERRANEAN SEA
LIBYA
CYPRUS
SYRIA
IRAN
IRAQ
EGYPT
ARABIA
0
1000 Km
(Key map)
LEGEND
International boundary
Railway
Highway
BEŞKONAK PROJECT
KEY AND LOCATION MAP
DWG. 1-1
Nov. 1983


SECONDARY DAM
Access Road
Relocation Road
Borrow Area (B)
BEŞKONAK POWER STATION
BEŞKONAK DAM
Beşkonak
Köprüçay River
Oluk Köprü Springs



BEŞKONAK PROJECT

GENERAL LAYOUT

DWG. 1-2 | Nov. 1983

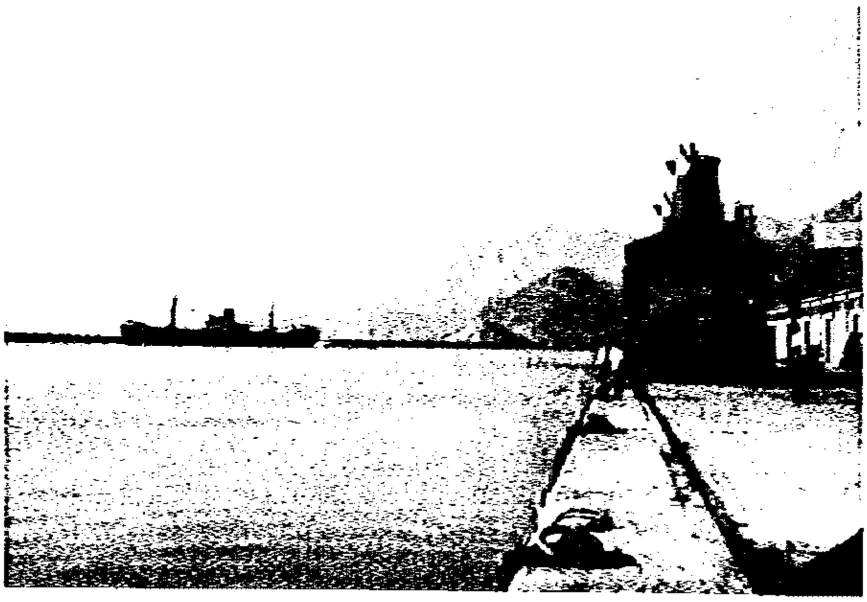
Beskonak Dam Site
— Looking from the upstream side —

Beskonak Dam Site
– Looking downstream –

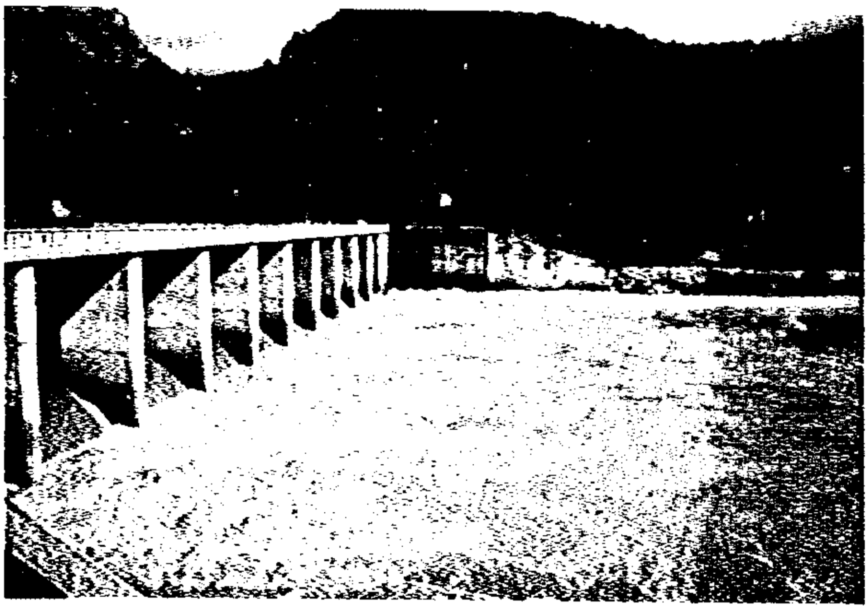
Secondary Dam Site
– Looking from the downstream side –

Oluk-köprü Springs

Site for Power Station
— Looking from the downstream side —



Antalya Port



Köprüçay Diversion Dam

FORWARD

The fruits of feasibility study on the Beskonak Project are presented in 2 volumes as follows:

- * FEASIBILITY REPORT —— Summary ——
- * VOLUME 1

  FEASIBILITY REPORT —— Main —— comprising 15 chapters

- * VOLUME 2 —— Appendix ——

CONTENTS

CHAPTER 15 STUDY ON KISIK DAM AND POWER STATION PROJECT

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS AND RECOMMENDATIONS

The Project is a hydroelectric power development scheme to be implemented at the Beskonak site located at the downstream part of the Köprücay River in the southern Turkey which flows into the Mediterranean Sea.

Judging from the studies performed up to the present, it is concluded that the Project is feasible from both technical and economic viewpoints.

While, since the project site is located in an area where calcareous rocks are distributed, the reservoir watertightness is the most important problem, which governs the possibility of the Project realization. Accordingly in order to confirm the reservoir watertightness evaluated in this report, it is recommended further to carry out additonal investigations at the final design stage.

The conclusions and recommendations are stated in full as follows:

CONCLUSIONS

1. The growth rate in electric power demand in Turkey has declined for the past three or four years and this may be said to clearly reflect the effects of the oil crisis. However, the potential power demand is strong, and with the recent trend of an economic upturn in addition, much is expected of satisfying this power demand.

   The Government of Turkey, in order to satisfy the power demand, is presently proceeding with planning and construction of large-scale power projects utilizing indigenous resources. However, because of the slowdown in the domestic economy triggered by the oil crisis, delays are being seen in construction and planning of the power projects, and whether supply capability can be secured is still unpredictable.

   As a result of the demand forecast made in this study, it is estimated that the power demand hereafter will increase at an annual rate of approximately 10%, becoming 8,100 MW and 45,400 GWh at generating end in 1985, respectively 1.65 and 1.66 times the figures in 1980, and 12,800 MW and 71,600 GWh at generating end in 1990.

2. Assuming that the power demand and supply plan presently set up proceeds as scheduled, it is appropriate for the Project to be incorporated around 1993 in consideration of the required period for additional investigation, final design and construction. Further, it is much expected to advance the commencement of the Project by completing the additional investigation and final design in a short period. This Project is an advantageous scheme for development since required construction funds is not enormous because of a medium scale, and moreover, that it is close to a power consumption area.

3. The Köprücay Conglomerate is mainly distributed at the right bank of the reservoir and the Beskonak Formation at the left bank. As a result of the study of the reservoir watertightness, the leakage through karstified Köprücay Conglomerate probably occurrs only by passages in the vicinity of the dam site to reach the downstream area.

The Köprücay Conglomerate in the vicinity of the dam site is distributed over a wide area of 3.5 km on the right bank side and 1.5 km on the left bank side, and the evaluation of the permeability of this Köprücay Conglomerate is the most important matter in study of the reservoir watertightness.

Judging from the investigation data obtained up to the present, this Köprücay Conglomerate has been subjected to carstification above EL. -120 m with small-scale cracks comprising a three dimensional network, and this is considered to be the cause of reduction in watertightness capability. However, since leakage passages and continuous solution cracks of relatively large size have not been confirmed, this conglomerate is considered as macroscopically a homogeneous medium with regard to permeability.

As a result of numerical analyses of seepage flows, including cases of continuous solution cracks existing, it was judged that the leakage from the reservoir in the vicinity of the dam site could be reduced by providing a grout curtain. Curtain grouting was planned to be of a range of 2 km long, and the curtain area of 380,000 m^2.

It is considered that some amount of leakage cannot be avoided even with this grout curtain, but it is judged that with such amount of leakage there would be no hindrance to function of the reservoir filling and to safety of the Beskonak dam of concrete type.

4. Installed capacity of 200 MW is the optimum scale for the Project. The power station is planned to be provided with two units, large and small, of 155 MW and 45 MW, and irrigation water for the downstream area is to be secured through 24-hour power discharge from the smaller unit during the irrigation season (June - September). While, it was also studied to provide two units of 100 MW. This case is favorable for operation and maintenance of the power station. However, unless the regulating pondage is provided downstream, this is undesirable for turbines because of small discharge and low efficiency during the irrigation season.

In order to provide a regulating pond for the Beskonak project, two cases are considered, such as a case to rebuild the existing Köprücay diversion dam and the other case to construct the Kisik dam. In rebuilding the existing diversion dam, new gates are added to the existing structures and the power discharges from the Beskonak power station are regulated. There is no detail information about the dam foundation and piers. Accordingly the case to rebuild the existing diversion dam was not considered in this report. However, it should be studied in detail at the final design stage concerning the rebuilding of the existing Köprücay diversion dam.

It is judged that it would not be appropriate for the Kisik project to be developed simultaneously with the Beskonak project because the benefit-cost ratio (B/C) would be lower compared with the proposal to develop the Beskonak project independently, and moreover, because there would be conflict with the irrigation program already being carried out by DSI in the project area. However, there is a possibility for development of the Kisik project in the future, after these problems have been resolved.

5. Since the Beskonak dam site is located at an extremely narrow gorge of river width of 15 - 20 m and with the river banks on both

sides rising almost straight up, a dam type other than concrete would not be appropriate. Accordingly, a comparison study was made of the two alternatives of concrete arch dam and arch gravity dam, including layouts of spillways, and as a result it was judged that an arch gravity dam would be suitable both economically and technically.

A secondary dam is to be constructed at the saddle of Hortu Creek.

The power station site was selected at the confluence with the Hortu Creek approximately 600 m downstream of the dam site. The connections from intakes to the power station are to be made by two pressure tunnels.

6. It is planned that the energy generated of the Project is supplied to Antalya region through Kepez substation. As the result of system analysis and economic comparison of the five alternatives, the transmission line was selected to be connected to the 380 kV line between Kepez and Oymapinar scheduled to be expanded by the time of start-up of the Beskonak project.

According to the analysis of 380 kV transmission system, there is no problem from the standpoint of the power system stability with regard to the power transmission from Beskonak power station. But various problems have arisen in the power system accompanying the increase in the scale of power demand, since the power consumption areas (Western Turkey) are approximately 1,000 km distant from the power source area (Eastern Turkey).

In proceeding with the expansion plans for transmission lines in step with the electric power development program in Eastern Turkey, studies are required including introduction of the next higher voltage lines.

7. The total investment required for development of the Project would be 35,478 million TL at March 1982 prices, of which the domestic currency requirement is estimated to be 27,468 million TL, and the foreign currency requirement 8,010 million TL.

The construction period of the Project is estimated to be six years.

8. In order to examine the financial soundness, the Project was evaluated firstly by comparing financial internal rate of return (FIRR) based on market prices with interest rate on borrowings assumed for the Project.

Next, Price modifications were made on the market prices employed in the financial evaluation so as to obtain accounting prices, and based on these accounting prices, the economic internal rate of return (EIRR) was obtained. The economic effect of the Project was evaluated by comparison of EIRR and the opportunity cost of capital in Turkey.

The FIRR of the Project is estimated to be 9.4%. This value is advantageous compared with the estimated interest rate on borrowings of 9.14%. On the otherhand, the EIRR of the Project is 12.9%, and this value exceeds the opportunity cost of capital (12%) in Turkey. This rate also exceeds 10% which is the criterion for loans from international financing institutions such as the World Bank and the Asian Development Bank.

Consequently, it is concluded that the Project is feasible from financial and economic points of view.

RECOMMENDATIONS

The most important problem concerning the Project is the watertightness of the reservoir. Based on the investigation data obtained up to the present, the problem was studied mainly from hydrogeological aspect, and in addition, it was approached by the numerical analysis concerning the leakage from the reservoir.

The numerical analysis is one technical approach for resolving the problem, and a more accurate hydrogeological grasp of the dam site vicinity is indispensable.

However, it was judged that these obtained data were not enough to perform the thorough study on the state of karstifications of Köprücay Conglomerate distributed in the vicinity of the dam site.

Accordingly, in order to implement the Beskonak project in the future, additional investigations described in 7.6 should be made at the final design stage and efforts should be continued to locate leakage passages and to study the range of the grout curtain qualitatively and quantitatively. The results of the additional investigations must be amply reflected when performing the final design.

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

LIST OF TABLE

CHAPTER 1 INTRODUCTION

The Government of Turkey has been implementing a program for planned economy since 1963, the goal of which is to industrialize the structure of the country which had mainly been supported by agriculture, and efforts are being continued for the economic growth of the country. For this purpose it is absolutely necessary to secure energy resources. In this country where petroleum resources are lacking, an extremely high priority has been placed on development of indigenous energy resources for achievement of the economic growth targeted.

In the 4th Five-Year Plan (1979-1983) which was initiated in 1979, a GNP growth rate of 8% is aimed for, and for this purpose the first priority is given to the electric power development sector of the infrastructure. However, the investment program of the state has not proceeded as planned with delays in the realization of electric power development projects. The growth rate of demand up to 1981 has been held to about 4% annually. For this country which has little petroleum resources, the rise in prices and instability of supply of oil since 1973, and the accompanying stagnation in the world economy have had severe and long lasting adverse effects.

Meanwhile, the installed capacity for electric power generation which was 4,869 MW in 1978 became approximately 5,300 MW in 1980, while the annual energy consumption which was 21,700 GWh was expanded to 23,300 GWh. However, the power was still short of supply and the increasing demand had to be coped with through planned outages and importing of electric power from Bulgaria and the Soviet Union. The supply capability was increased slightly with the completion of an expansion project of Keban Hydroelectric Power Station in the fall of 1981, and planned outage in Ankara, the capital city of Turkey, has been discontinued. With the recent favorable turnabout in the Turkish economy, the Government has again begun to stress both early completion of electric power facilities under construction and vigorous planning of new projects. The construction of them are all extremely delayed from the original schedules, and it is thought so far ahead for a balance to be achieved between supply and demand in energy for the country.

1.1 Antecedents

This Project has been studied at the reconnaissance level by the General Directorate of State Hydraulic Works (DSI) since 1965, with the aim of supplementing the supply of electric power of which there had been a constant shortage in Turkey. In 1975 the Project was incorporated in the long-range development program with the scale of approximately 100 MW. Since 1965, wide-range investigations, such as preparation of topographical maps, geological explorations by boring and test adits, pressure tests, etc. have been carried out by DSI and the Power Resources Surveying Administration (EIE).

As a result of these investigations, the most important problem to be resolved is judged to be the watertightness of the reservoir, in effect, a hydrogeological problem remains to be cleared up. As will be dealt with in a later chapter, this project area belongs to a calcareous rock zone, and calcareous conglomerate is distributed continuously to a fairly great depth at the right bank of the dam site. This conglomerate comprises stratums with high permeability. Consequently, the degree to which leakage from the reservoir can be technically and economically prevented, or can be allowed, is not just a problem from the viewpoint of geology, but is considered a deciding factor regarding whether or not the entire Project would be viable.

The Turkish Government, in order to meet the increasing demand in electric power, is proceeding with selection of projects to be developed in succession to the various hydroelectric projects presently under construction. The Government requested the Japanese Government by a letter dated July 2, 1981 to make a feasibility study on this Project, as a link of electric power projects which are relatively close to power consumption areas while not requiring huge amounts of construction funds.

The Japanese government, in response to the request, dispatched a Preliminary Survey Mission headed by Shizuo Kishida, Director, Japan International Cooperation Agency (JICA), to the Republic of Turkey for exchanging opinions with the Turkish Government regarding the request and for carrying out general survey of the project area. The Japanese Government, on receiving the report of the Survey Mission, decided to proceed with a feasibility study for the Project. The Japanese Government invited competitive bidding to decide the consultant to carry out the feasibility study, and as a result, the Electric Power Development Co., Ltd. (EPDC), with an extensive performance in the Republic of Turkey, was commissioned. As for the scope of works on the feacibility study, an agreement was reached and signed between Mr. Sabahattin Sayin, General Director of DSI, and Mr. Keiji Iimura, Chief, Resources Survey Section of JICA, on February 16, prior to commencement of investigations.

1.2 Scope of Work and Field Survey

Based on the abovementioned agreement concerning the contents of work, the Japanese Government, through JICA, dispatched the First Feasibility Study Survey Mission consisting of seven engineers of EPDC to the field for a period of 30 days from February 21 to March 22, 1982. The Mission carried out the survey work, collected various data, and exchanged opinions with engineers of the Turkish Government. The Mission, after returning to Japan, carried out various studies in the fields of hydrogeology, hydrology, development system and power system analysis. In May of 1982, the Mission submitted an additional investigation plan to the Turkish Government and made a recommendation for early implementation of various field tests related to leakage from the reservoir. While at the same time, it was requested that data be prepared concerning the topography, geology and compensation concerning the downstream regulating pond. The Survey Mission again visited Turkey from October 4 to 26, and collected additional data together with making a reconnaissance again of the Beskonak project area in the dry season.

Based on these obtained data, the Study was carried out in Japan until November of 1983, and this final report was completed. The principal studies in Japan were concerned with the items below thoroughly taking into consideration the characteristics of the Project.

- Hydrogeological study concerning leakage from the reservoir
- Hydrological study
- Optimum development scale and layout of the Project.
- Preliminary designs of structures
- Power transmission plan and power system analysis
- Construction cost estimation, funding plan and economic evaluation
- Study of regulating pondage (Kisik Project)

1.3 Survey Mission Members and Turkish Government Participants

The members of the Feasibility Study Survey Mission and the persons concerned on the Turkish Government side who cooperated in the survey, namely, the engineers of the DSI Planning Department, the TEK Planning & Coordinating Department, the EIE Head Office, the DSI 13th Regional Office, and the Kepez & Antalya Electric Power Company are the following:

Survey Mission Members 1st: February 21 - March 22, 1982
2nd: October 4 - 26, 1982

Shozo Yuzawa, Team Leader	Civil Engineer	EPDC
Tokuji Tezuka	Civil Engineer	EPDC
Hiroshi Kodani (First only)	Electrical Engineer	EPDC
Azuma Tsunoda (First only)	Civil Engineer	EPDC
Tosaku Okabayashi	Electrical Engineer	EPDC
Nobuo Hoshino	Geologist	EPDC
Takayuki Niimura	Civil Engineer	EPDC

Turkish Government Participants

Mr. Sabahattin Sayin	General Director, DSI
Mr. Ahmet Ünver	Assistant General Director, DSI
Mr. Ismet Bozkurt	Adviser, Foreign Relations, DSI
Mr. Sayhan Bayoğlr	Director, Planning Dept., DSI
Mr. Yüksel Sayines	Assistant Director, Planning Dept., DSI
Mr. Tuncay Soysal	Manager, Planning Sect. II, Planning Dept., DSI
Mr. Hasan Erke	Chief, Energy Studies Sect., Planning Dept., DSI
Dr. Mehmet Karadeniz	Chief, Hydro-geological Sect., Planning Dept., DSI
Mr. Ayhan Teker	Hydrometric Sect. I, Planning Dept., DSI
Mr. Ramazan Koşdere	Surveying engineer, DSI
Mr. Engin Atalay	Head, Geotechnical Services, Groundwater Dept., DSI
Mr. Abdülmesih Abidoğlu	Agriculture Economist, DSI
Mr. Şaban Yıldız	Geotechnical Services, Groundwater Dept., DSI
Mr. Erdōgan Demiryürek	Director, Planning & Coordinating Dept., TEK
Mrs. Sevinç Kıcıman	Assistant Director, Planning & Coordinating Dept., TEK
Mr. Mehmet Atacan	Assistant Director, Planning & Coordinating Dept., TEK
Mr. Turgut Akmil	Electrical Engineer, Planning & Coordinating Dept., TEK
Mr. Nezih Arran	Head, Transmission & Planning Sect., TEK
Mr. Kaler Sümerman	Engineering Geologist, EIE
Mrs. Şenel Tekel	Manager, Electrical Sect., EIE

The Late Mr. Niyazi Dereci	Director, 13th Regional Office, DSI
Mr. Hikmet Batu	Assistant Director, 13th Regional Office, DSI
Mr. Çetin Cakmak	Assistant Director, 13th Regional Office, DSI
Mr. Necati Sezen	Manager, Planning Sect., 13th Regional Office, DSI
Mr. Tunç Tarımcı	Geological Engineer, Planning Dept., 13th Regional Office, DSI
Mr. Candan Özçelik	Geological Engineer, Planning Dept., 13th Regional Office, DSI
Mr. Ünal Dogru	Geological Engineer, Planning Dept., 13th Regional Office, DSI
Mr. Necati Sayın	Agriculture Economist, 13th Regional Office, DSI
Mr. Mehmet Alı Dayıoğlu	Civil Engineer, 13th Regional Office, DSI
Mr. Ahmet Ünsal	General Director, Kepez & Antalya Electric Power Co., Inc.

1.4 Acknowledgements

Preparation of this Feasibility Study Report was made possible through the appreciable cooperation of the persons concerned in the Planning Department and the 13th Regional Office of DSI. The deepest gratitude is owed those persons who made utmost efforts in collection of data and coordination concerning the work of the Survey Mission during its stay in the Republic of Turkey. The Survey Mission also wishes to express its sincerest respects to the spirit of the late Mr. Niyazi Dereci, Director, 13th Regional Office, DSI, who was deceased during the period of this Study.

Table 1-1 Summary of Beşkonak Dam and Power Station

Item	Unit	Description
Location	-	on the Köprüçay River
Catchment Area	Km^2	1,980
Annual Inflow	10^6m^3	2,635
Design Flood	m^3/sec	4,500
Reservoir		
High Water Level	m	EL. 155.00
Low Water Level	m	EL. 134.50
Reservoir Area	Km^2	18.4
Gross Storage Capacity	10^6m^3	507
Effective Storage Capacity	10^6m^3	275
Diversion Tunnel		
Diameter	m	(No.1) D = 8.00, (No.2) D = 8.00
Length	m	(No.1) ℓ = 385.00 (No.2) ℓ = 416.00
Design Flood	m^3/sec	1,250
Beşkonak Dam		
Type	-	Concrete Arch-Gravity Dam
Elevation of Crest	m	EL. 160.00
Height of Dam	m	165.00
Length of Crest	m	160.86
Volume of Dam	m^3	488,000
Spillway		
Type	-	Dam Center Overflow with Radial Gates
Capacity	m^3/sec	4,500
Number of Gates	set	4
Size of Gate	m	(B x H) 12.00 x 10.00
Power Intake		
Control Gate	-	Roller Gate with Trashrack
Number of Gates	set	2

Item	Unit	Description	
Headrace Tunnel			
Type	-	Reinforced Concrete Lining	
Length	m	(No.1 ℓ = 240.45 (No.2)ℓ = 190.15	
Diameter	m	No.1 D = 7.30, No.2 D = 4.30	
Penstock			
Type	-	Embedded Steel Penstock	
Length	m	(No.1)ℓ = 357.45 (No.2)ℓ = 408.60	
Diameter	m	(No.1)D = 7.30 - 4.00 (No.2)D = 4.30 - 2.50	
Powerhouse			
Type	-	Semi-underground Type	
Secondary Dam			
Type	-	Rock-fill Dam with Impervious Core	
Elevation of Crest	m	EL. 161.00	
Height of Dam	m	31.00	
Length of Crest	m	237.00	
Volume of Dam	m^3	160,600	
Power Generation Facilities			
Number of Units	unit	2	
		(No.1)	(No.2)
Unit Capacity	kW	154,800	45,900
Turbine			
Number	unit	2	
Type	-	Vertical-shaft Francis Turbine	
		(No.1)	(No.2)
Normal Effective Head	m	105.00	105.00
Maximum Discharge	m^3/sec	167.00	50.00
Standard Output	kW	158,000	47,000
Revolving Speed	rpm	167	300

Item	Unit	Description	
Generator			
Number of Units	unit	2	
Type	-	3-Phase, Alternating Current Synchronous Generator	
		(No.1)	(No.2)
Output	kVA	172,000	51,000
Voltage	kV	14.4	14.4
Power Factor	%	90 (Lagging)	90 (Lagging)
Frequency	Hz	50	50
Revolving Speed	rpm	167	300
Main Transformer			
Number of Units	unit	3	
Type	-	Outdoor, Single Phase, Oil-Immersed, Forced-Oil Cooled with Forced-Air Cooled	
Capacity	kVA	75,000	
Voltage	kV	$380/\sqrt{3}$ / 14.4 kV	
Frequency	Hz	50	
Switchyard			
Nominal Voltage	kV	380	
Type of Circuit Breaker	-	Outdoor, AC, 3-phase, Gas Blast Circuit Breaker	
Transmission Line			
Number of Circuit	unit	1	
Nominal Voltage	kV	380	
Construction Period	month	72	
Annual Energy Production			
Total Energy	GWh	659.9	
Firm Energy	GWh	380.0	
Secondary Energy	GWh	279.9	
Project Cost			
Investment (9.5% interest rate)	10^6TL	35,478 (as of March, 1982)	

Item	Unit	Description
Financial Internal Rate of Return (F.I.R.R.)	%	9.4
Economic Internal Rate of Return (E.I.R.R.)	%	12.9

CHAPTER 2

GENERAL SITUATION IN THE REPUBLIC OF TURKEY

CHAPTER 2 GENERAL SITUATION IN THE REPUBLIC OF TURKEY

LIST OF TABLES

CHAPTER 2 GENERAL SITUATION IN THE REPUBLIC OF TURKEY

2.1 Geography

The Republic of Turkey is outlined by 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 national territory is in the shape of a rectangle of 650 km wide and 1,565 km long having an 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 the borders with Bulgaria and Greece, on the north by the Black Sea, and on the east by the borders with 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 of elevations under 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 which, the famous Tigris and Euphrates are international rivers which rise within the boundaries of Turkey.

Among natural lakes, Lake Van (3,700 km^2) in Eastern Anatolia, and Lake Tuz (1,500 km^2) in Central Anatolia are representative, and both are salt 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. Süphan (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 broadly divided, it is described below.

Black Sea Coast Region	:	Forest zones are distributed at mountain slopes facing the shoreline, with oak, elm and birch being large in number.
Aegean-Mediterranean Coast Region	:	Olive, citrus, and pine are large in number 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 national land is a high 1,132 m. The climate differs greatly according to region due to the finfluence of the mountain ranges running parallel to the north and south coast lines.

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 to be relatively comfortable, and in the cold season of January and February the temperature is from 5°C to 7°C so that the cold is not very severe.

The annual mean temperature of the Aegean-Mediterranean Region is a warm 18°C to 20°C for 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, for 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 with respect to areas.

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 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	Altitute Above Sea (m)	Temperature (°C)			Average Humidity (%)	Average Precipitation (mm)
			Average	Lowest	Highest		
Istanbul	Mar.	39	14.0	-16.1	40.5	75	573.4
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
Bdirne	Thrace	48	13.5	-22.2	41.5	70	599.3
Barsa	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
Zengusdak	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 1981 was 46,360,000 (according to Briefing No. 411, Jan. 3, 1983) the ratio between urban and rural areas being 42:58.

90% of the people consists of 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 occupied 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.

The attainment would be realized through promoting the industrialization and absorbing the surplus labor of agriculture into the industrial sector.

At present, the 4th Five-Year Plan (1979-1983) is being implemented.

Under the 3rd Five-Year Plan (1974-1978), investments of 41 billion dollars (manufacturing industries 26%, housing 18%, transportation and communications 22%, agriculture 12%, energy 7%, others 15%) were made and an annual economic growth was planned at the rate of 7%. As shown in Table 2-2, however, the performances had fallen short of the planned targets by about 1%.

In the 4th Five-Year Plan investment of a total of 63 billion dollars (1978 prices) is to be scheduled, the breakdown of which is 57% for the public sector and 43% for the private sector. By category, 27.4% will be for manufacturing industries, 16.3% for transportation and communications, 14.6% for housing, 12.2% for agriculture, 10.6% for energy, and 18.9% for others, and with these investments the aim is to attain an average annual growth rate in GNP of 8%. The targets and performances in the long-range plan are respectively indicated in Table 2-2.

Table 2-2 Targets and Performances of Long-range Plans (Growth Rate)

Unit : %

	1st (1963-1967)		2nd (1968-1972)		3rd (1963-1977)		4th (1978-1982)	
	T.	P.	T.	P.	T.	P.	T.	P.
Agriculture	4.2	3.7	4.1	3.6	3.7	3.1	5.5	
Industry	12.3	10.6	12.0	9.9	11.2	10.4	11.7	
Construction	10.7	8.0	7.2	5.0	11.9	9.0	11.4	
Transp. Communic.	10.5	7.8	7.2	8.8	8.2	9.9	11.3	
Housing	-	3.5	5.9	6.8	5.0	6.5	11.2	
Services	6.2	7.5	6.3	7.3	7.1	8.2	8.5	
GNP	7.0	6.7	7.0	7.1	7.9	6.9	8.0	

Note : (T) for Target, (P) for Performance
Source: State Planning Organization

The major economic activities during the 6-year period of 1976-1981 (with estimates partially included) are indicated in Table 2-3.

Table 2-3 Economic Activity

Item	Unit	1976	1977	1978	1979	1980	1981*
GNP (Current Price)	$\$10^9$	26.80	34.81	49.55	89.02	179.77	259.23
Total Resources	$\$10^9$	28.32	37.25	52.94	90.77	189.77	275.23
External Deficit	$\$10^9$	1.52	2.44	3.39	1.75	10.00	16.00
Growth Rate	%	7.70	3.90	3.10	-0.50	-0.70	4.40
Total Investment	$\$10^9$	6.24	8.78	11.72	19.13	35.32	53.00
Total Consumption	$\$10^9$	22.08	28.46	41.22	71.64	154.45	234.92
GNP by Origin							
Agriculture	%	21.9	20.9	20.7	21.7	22.1	21.7
Industry	%	20.2	21.4	22.0	23.8	23.2	25.2
Services	%	57.9	57.7	57.3	54.5	54.7	53.1
Income Per Capita	$/ Capita	653	829	1,197	2,019	3,977	5,789

* Target, Source : S.P.O.

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

The escalation rate of wholesale commodity prices in general was 10.1% in 1975, 15.6% in 1976 and 24.7% in 1977, but from 1978 to 1979 a rate of 63.9% was recorded, and from 1979 to 1980, 107.2%. From 1980 to 1981 the rate was settled down to 36.8%.

As for the unemployment rate, it was 13.6% in 1978, 14.1% in 1979, and 16.1% in 1980 to show a trend of annual increase.

The exchange rate between the Turkish lira and the U.S. dollar had been revised annually or monthly as necessary, but from May 1981, the exchange rate has been adjusted daily. As of April 1981 the rate was 98.2 TL/$ buying, and as of the end of December 1981, 126.7 TL/$.

The foreign trade structure of the Republic of Turkey is of a pattern of export of agricultural products and import of capital goods and raw materials. In 1981, the proportion of agricultural products in exports was 47%, the principal products being tobacco, cotton and hazel nut. The proportion of manufactured products represented by cotton yarn, leather and olive oil was 49%, while the remaining 4% consisted of mined products such as chromite. On the other hand, out of imported items, manufactured goods such as machinery, chemical products, steel, electrical appliances, and automobiles made up 52% of the whole, followed by 46% for mined products such as crude oil and oil. The remainder consisted of agricultural products. The proportion taken up by crude oil was 36% in total payments for imports (1981: $\$3,235 \times 10^6$).

Foreign trade according to countries is made up of 48% with OECD countries for both exports and imports, all of the remainder consisting of barter with the Soviet Union, Western European countries and OPEC countries based on government-to-government agreements.

Recent balances of trade have been constantly in the red affected by the first and second oil crises. In essence, in 1981, exports amounted to $\$4,703 \times 10^6$ and imports $\$8,933 \times 10^6$, and the trade balance was improved somewhat compared with the previous year, but there was a deficit of approximately $\$4,230 \times 10^6$. The principal cause of the deficit is that imports must be depended upon for crude oil and oil which make up 43% ($\$3,856 \times 10^6$) of the entire amount of imports. Because of this, the Government, in order to increase invisibles, has encouraged emigration of workers to West Germany and oil-producing countries while promoting tourism, thereby obtaining income of $\$2,138 \times 10^6$. This was not sufficient to offset the trade deficit and there still remained a minus of $\$2,092 \times 10^6$ in ordinary accounts.

Although the balance of capital accounts for the year showed a surplus of $\$879 \times 10^6$, the ultimate balance of international payments could not be covered even on obtaining various loans, and there was a deficit of $\$1,213 \times 10^6$.

With regard to the fiscal year of Turkey, it had been from March 1st to the end of February of the following year, but it has been changed to the calender year from 1982, and as a result, fiscal year of 1982 was for 10-month period from March 1st to December 31st.

2.5 Energy Resources

Securing energy is an extremely important matter for Turkey, which is endeavoring to convert its industrial structure from agriculture to manufacturing through promotion of a long-range economic development program. However, there is a constant shortage of supply capacity in the electric power, and the shortage is being covered partly through supplies from the Soviet Union and Bulgaria.

The present energy consumption is indicated in Table 2-4. This table shows the gradual reduction of petroleum consumption through the development of indigenous resources such as lignite and hydropower, but there is still about 50% reliance on petroleum in overall energy consumption.

Table 2-4 Energy Resources in National Consumption

Energy Resources	1976	1977	1978	1979	1980*	1981*
Petroleum Products	43.8	52.3	52.2	50.7	46.3	46.0
Wood	13.9	12.7	12.2	11.0	4.6	12.9
Coal	13.3	8.9	9.0	11.1	7.5	7.8
Animal and Plant Residue	12.0	7.0	6.8	6.5	9.3	7.2
Lignite	9.7	12.3	12.8	13.1	13.4	14.7
Hydraulic Power	6.6	6.4	6.6	7.0	8.3	9.6

Source : Ministry of Energy

* Turkey 1982 Almanac

The electric power supply facilities as of 1980 amounted to 5,300 MW (23,300 GWh), and the ratio between hydroelectric power generating facilities (2,131 MW) and thermal power generating facilities (3,153

MW) was 40% to 60%. The per capital power consumption was 520 kWh. The future average growth rate in power demand is forecast to be approximately 10%.

It is estimated that the economically developable hydroelectric potential of Turkey is 27,000 MW (91,000 GWh). Since only about 9% of the potential has been developed up to the present, hydroelectric power is one of the energy resources expected to be developed in the future. Other indigenous forms of energy resources are petroleum, coal, uranium, etc., while in recent years, it was started to make a study of utilizing geothermal energy and solar energy.

The production of petroleum is about 17% (2.3×10^6 ton/1980) against the estimated reserves of 57×10^6 ton, and more than 80% of the entire consumption of 13.8×10^6 ton for the year depended on imports.

It is estimated further that there are reserves of 1.3×10^9 ton of hard coal, 5.6×10^9 ton of soft coal, 6.0×10^9 ton of peat and oil shale, and 45×10^6 ton of natural uranium.

As for nuclear power, the first unit of 600 MW is scheduled to start operation in 1987.

In any event, Turkey is an oil-importing country and the economic activities of the country were heavily hit by the repeated oil crises, the aftershocks of which have left adverse effects to this day. In order to stimulate economic activity, much effort is being expended in development of domestic energy resources, particularly, hydropower and fossil fuel resources.

2.6 Transportation and Communications

Domestic transportation mainly relies on roads. The total length of national highways and provincial roads is 61,000 km, of which 59% is paved. The total length of railroads is 8,200 km with 98% not electrified.

Telephone service and broadcasting are operated and managed by the State, with broadcasts covering the entire national territory. The ownerships of telephones, radios and televisions in 1979 were 3%, 10% and 6%, respectively.

CHAPTER 3

GENERAL CONDITIONS OF PROJECT AREA AND SURROUNDINGS

CHAPTER 3 GENERAL CONDITIONS OF PROJECT AREA AND SURROUNDINGS

LIST OF FIGURE

CHAPTER 3 GENERAL CONDITIONS OF PROJECT AREA AND SURROUNDINGS

The Beskonak Project are in Serik District of Antalya Province and are locatd 73 km northeast of the city of Antalya, the capital of the province, at the downstream of the Kopruçay River which flows from north to south to feed into the Mediterranean Sea.

3.1 General Conditions of the Surroundings

Antalya province is situated in the Mediterranean Region in the southern part of the Republic of Turkey, and belongs to a temperate Mediterranean climate zone. Agriculture has flourished from a long time ago and even today is the main industry of the province. There are also numerous historical sites such as Perge, Aspendos, Side, and Alanya remaining from ancient Grecian and Roman ages, and favored with a scenic natural environment along the Mediterranean seacoast. The province is a leading tourism center of Turkey, and is also famed as a major resort area.

According to statistical data of 1981, the area of Antalya Province is 22,252 km^2 (corresponding to 2.7% of the national territory). The total population is 748,706 (1980), and the population density is 34 per square kilometer. The ratio of the population in urban and rural areas is 2:3.

The provincial capital of Antalya faces on the Mediterranean Sea and is at a distance of 550 km (road length) from Ankara, while there is a connection from Istanbul by air service. Railroads connect neighboring Burdur and Isparta provinces with Ankara, but do not extend into Antalya. Transportation and trade within the province relies principally on long-distance bus and trucks.

The Beydagi Mountain Range runs along the western boundary of the province and the Taurus Mountain Range along the northern and eastern boundaries. Both of the mountain ranges have strings of high peaks of 2,000 to 3,000 m class, and the Mediterranean Region is separated from the Anatolian Plateau by these mountain ranges. The principal roads in this province extend east-west along the Mediterranean coast with the city of Antalya as the hub. The Koprucay River, crosses a national highway to the east of Serik, 45 km east of Antalya, to enter the Mediterranean Sea.

The Köprücay River has its basin at the southern slope of the Taurus mountainlands which reach heights of 2,000 to 3,000 m. The Taurus Mountains run from the Mediterranean Sea coast through the eastern part of Turkey to the Iranian border, and the region along these mountains belong to a geological structure called the South Anatolian Folds where Paleozoic to Tertiary limestones are widely distributed, and the largest karstic area in Turkey is comprised. The project area adjoins the region where these limestones are distributed, and Neogene sedimentary rocks are mainly exposed.

Of the two hydropower projects in the Antalya Region where construction works are under way, namely, Oymapinar in the Manavgat River basin adjoining the Koprucay River on its eastern side, and the Karacaoren in the Aksu River basin next to the Koprucay River on its western side, the former is located at the fringe of the limestone distribution area, while the latter is in the distribution area of Neogene sedimentary rocks, the same as the Beskonak project.

The port of Antalya, located to the southwest of Antalya city, has enough facilities to handle cargo of ocean-going freighters of several ten thousand-ton class, and domestic and foreign trade are carried on.

The main agricultural products of the province are narenciye, cotton, wheat, sesame and vegetables in areas where irrigation facilities are available, and dry farming crops such as wheat (barley, rye and oats), cotton, beans, and pepper where irrigation facilities are not available. Since the province is favored with meteorological conditions, citruses such as orange and lemon, pineapple, and banana are cultivated at low elevation, and grape and apple are grown at slightly high elevation.

With regard to climate conditions (precipitation, temperature, etc.) in the surroundings, it is listed in Table 2-1 (Antalya city).

Antalya is a large city with a population of approximately 176,000 and is provided with various government agencies, various banks, hospitals, schools, hotels, telecommunications and transportation facilities, shops, etc.. All facilities indispensable for commercial activities and daily life are available.

Manufacturing industries in Antalya city are a chrome refining plant, oil processing plants and small-scale textile mills, and nothing else of note.

3.2 Water Resources Development Program and its Present State

The Project area is surrounded by water resources development projects and Antalya Province is under the jurisdiction of the 13th Regional Office of DSI.

The hydroelectric potential in Antalya Province which can be developed economically is estimated to amount to 887 MW (3,354 x 10^6 kWh), and the large-scale irrigation area is estimated to be 152,000 ha. The state of development of these resources is shown in the table below.

	Hydropower Project	Major Irrigation Project
1. Potential	887 MW, 3,354 x 10^6 kWh	152,000 ha
2. Projection (1979)	598 MW, 1,954 x 10^6 kWh	96,000 ha
3. Operating (1979)	28 MW, 195 x 10^6 kWh	57,000 ha
Development Ratio	3.1% 5.8%	37.5%

* Data from 13th Regional Office, DSI

The following indicates the outlines of the major projects in the surroundings of this project area under the jurisdiction of the 13th Regional Office of DSI.

3.2.1 Water Resources Development Projects on Aksu River

The Aksu River is the primary river in Antalya Province which flows from north to south between Antalya City and the Köprücay River (20 km east of Antalya, 25 km west of the Köprücay River) to feed the Mediterranean Sea.

At the upstream part of this river basin, Kovada No. 1 and No. 2 Hydroelectric Power Stations (total output 59.6 MW, 261 x 10^6 kWh/yr. - in Isparta Province) are presently in operation, utilizing the head between the natural Kovada Lake and the Aksu River. At the middle stretch, Karacaoren Dam and Power Station (30 MW, 142 x 10^6 kWh/yr.) with the purposes of power generation, irrigation, and flood control are now being constructed, while No. 2 Power Station (15 MW, 68 x 10^6 kWh/yr) is also planned.

At the downstream part, there is the Asagi-Aksu Irrigation Project (Phase I: 16,000 ha of irrigation and 7,500 ha of drainage improvement, Phase II: 7,200 ha of irrigation). Phase I is already completed and Phase II now carried out.

3.2.2 Water Resources Development Projects on Manavgat River

This river flows into the Mediterranean Sea approximately 30 km east of the Köprücay River.

At the downstream part of the river, the Oymapinar Hydropower Project (ultimately 540 MW, 1,620 x 10^6 kWh/yr) is now under energetic construction aiming for start of operation of the No. 1 unit (135 MW) in 1983. Downstream of the power station there is the Manavgat Irrigation Project (Phase I: 1,635 ha, Phase II: 8,765 ha, Total: 10,400 ha) presently at the stage of construction of Phase II facilities.

3.2.3 Water Resources Development Projects on Köprücay River

At the upstream of the Beskonak Hydropower Project, there are the Yilanli Irrigation Project (1,648 ha) and the Degirmenözü-Beskonak Irrigation Project (1,646 ha), and both are under construction. Immediately downstream of the Beskonak dam-site the Bucak-Akbas-Karatas Irrigation Project (1,500 ha) is under construction. In the event the Kisik Dam and Power Development Project studied in this Report is realized, part of the irrigation project will be inundated by its regulating pond. At the downstream, there is the Lower Koprucay Irrigation Project (Phase I: 26,382 ha, Phase II: 4,100 ha). Phase I is being irrigated by means of a diversion dam, and Phase II is under construction.

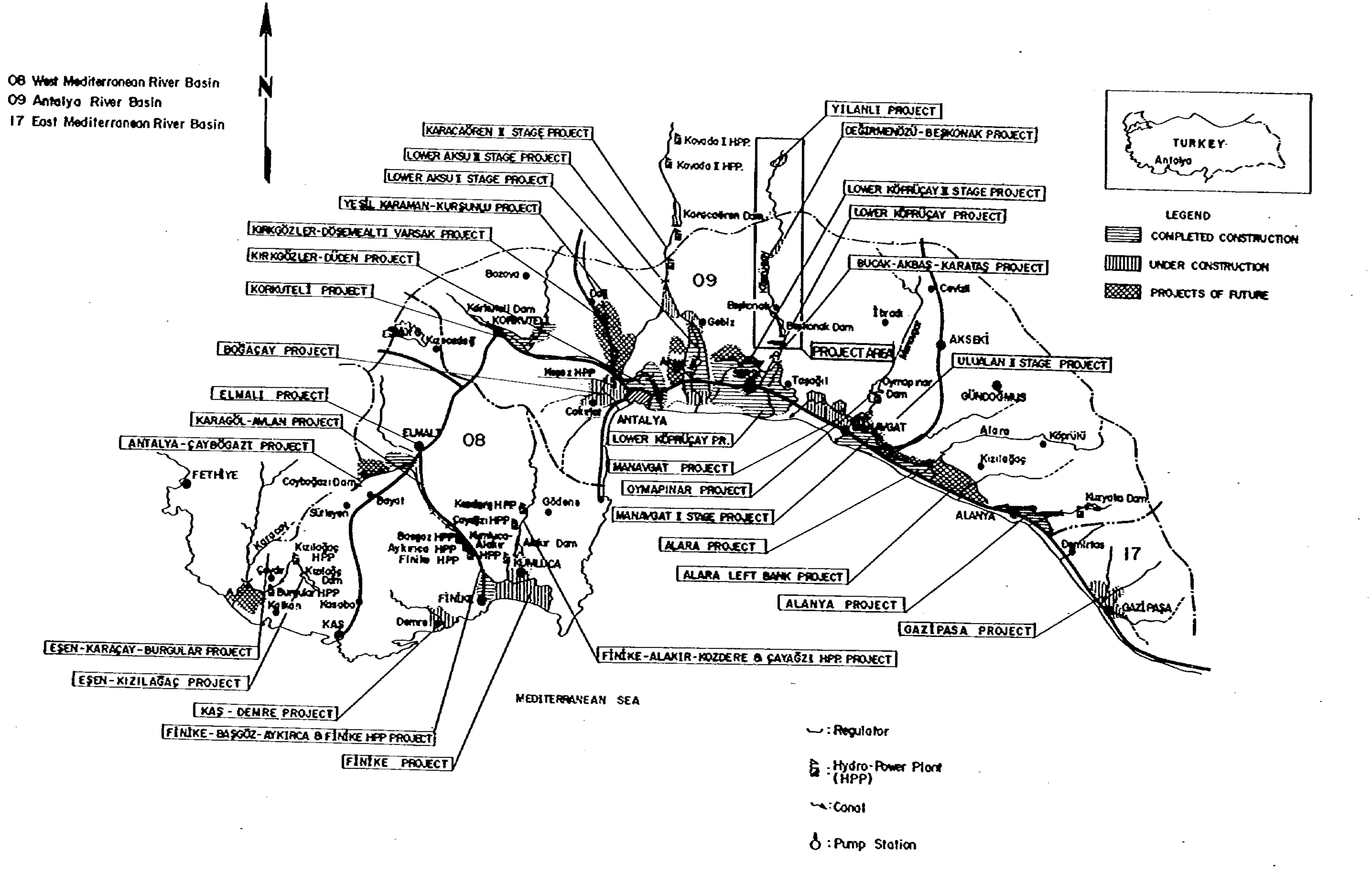
As described above, the development projects utilizing this river water resources are presently limited to irrigation projects, and in case Beskonak Project were to be realized, it would be the first hydroelectric power development project on this river.

3.2.4 Other Hydroelectric Power Development Projects

Besides the above, the projects in Altalya Province which are existing, under construction, or being planned, may be listed as shown below.

Power Station	Installed Capacity (kW)	Annual Energy Production (10^6 kWh)	Remarks
Kepez	26,400	180	In operation
Diger Kücük	1,850	15	In operation (by Municipality)
Kumluca-Alakir	1,500	12	Planning completed
Esen-Burgular	11,100	80	Under planning
Bolasan	72,000	315	Master plan completed
Zincirli	16,000	72	Ditto
Esen-Kizilagac	63,000	257	"
Finike-Alakir-Kozdere & Cayagzi	8,900	78	"
Finike-Basgöz-Aykirca & Finike	17,400	153	"

As may be seen from this table, Antalya Province would be classified as a hydropower potential area having medium- to small-scale potentials compared with the large hydropower potential areas of Eastern Turkey and the Black Sea Coast Region. As previously mentioned, however, since this region has favorable meteorological conditions, hydroelectric power development are of extreme importance for securing the supply of irrigation water at the same time. The necessity for development will therefore become stronger in the future. An outline of the water resources development program in the Province is shown in Fig. 3-1.



Source; DSİ XIII REGIONAL DIRECTORATE

Fig. 3-1 General Layout Plan of the Investment Projects

3.3 General Conditions in Project Area

3.3.1 Morphological Features

Topography

The project area consists generally of hills and mountainlands. Major peaks within the area are Mt. Anamas (2,337 m), Mt. Dipoyraz (2,980 m), Mt. Dolup (2,033 m), Mt. Bozburun (2,504 m), and Mt. Keriz (2,020 m), all of these comprising watersheds. Consequently, there are few plains, and the areas are small. The largest plain on the left-bank side is the Sagirin Plain, while that on the right-bank side is the Bucak-Akbas Plain.

Rivers and Streams

The Köprücay River rises from the western foot of Mt. Anamas (east of Lake Egridir), flows south and merges the Oluk-köprü Springs. Later, it is joined by the tributary Kocadere from the west, and by the Sagirin River from the east. It then flows through the Serik Plain and in the end flows into the Mediterranean Sea. The Köprücay River has a total length of 156 km and a catchment area of 2,498 km^2, and an annual average runoff of $3,200 \times 10^6 m^3$. It is a major river in the province.

3.3.2 Natural Conditions

Geology

Sedimentary rocks of the Miocene Epoch are distributed at the damsite and the reservoir area of this Project. These sedimentary rocks consist of Köprücay Conglomerate and the Beskonak Formation. Köprücay Conglomerate is mainly distributed at the right bank of the Köprücay River and at the dam site, and has been subjected to karstification. The Beskonak Formation is chiefly distributed at the left bank of the Köprücay River and is impermeable or semi-impermeable. The Köprücay Conglomerate and the Beskonak Formation are interfingered. These sedimentary rocks indicate a simple geological structure with bedding planes dipping 10 - 15 deg. toward the valley at both banks of the Köprücay River.

The prominent faults which have been confirmed up to the present are mainly distributed outside the reservoir area, but there is one prominent transverse fault upstream of the damsite. These principal faults had been formed from the Late Miocene to Pleistocene Epochs accompanying upthrusting in late orogenic movements.

Earthquakes

Turkey belongs to the Alpine-Himalayan Seismic Belt, and in the past there have been observed earthquakes caused by the Mediterranean-European Alpine tectonic action. However, the project area is considered to be a region with little possibility of earthquake occurrence.

Meteorology

Concerning the meteorology in the project area, it will be described in Chapter 6.

3.3.3 Social Conditions

Population

According to the census of 1980, the population was 4,609 in the project area. The breakdown is as follows:

Beskonak (sub-district center)	1,243
Bucak Village	516
Akbas Village	1,079
Sagirin Village	1,771

Population growth in rural areas is extremely slow and there are years when decreases have occurred. This shows that there is a strong trend existing for migration from rural to urban areas.

Culture

There is at least one elementary school in each of the villages in the project area, while at Beskonak there is also a secondary school. The general level of culture is not very much different from that of other areas.

Hygiene

The population in the project area has a good state of hygiene and there is no outbreak of contagious diseases at present. Hospitals are located in Serik, Manavgat and Antalya, while there is a hygienic center at Beskonak.

Transportation and Communications

A national highway (asphalt paved), connecting Antalya with Mersin and Adana, passes approximately 28 km to the south of the Beskonak damsite. Therefore, this national highway would be utilized over the 45 km from Antalya to Serik, and turning left at Serik the highway (asphalt paved) between Tasagil and Beskonak would be travelled for 26 km, after which the 2 km to the Beskonak damsite would be a gravel road.

PTT services providing telephone and telegraph communication are available at Beskonak Village.

3.3.4 State of Economic Activity

Agriculture

Agriculture is the principal industry in the project area. The great part of agriculture consists of dry farming utilizing rainwater, but there are farmland areas along the Koprucay River which have irrigation facilities. A project with an organized irrigation system is the Bucak-Akbas-Karatas Irrigation Project

(Project area 2,100 ha, irrigated area 1,500 ha) spread out on the Bucak-Akbas and Sagirin Plains. The main agricultural crops of districts with irrigation facilities are cotton, cereal grains, vegetables, melon, watermelon, sesame, etc. While wheat, barley, sesame, etc., are cultivated at dry areas.

Mining and Manufacturing

Manufacturing industries have not yet developed within the project area, and there is no mining.

Trade

Trade within the project area mainly involves agricultural products. The trading centers are Serik, Manavgat and Antalya. Consequently, agricultural products of the project area are hauled to these centers to be bought and sold. Cotton, citruses and vegetables are shipped to other regions of the country, and are also exported.

Tourism

Tourism resources of international level exist to the north and south of the project area. To the north there are the Zerk Ruins at the upstream end of Beskonak Reservoir proposed in this Report and also the Oluk Kopru Springs, while to the south there is the Aspendos Theatre.

CHAPTER 4

PRESENT STATE OF ELECTRIC ENTERPRISES

CHAPTER 4 PRESENT STATE OF ELECTRIC ENTERPRISES

LIST OF FIGURES

LIST OF TABLES

CHAPTER 4 PRESENT STATE OF ELECTRIC ENTERPRISES

4.1 Present State of Electric Power

Electric power development in the Republic of Turkey is proceeding steadily, and particularly, great effort is being expended in hydropower development as a part of the economic reconstruction program. However, since the first and second oil crises, the worsening of the international balance of payments has affected the situation and the growth in installed capacity has been slowed down for the past three or four years.

Fig. 4-1 shows the transitions in installed power generating capacity and total electric engergy production in the Republic of Turkey. The total installed capacity as of 1980 was 5,300 MW with the composition of facilities 60% thermal and 40% hydro.

Meanwhile, the annual electric energy production was 23,300 GWh, of which 49% was from hydroelectric power generation, showing that water power resources were being effectively utilized.

The per capita energy production of the country was 520 kWh, which cannot be said to be on the high side for a per capita level, but the high growth rate in energy production has been indicated, and the 10-year average is exceeding 10%.

It is thought that these trends have been due to increase in the ratio of electrification in the country besides the Economic Development Plans (1st to 4th) initiated in 1963.

Both the rapid growth in electric energy consumption and the slowing down in power development have resulted in a shortage of supply capability making it necessary for electric power to be imported.

Electric power imported from Bulgaria and the Soviet Union in

1980 amounted to a total of 1,300 GWh. In spite of the imported power, the shortage in power supply could not be eliminated and the average growth rate during the three years from 1978 to 1980 had been held to about 4.2%. However, the potential power demand is still strong, and it is forecasted that there will be a growth in power demand in excess of 12% with the future economic recovery.

In order to cope with this growth in power demand, an expansion program of electric power sources is being implemented. According to the program, the installed capacity would be expanded to six times the present by 1994.

Effective utilization of domestic resources is also being considered, and emphasis is being placed on development of hydropower and lignite thermal.

In particular, it is noted that the aim is to raise the proportion of hydroelectric power generation in the total capacity in 1994 to 50%.

According to the expansion program, a group of large-capacity power stations such as Karakaya-hydro of 1,800 MW, Altinkaya-hydro of 700 MW, Oymapinar-hydro of 540 MW, and Elbistan lignite-fired thermal of 3,160 MW (ultimately 5,560 MW) are planned to be completed in succession. In 1992, it is planned for the first nuclear power station (1,000 MW) to go into operation.

However, in the most recent several years, sufficient supply capability to satisfy growth in demand has not been added, and it is thought that the shortage in electric power supply will continue for several more years.

The proportions of electric energy consumption in 1979 by type of customer were 65% for mining and manufacturing, 33% for agriculture, commerce and ordinary residential use, and 2% for transportation. These proportions have not changed very much in the past 10 years.

Practically almost all of the transmission system has been interconnected in Turkey, with about 4% of the whole remaining in the form of isolated systems.

The principal networks are composed of 380 kV transmission lines (2,900 km), 154 kV (14,200 km), and 66 kV (2,500 km). Voltages of 66 kV and 34.5 kV are adopted for local transmission lines.

Transmission line networks of 34.5 kV and under are said to amount to a total length of approximately 100,000 km. These networks are being expanded annually in a steady manner, but there is still a considerable number of unelectrified villages in provincial rural areas.

The electricity tariffs in the Republic of Turkey as of December 1982 were according to the following two systems of (1) and (2). All customers are allowed to select either one of the tariffs.

(1) Double Term Tariff System

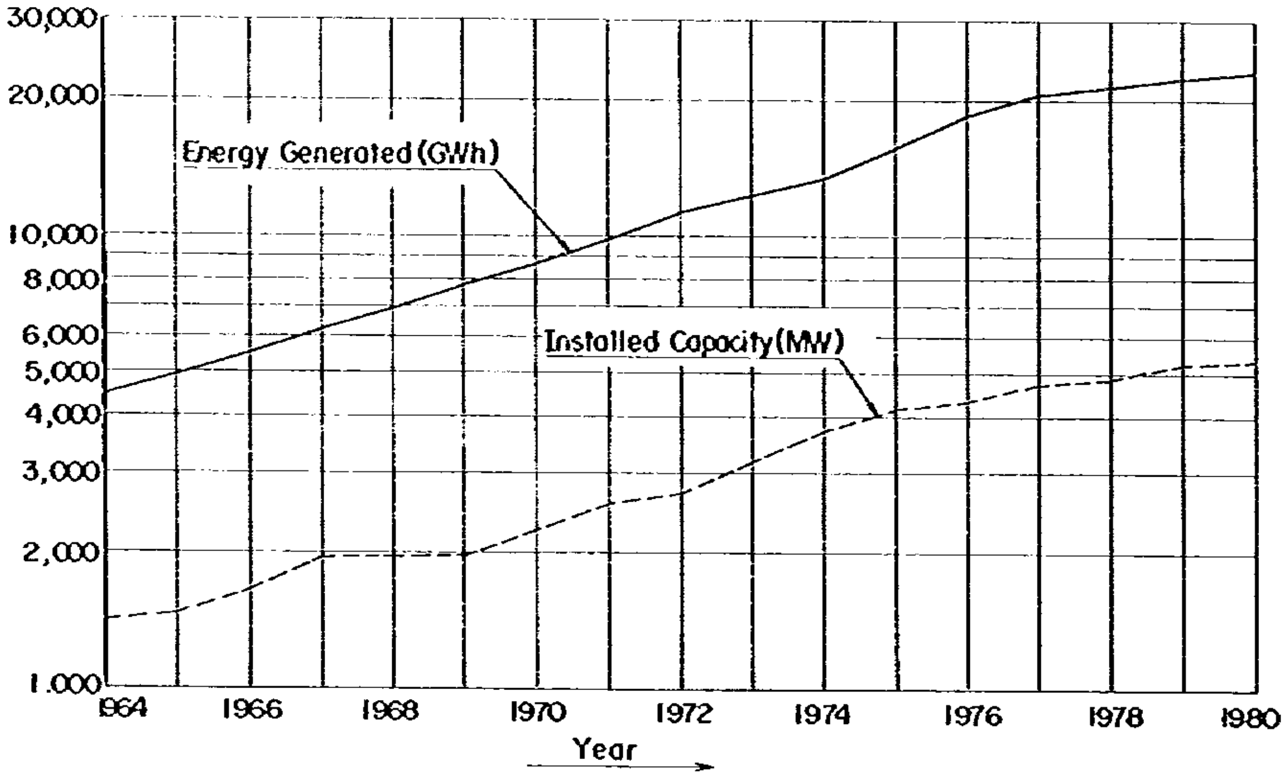
a) Power base tariff: 350 TL/kW (monthly)

b) Energy base tariff: 6.04 TL/kWh

(2) Single Term Tariff System: 7.19 TL/kWh

These tariffs, however, would be subject to revision due to variations in import prices of oil.

Fig. 4-1 Installed Capacity and Energy Generated



4.2 Electrical Entrepreneurs

Electric power administration in the Republic of Turkey is under the jurisdisction of the Ministry of Energy and Natural Resources.

The greater part of the electric enterprise is made up of state-owned systems, and these are operated by the Turkish Electricity Authority (TEK). In addition, there are the Power Resources Surveying Administration (EIE) and the General Directorate of State Hydraulic Works (DSI) which are concerned as government agencies.

EIE is an organ for making surveys and formulating plans for electric power development. EIE carries out investigations of development sites, scales, and timings in consideration of future power demand and supply.

DSI is an organ established in 1953 with 28 regional offices throughout the country and is in charge of construction and operation of facilities for flood control, irrigation and drainage, and, in addition construction of hydroelectric power plants. With regard to hydroelectric power projects, there are cases where DSI implements them independently and cases when EIE participates in the survey stage.

TEK is an electric power supplying organ for construction, maintenance and operation of thermal power stations, nuclear power stations and transmission lines, and for maintenance and operation of hydroelectric power stations constructed by DSI. Of the entire power generating capacity in the Republic of Turkey, 80% is operated by TEK. The remaining 20% consists of municipally-owned power stations and plants operated by private enterprises.

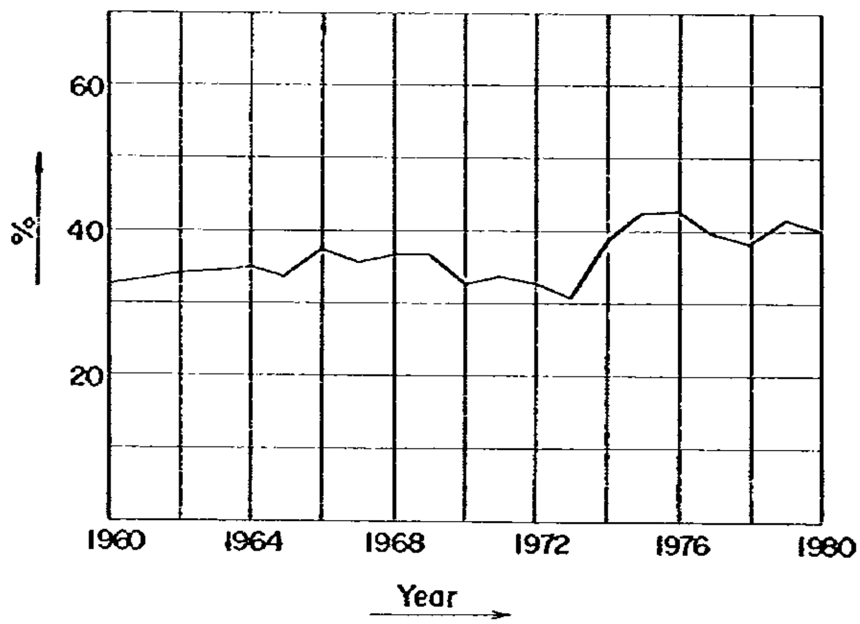
Power distribution is carried out in the three forms of areas directly handled by TEK, areas handled by municipal organizations supplied with power by TEK, areas supplied by Electricity and Gas Services in sume communities. Since the service areas of these three forms overlap at places, there is an initiative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

4.3 Present State of Electric Power Supply Facilities

The major power stations in the Republic of Turkey are listed in Table 4-1. The annual trends in installed power generating capacity are shown in Table 4-2, 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 shown in Fig. 4-2, and with hydroelectric power generation comprising 40% (2,131 MW) of the entire capacity in 1980, it plays an extremely important role in power supply. Also in the future, from the standpoint of conserving foreign currency, it is expected to promote the development of hydroelectric and lignite-fired thermal.

Fig. 4-2 Percentage of Hydraulic Power Stations in Total Installed Capacity



As previously mentioned, the major transmission lines in the Republic of Turkey are 380 kV and 154 kV although there is partial adoption of a voltage of 220 kV for the tieline with Bulgaria. A list of the major transmission lines is given in Table 4-3.

The Keban-Gölbasi and Gölbasi-Ümraniye lines are major transmission lines running through the central part of Turkey with total length of 900 km and are the main arteries connecting the power sources areas located in the east and the large power consumption areas in the west.

At present, a plan is being implemented to further strengthen these 380 kV trunk transmission lines on the Black Sea side and the Mediterranean Sea side.

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

Table 4-1 Major Power Plants in Operation

Name	Thermal Power Plants		Name	Hydraulic Power Plants		
	Installed Capacity (MW)	Energy Generated (GWh)		Installed Capacity (MW)	Energy Generated (GWh)	
					Average	Firm
İzmir	37.5	192	Almus	27	83	45
Silahtar	82.5	430	Çağ - Çağ	14.4	39	28
Catalağzi	129	874	Demirköprü	69	146	76
Soma	44	311	Doğankent	32.8	124	99
Tunçbilek A + B	429	2,635	Göksu	10.6	65	58
Anbarli	630	3,809	Gökçekaya	278.4	645	611
Hopa	50	312	Hirfanlı	96	355	178
Bornova G.T.	30	90	Hazar 1-2	30.1	94	24
Seydischir G.T.	120	320	İkizdere	15.1	96	84
Seyitömer	450	2,700	Kesikköbrü	76	185	110
Aliaga G.T.	120	360	Kemer	48	112	62
Hazar G.T.	30	90	Kovada 1-2	59.6	257	140
Mersin	106	700	Sariyar	160	491	328
Karabük	21.2	60	Tortum	26.2	97	86
Soma B-1	165	990	Keban	630	4,778	4,447
Erdemir	20	130	Cıldır	15.4	28	26
Seka - Ismir	11.2	31	Seyhan	60	350	290
Seka - Dalaman	26.2	65	Kadincik 1-2	126	622	390
Tpao - Batman	15	75	Kepez	26.4	160	130
Engil - Van G.T.	16.2	49	Engil	4.6	14	12
İsdemir	60	330	Hasan-Uğurlu	250	900	820
İgsapş	15	75	Sızır	6.8	35	29
Aksa	21.2	70	Yüreğir	6.0	21	19
Turhal-Şeker	12.8	38	Bünyan	1.4	4	3
M.K.E.K.-Kinkale	15.4	60	Derme	4.5	10	5
			Murgul	4.7	10	5

Table 4-2 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	203	834	1,819	893	2,712
1973	1,563	782	2,345	644	203	847	2,207	985	3,192
1974	1,643	1,190	2,833	640	259	899	2,283	1,449	3,732
1975	1,709	1,521	3,230	698	259	957	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
1978	2,179	1,622	3,801	809	259	1,068	2,988	1,881	4,869
1979	2,179	1,872	4,051	809	259	1,068	2,988	2,131	5,119
1980	2,344	1,872	4,216	809	259	1,068	3,153	2,131	5,284

Table 4-3 Major Transmission Lines in Operation

Name	Nominal Voltage (kV)	Length (km)	Conductor (MCM)
Keban - Gölbasi	380	546	2 x 954 (2 circuits)
Gölbasi - Gökcekaya	380	167	2 x 954
Gökcekaya - Ümraniye	380	216	2 x 954
Gölbasi - Ümraniye	380	355	2 x 954
Gökcekaya - Seyitömer	380	112	2 x 954
Seyitömer - Isiltar (Izmir)	380	265	2 x 954
Seyitömer - Seydisehir	380	295	2 x 954
Adapazari - Eregli	380	108	2 x 954
Tuncbilek - Seyitömer	380	42	2 x 954
Babaeski - Dough Meric	220	77	2 x 954

Table 4-4 Transmission and Distribution Lines

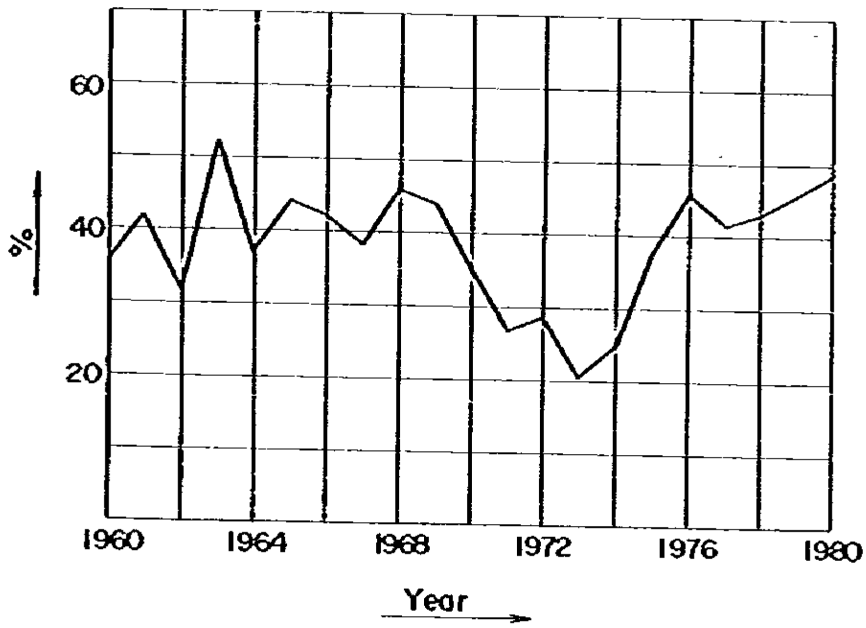
Unit: km

Year	Transmission Lines				Distribution Lines	Total
	380 kV & 220 kV	154 kV	66 kV	Total		
1962	-	2,166	1,024	3,190	2,432	5,622
1967	-	4,129	1,870	5,999	6,071	12,070
1972	355	6,010	2,426	8,801	44,861	53,662
1977	2,684	10,748	2,481	15,913	70,583	86,496
1978	2,856	12,527	2,490	17,873	77,214	95,086
1979	2,890	13,677	2,494	19,061	83,714	102,775
1980	2,890	14,189	2,498	19,577	96,533	116,110

4.4 Present State of Demand and Supply of Electric Power

The average growth rate in energy generated was 10.4% in the past 10 years, and as of 1980 the energy production had become approximately 2.7 times the production 10 years before. The trends of the total energy production in Turkey are shown in Table 4-5. The trends of the proportion made up by hydroelectric power in the total energy production are shown in Fig. 4-3, the proportion having been 49% in 1980.

Fig. 4-3 Percentage of Hydraulic Energy in Gross Energy Generated



The trends of monthly maximum demands are indicated in Table 4-6. Annual maximum demand normally occurs in December, but in 1980 it was in November. However, there are not many differences between the maximum demands in each month and the maximum demand of the minimum month is in a range of 80% to 95% of the maximum month. The growth rate in maximum load by year was 10.3% in terms of 10-year average to indicate a value of the same level as the growth rate in electric energy.

A typical daily demand is shown in Fig. 4-4. Table 4-7 shows the annual trends in the demand and supply balance of the power system of TEK. Table 4-8 indicates the total energy generation from 1978 to 1980 classified according to type of energy resources.

According to the demand and supply balance sheet of TEK in 1980, 3.8% of the total energy supplied was imported from Bulgaria, and 3.0% from the Soviet Union, while 0.7% was supplied from other companies. The transmission loss rate was less than 6.1% indicating that a world level is being maintained.

Table 4-5 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	674	2,349	5,590	3,032	8,622
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	2,036	10,259	1,599	567	2,166	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	7,201	15,455	1,654	1,174	2,828	9,908	8,375	18,283
1977	9,802	7,428	17,230	2,170	1,164	3,328	11,972	8,592	20,564
1978	9,907	8,061	17,968	2,454	1,304	3,758	12,361	9,365	21,726
1979	9,800	9,134	18,934	2,418	1,170	3,588	12,218	10,304	22,522
1980	9,382	10,033	19,415	2,545	1,315	3,860	11,927	11,348	23,275

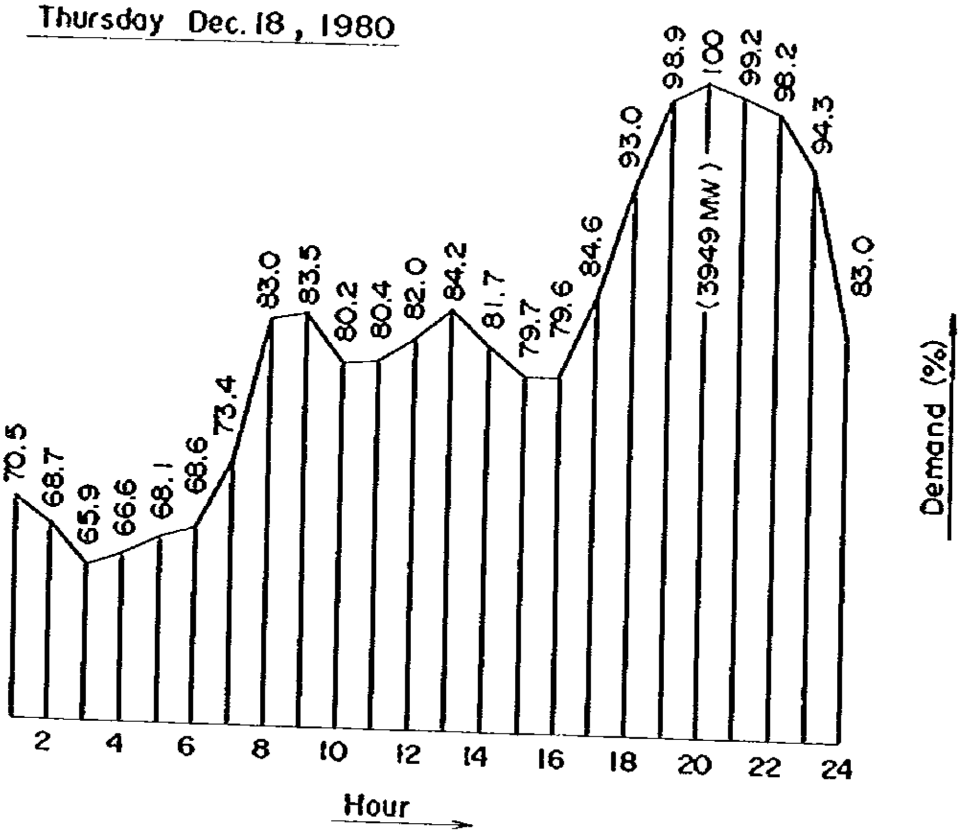
Table 4-6 Monthly Maximum Demand

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
1978	3,554	3,399	3,467	3,412	3,345	3,401	3,372	3,414	3,507	3,609	3,682	3,699
1979	3,630	3,722	3,751	3,692	3,514	3,514	3,561	3,575	3,591	3,718	3,717	3,731
1980	3,672	3,665	3,776	3,737	3,690	3,586	3,716	3,739	3,879	3,915	4,023	3,947
1981	3,759	3,822	3,934	3,952	3,932	3,973	3,988	3,833	3,894	3,825	3,917	4,193
1982	4,172	4,199	4,240									

Fig.4-4 Typical Daily Demand Curve

Thursday Dec. 18, 1980



Wendsday Jun. 24, 1981

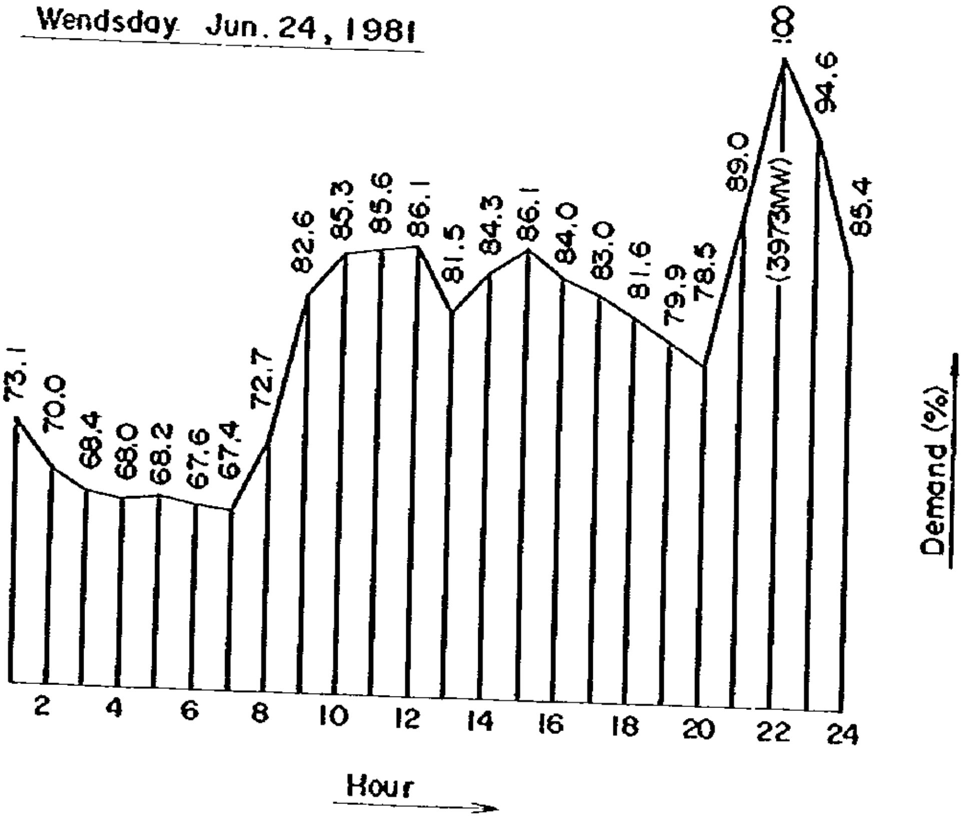


Table 4-7 TEK's Energy Balance

Year	1977	1978	1979	1980
Gross Generation (GWh)	17,230	17,968	18,934	19,414
Power Plant Internal Consumption (GWh)	985	1,060	1,117	1,074
Net Generation (GWh)	16,245	16,908	17,817	18,340
Energy Purchased (GWh)	809	912	1,172	1,484
Energy Supplied to the Network (GWh)	17,054	17,820	18,989	19,824
Network Loss (GWh) (%)	841 (4.9)	923 (5.2)	1,033 (5.4)	1,200 (6.1)
Energy Sold (GWh)	16,213	16,897	17,956	18,624

Table 4-8 Distribution of Electrical Energy Generated

Year	1978		1979		1980	
	GWh	%	GWh	%	GWh	%
Thermal Power Plants	12,361	57.0	12,218	54.2	11,927	51.2
Coal	1,207	5.6	1,067	4.7	912	3.9
Lignite	4,382	20.2	5,356	23.8	5,048	21.7
Oil	6,772	31.2	5,795	25.7	5,967	25.6
Hydraulic Power Plants	9,365	43.1	10,304	45.8	11,348	48.8
Total	21,726	100	22,522	100	23,275	100

CHAPTER 5

DEMAND AND SUPPLY FORECAST

CHAPTER 5 DEMAND AND SUPPLY FORECAST

LIST OF FIGURES

LIST OF TABLES

CHAPTER 5 DEMAND AND SUPPLY FORECAST

5.1 Demand Forecast

The contents of this chapter consist of the three items, such as outline of the demand forecast made by TEK in 1977, long-range forecast made by the macroscopic method, and results of studies.

It is thought the operation of the Beskonak project will become possible only in the early or middle part of the 1990s. Consequently, a long-range forecast until the year 2002 has been made, where it will be possible to consider the trend of power demand in the years around that time.

5.1.1 Demand Forecast by TEK

TEK published in December 1977 a report entitled "Electrical Energy and Power Estimates of Turkey (1978-2000)", edited by the TEK Planning and Coordination Department.

This report performed a long-range demand forecast for a 23 year period from 1978 to 2000. This period was divided into first and second one. For the first period a system was adopted based on customers and aggregating energy consumption, while for the second the demand was computed based on the gross energy generation.

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

The electric energy of this period is forecast based on customers. The classifications of the various consumption groups and the method of estimation are stated below.

(a) Trend values adopted for customers in general and medium to small enterprises

(b) Planned values adopted for large enterprises, public organs, irrigation facilities, power for project construction

In making this forecast, a total of 8% is taken into account as station service consumption and transmission losses.

A variation from 8% to 9% was recognized in the past, and it is assumed that by introduction of modern power stations and a 380 kV transmission system, this can be stabilized at approximately 8%.

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

The following equation is derived both from the actual records of gross energy generation from 1963 to 1977, and forecast values calculated for First Period(1978 - 1981).

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

where,

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

Estimation for second period is performed by use of the equation.

(3) Estimations of Maximum Demand

The load factor is forecast to be 64% in view of past performance, and maximum demand for each year is calculated by the equation below.

$$P_{max} = \frac{E_g}{L_f \times 8,760}$$

where,

P_{max} : maximum demand (MW)
E_g : annual gross energy generated (MWh)
L_f : load factor (= 0.64)

(4) Results Obtained by TEK

The demand forecast made by TEK may be said to be obtained by a composite of microscopic and macroscopic techniques when seen for the entire forecast period.

Table 5-1 shows the results of demand forecast made by TEK. The average growth rates in energy generation are shown in Table 5-2 for every five years.

As is clearly seen in Table 5-2, the increase has slackened since 1977, but if energy generation is increased at this degree, the per capita energy generation will become 3,140 kWh in the year 2000.

Table 5-1 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
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

Table 5-2 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
1987 - 1992	10.7
1992 - 1997	9.7
1977 - 1997	11.3

Table 5-3 shows the trends of per capita energy production for the forecast period. The population growth rate to be the basis is taken to be 2.5% annually.

Tale 5-3 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

5.1.2 Demand Forecast by Macro-Method

Macroscopic techniques include a technique using time series trend curves and techniques utilizing correlations with GNP. In this report a demand forecast based on GNP was attempted.

(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 good correlation 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 was made using this macroscopic method. The indices, basic conditions, etc., used in the study were the following:

(a) Guiding Principle of Study and Statistical Indices

"New Method of Long Range or Very Long Range Demand Forecast of Energy Including Electricity Viewed from Worldwide Standpoint," Edited by EPDC

(b) Period of Forecast: 25 years (1978-2002)

(c) Calculation Conditions

As shown in Table 5-4, growth in GNP has stagnated in recent years due to the effects of the oil shocks and the pace of electric power development has also slowed down.

As a result, growth in demand have been suppressed, but this was judged as being a temporary phenomenon. The starting point of the forecast was taken to be 1977 when the effects were small.

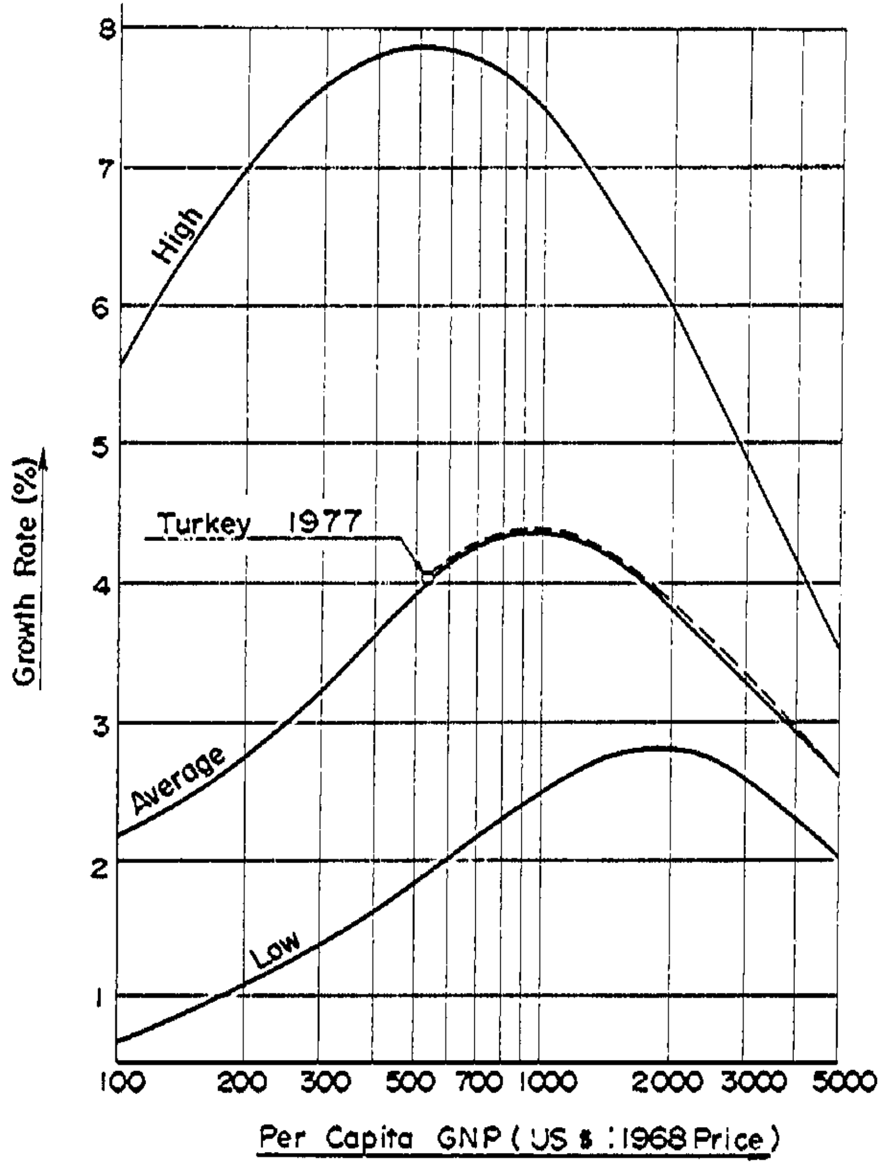
(i)	GNP per capita (1968 base)	:	540 US$ (1977)
(ii)	Growth rate of GNP per capita	:	4.0% (5-year average 4.2% for 1973-1977)
(iii)	KWh per capita	:	490 kWh (1977)
(iv)	Population	:	41,768,000 (1977)
(v)	Population increase rate	:	2.4% (5-year average 2.4% for 1973-1977)

Demand forecast was performed based on both the correlation between GNP per capital and its growth rate (see Fig. 5-1) and the correlation between GNP per capita and kWh per capita (see Fig. 5-2).

(2) Forecast Results

Table 5-5 indicates the gross energy generated each year obtained from Table 5-4, Fig. 5-1 and Fig. 5-2. The forecasts of maximum demands were calculated from gross energy generated based on the load factor of 64% predicted by TEK.

Fig. 5-1 Correlation Between per Capita GNP and Growth Rate



GNP/Capita (US $)	Growth Rate (%)	Average Growth Rate (%)
540	4.0	
600	4.1	4.05
700	4.25	4.2
800	4.3	4.3
900	4.35	4.3
1000	4.35	4.35
1100	4.30	4.3
1200	4.25	4.3
1300	4.20	4.2
1400	4.15	4.2
1500	4.1	4.1

Fig. 5-2 Correlation between per Capita GNP and per Capita Energy

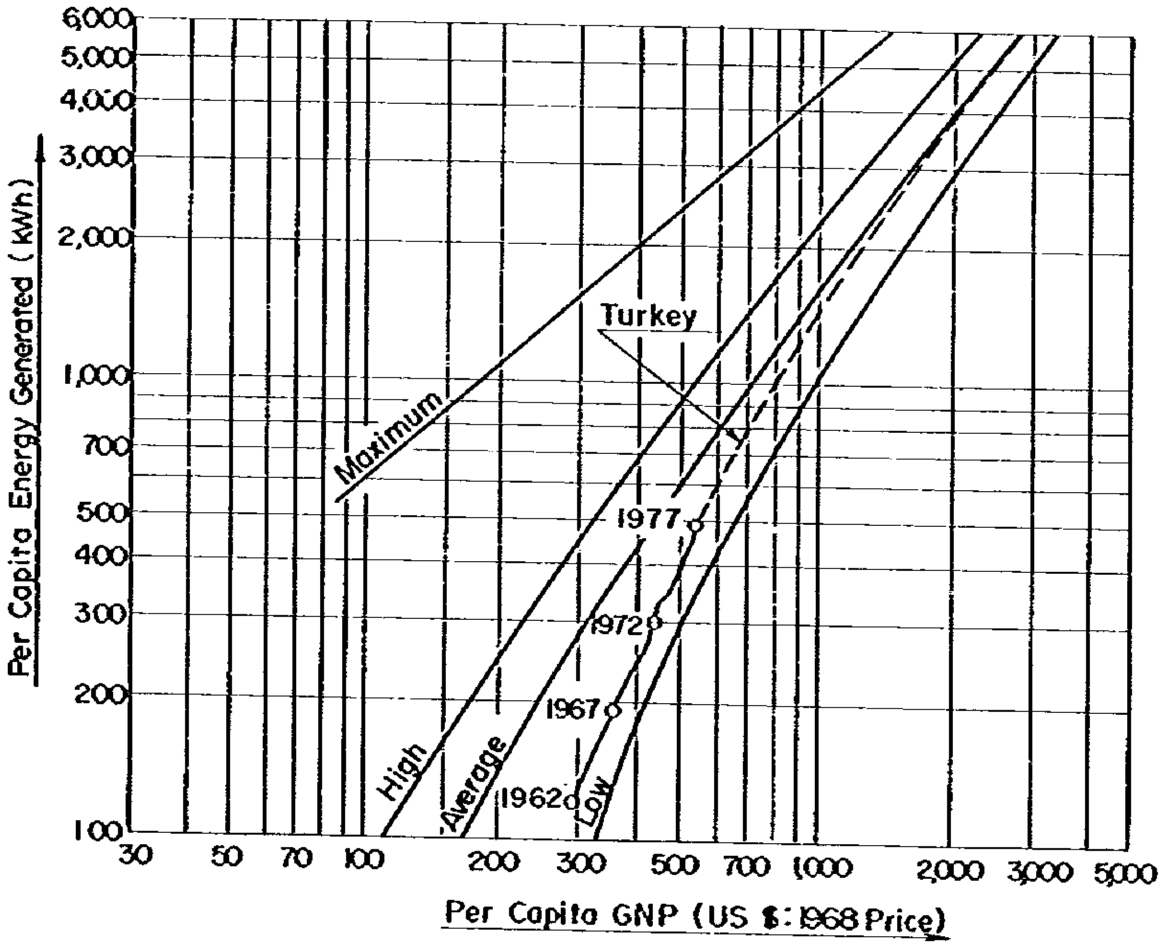


Table 5-4 Basic Data for Demand Forecast

	GNP (Constant Price in 1968)			Energy Generated		Population	Per Capita			
							GNP		Energy Generated	
	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		13,360		7,838	13.0	34,442	390	5.4	230	9.5
1970		14,350		8,623	10.0	35,605	400	2.6	240	4.3
1971		15,410		9,781	13.4	36,215	430	7.5	270	12.5
1972	148.5	16,420	6.6	11,242	14.9	37,132	440	2.3	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	181.4	20,060	8.0	15,623	15.9	40,348	500	4.2	390	11.4
1976	195.3	21,600	7.7	18,283	17.0	40,915	530	6.0	450	15.4
1977	203.0	22,450	3.9	20,565	12.5	41,768	540	1.9	490	8.9
Average			6.5		12.8	(2.4%)		4.2		10.3
1978	209.3	23,140	3.1	21,726	5.6	42,640	540	0	510	4.1
1979	208.3	23,030	-0.5	22,522	3.7	43,530	530	-1.9	520	2.0
1980	206.9	22,880	-0.7	23,275	3.3	44,737	510	-3.8	520	0
Average			0.6		4.2	(2.3%)		-1.9		2.0

Source of GNP (TL) and Growth Rate: ALMANAC TURKEY 1981

Table 5-5 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	41,768	20,565	12.8	3,376
1978	4.05	562	520		42,770	22,200		4,000
1979	4.05	585	570		43,800	25,000		4,500
1980	4.05	608	610		44,850	27,400		4,900
1981	4.2	634	650		45,920	29,800		5,300
1982	4.2	660	720		47,030	33,900		6,000
Average	4.1			8.0	(2.4%)		10.5	
1983	4.2	688	780		48,160	37,600		6,700
1984	4.2	717	820		49,310	40,400		7,200
1985	4.3	748	900		50,490	45,400		8,100
1986	4.3	780	970		51,710	50,200		9,000
1987	4.3	814	1,030		52,950	54,500		9,700
Average	4.25			7.4	(2.4%)		10.0	
1988	4.3	849	1,100		54,220	59,600		10,600
1989	4.3	885	1,200		55,520	66,600		11,900
1990	4.3	923	1,260		56,850	71,600		12,800
1991	4.35	963	1,360		58,220	79,200		14,100
1992	4.35	1,005	1,450		59,610	86,400		15,400
Average				7.1	(2.4%)		9.7	
1993	4.3	1,048	1,510		61,040	92,200		16,400
1994	4.3	1,094	1,670		62,510	104,400		18,600
1995	4.3	1,141	1,780		64,010	113,900		20,300
1996	4.3	1,190	1,880		65,550	123,200		22,000
1997	4.3	1,241	2,000		67,120	134,200		23,900
Average	4.3			6.6	(2.4%)		9.2	
1998	4.2	1,293	2,100		68,730	144,300		25,700
1999	4.2	1,347	2,250		70,380	158,400		28,300
2000	4.2	1,404	2,400		72,070	173,000		30,900
2001	4.1	1,461	2,520		73,800	186,000		33,200
2002	4.1	1,521	2,700		75,570	204,000		36,400
Average	4.15			6.2	(2.4%)		8.7	

5.1.3 Results of Study

A comparison of the forecast made by TEK and that by the macro-method is given in Table 5-6 and Fig. 5-3.

Table 5-6 Comparison of Demand Forecasts

Period (Year)	By TEK		By Macro-method		Difference	
	GWh: (a)	Growth Rate (%)	GWh: (b)	Growth Rate (%)	(c): (a)-(b)	%: (c)/(a)
End of 1977	21,400*	13.7*	20,565**	12.8**	835	3.9
End of 1982	39,500	13.0	33,900	10.5	5,600	14.2
End of 1987	70,400	12.3	54,500	10.0	15,900	22.6
End of 1992	117,000	10.7	86,400	9.7	30,600	26.2
End of 1997	182,900	9.3	134,200	9.2	48,700	26.6
End of 2000	233,200		173,000		60,200	25.8
1977 - 2000		10.9		9.7		

Note: *) Estimated **) Recorded

As is clear in the table and graph, for gross energy generated by year, the results of the macroscopic method are lower, and there is the largest difference of 26.6% for the year 1997.

It is considered that the difference between the two were due to the following:

(a) As the energy production of 1977 serving as an initial condition for the forecast, TEK adopted an estimated value, whereas the macro-method took actual values.

(b) With regard to the future population increase rate, TEK used an annual rate of 2.5%, while the macro-method used 2.4% taking into consideration the trend of decline in the population increase rate in recent years.

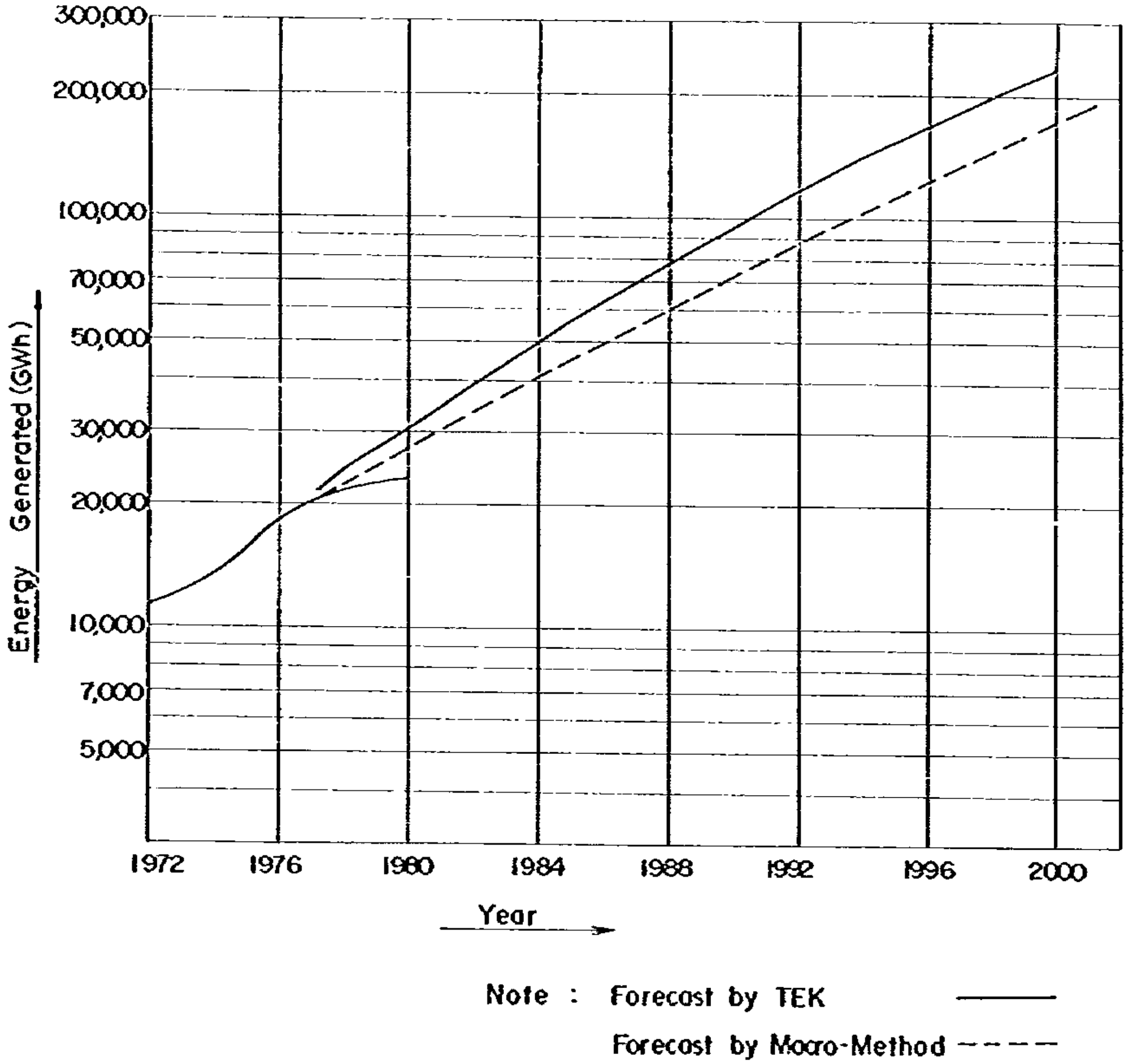
(c) As the per capita GNP growth rate to be an initial condition of the forecast by macro-method, the situation in the past two or three years was taken into account and 4.0% was used.

Concerning growth rates by both methods, there is not much difference between the two. The average growth rate for the 23 years to the year 2000 is 10.9% according to TEK, while that by the macro-method is 9.7%.

The correlations shown in Figs. 5-1 and 5-2 have been established based on the present and past conditions in the Republic of Turkey, and with worldwide trends as indices.

The ratio between the growth rate in GNP per capita and the growth rate in kWh per capita of the Republic of Turkey, namely, the elasticity coefficient, indicates a very high level. This signifies that growth rate of electric energy consumption is at a higher level compared wih rate of economic growth. However, it was forecast that per capita electric energy, after attaining a certain level, would gradually be converged to the worldwide growth rate.

Fig. 5-3 Comparison of Demand Forecasts : Energy



5.2 Demand and Supply Balance

5.2.1 Energy Supply Plan

The theoretical hydroelectric potential of the Republic of Turkey is said to be 455,000 GWh annually, of which the annual electric energy of economic developable projects are indicated in Table 5-7, and as of the present, the evaluations are firm energy of 64,074 GWh and average energy of 90,606 GWh.

Table 5-7 Total of Hydraulic Power Plant Projects in Turkey

State of Project	Number of Project	Capacity (MW)			Energy Generated (GWh)	
		Installed	Average	Continuous	Average	Firm
In operation	44	2,131 (7.9%)	1,170	925	10,253 (11.3%)	8,107 (12.7%)
Under Construction	18	4,154 (15.4%)	1,672	1,080	14,651 (16.2%)	9,460 (14.8%)
Final Design	26	4,483 (16.6%)	1,712	1,400	14,977 (16.5%)	12,264 (19.1%)
In Planning Stage	20	3,871 (14.4%)	1,213	967	10,631 (11.7%)	8,471 (13.2%)
In Master Plan Stage	202	12,331 (45.7%)	4,577	2,942	40,094 (44.3%)	25,772 (40.2%)
Total	310	26,970 (100%)	10,344	7,314	90,606 (100%)	64,074 (100%)

The power development plans from 1981 to 1994 are indicated in Tables 5-8 and 5-9. These plans are based on the plans of DSI and TEK and slightly cut back to be in step with the results of the demand forecast by the macro-method.

In the event these plans are realized, the total installed capacity in 1994 will be 5.3 times the present and will reach 27,900 MW.

The firm energy in 1994 will be 5.1 times that at present, to be increased to 109,100 GWh. Accordingly, the installed hydroelectric capacity will be approximately 7.1 times the present capacity. As a result, as shown in Fig. 5-4, 55% of the entire facilities will be made up by hydro.

The effective utilization of hydraulic energy will be improved year by year (see Fig. 5-5). In 1994, 60% of the energy possessed by developable sites will have been realized. Thus hydro will be utilized as precious energy resources.

The major hydroelectric power stations presently being constructed are listed in Table 5-10.

Table 5-8 Construction Schedule of Power Plants in Turkey

(Unit: MW)

Year	Installed Capacity					Average Capacity		Continuous Capacity	
	Thermal		Hydraulic		Total	Hydraulic	Total	Hydraulic	Total
	New Plant	Total (1)	New Plant	Total (2)	(1) + (2)	(3)	(1) + (3)	(4)	(1) + (4)
Existing	-	3,153	-	2,131	5,284	1,170	4,323	925	4,078
1981	0	3,153	180	2,311	5,464	1,228	4,381	983	4,136
1982	375	3,528	711	3,022	6,550	1,410	4,938	1,021	4,549
1983	765	4,293	125	3,147	7,440	1,427	5,720	1,021	5,314
1984	680	4,973	678	3,825	8,798	1,677	6,650	1,117	6,090
1985	990	5,963	15	3,840	9,803	1,685	7,648	1,122	7,085
1986	1,070	7,033	816	4,656	11,689	2,293	9,326	1,684	8,717
1987	450	7,483	1,690	6,346	13,829	2,947	10,430	2,124	9,607
1988	600	8,083	967	7,313	15,396	3,138	11,221	2,215	10,298
1989	900	8,983	166	7,479	16,462	3,205	12,188	2,254	11,237
1990	600	9,583	1,099	8,578	18,161	3,614	13,197	2,470	12,053
1991	300	9,883	1,480	10,058	19,941	4,412	14,295	3,124	13,007
1992	1,000	10,883	1,788	11,846	22,729	5,182	16,065	3,674	14,557
1993	900	11,783	1,158	13,004	24,787	5,555	17,338	3,910	15,693
1994	900	12,683	2,229	15,233	27,916	6,158	18,841	4,292	16,975
Total (Additional)	9,530	-	13,102	-	-	-	-	-	-

Table 5-9 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	13,260	8,107	10,253	21,367	23,513
1981	13,260	8,607	10,753	21,867	24,013
1982	15,510	8,945	12,354	24,455	27,864
1983	19,830	8,945	12,501	28,775	32,331
1984	23,730	9,787	14,690	33,517	38,420
1985	29,670	9,829	14,761	39,499	44,431
1986	36,090	14,747	20,090	50,837	56,180
1987	38,790	18,599	25,816	57,389	64,606
1988	42,690	19,393	27,485	62,083	70,175
1989	48,390	19,731	28,069	68,121	76,459
1990	52,290	21,621	31,655	73,911	83,945
1991	54,090	27,346	38,648	81,436	92,738
1992	60,090	32,185	45,393	92,275	105,483
1993	65,790	34,248	48,659	100,038	114,449
1994	71,490	37,600	53,944	109,090	125,434
Total (Additional)	58,230	29,493	43,691	87,723	101,921

Fig. 5-4 Ratio of Hydraulic Power Stations in Total Installed Capacity (Forecast)

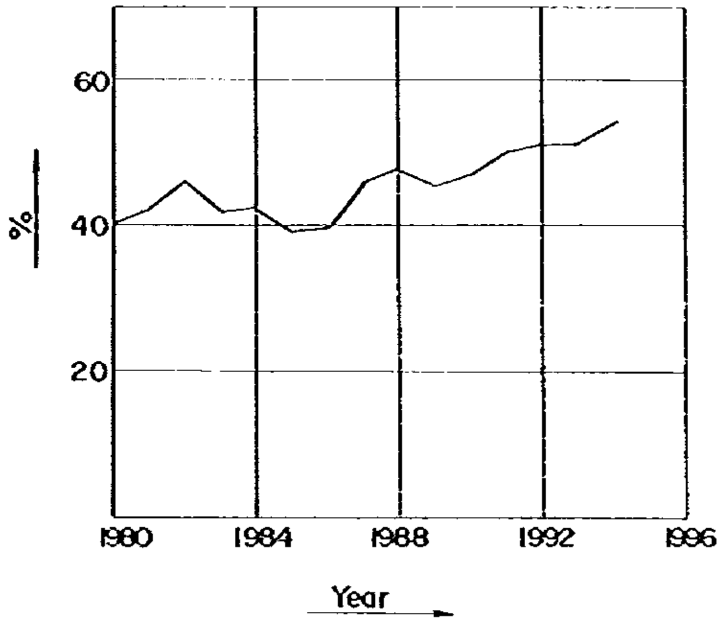


Fig. 5-5 State of Development of Hydraulic Energy (Forecast)

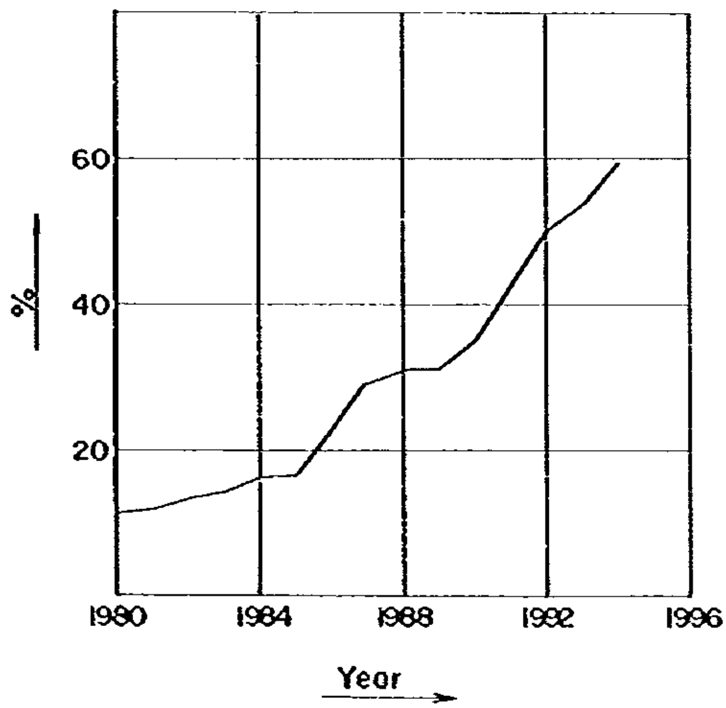


Table 5-10 Major Hydraulic Power Plants under Construction

Project	Installed Capacity (MW)	Energy Generated (GWh)		Year of Commissioning
		Average	Firm	
Keban (#1 - 8)	1,350	6,220	4,460	1974 - 1982
S. Ugurlu	46	273	206	1982
H. Ugurlu (#1 - 4)	500	1,297	820	1980 - 1983
Aslantas (#1 - 3)	138	569	360	1984
Oymapinar (#1 - 4)	540	1,620	482	1983 - 1984
Karacaören (#1, 2)	30	142	84	1984 - 1985
Adigüzel	60	280	150	1986
Köklüce	90	588	576	1986
Kapulukaya (#1 - 3)	51	190	150	1986
Altinkaya (#1 - 4)	700	1,632	1,334	1986 - 1987
Gezende	150	528	130	1987
Menzelet (#1 - 4)	120	334	192	1987
Kilickaya (#1, 2)	120	332	236	1987
Karakaya (#1 - 6)	1,800	7,354	6,278	1986 - 1989

5.2.2 Demand and Supply Balance

Table 5-11 indicates the balance sheet of electric energy up to 1994 predicted from the forecast results by the macro-method. The general trend of demand and supply are graphically indicated in Figs. 5-6 and 5-7.

As is clearly seen in the table and graphs, a shortage in energy supply was especially prominent from 1981 to 1985, and actually, the electric power situation will be fairly tight. However, if the present development plans proceed smoothly, from 1986 it will gradually become possible for electric power to be supplied stably with a fair amount of allowance.

Table 5-11 Energy Balance Estimated

Year	Energy Demand Estimated: (1)	Available Energy Supplied		Allowance			
		Firm: (2)	Average: (3)	Firm		Average	
	(GWh)	(GWh)	(GWh)	GWh: (4) (2) - (1)	% (4)/(1)	GWh: (5) (3) - (1)	% (5)/(1)
1980	23,275	21,367	23,513	-1,908	-8.2	238	1.0
1981	29,800	21,867	24,013	-7,933	-26.6	-5,787	-19.4
1982	33,900	24,455	27,864	-9,445	-27.9	-6,036	-17.8
1983	37,600	28,775	32,331	-8,825	-23.5	-5,269	-14.0
1984	40,400	33,517	38,420	-6,883	-17.0	-1,980	-4.9
1985	45,400	39,499	44,431	-5,901	-13.0	-969	-2.1
1986	50,200	50,837	56,180	637	1.3	5,980	11.9
1987	54,500	57,389	64,606	2,889	5.3	10,106	18.5
1988	59,600	62,083	70,175	2,483	4.2	10,575	17.7
1989	66,600	68,121	76,459	1,521	2.3	9,859	14.8
1990	71,600	73,911	83,945	2,311	3.2	12,345	17.2
1991	79,200	81,436	92,738	2,236	2.8	13,538	17.1
1992	86,400	92,275	105,483	5,875	6.8	19,083	22.1
1993	92,600	100,038	114,449	7,438	8.0	21,849	23.6
1994	104,400	109,090	125,434	4,690	4.5	21,034	20.1

Fig. 5-6 Demand Forecast : Energy

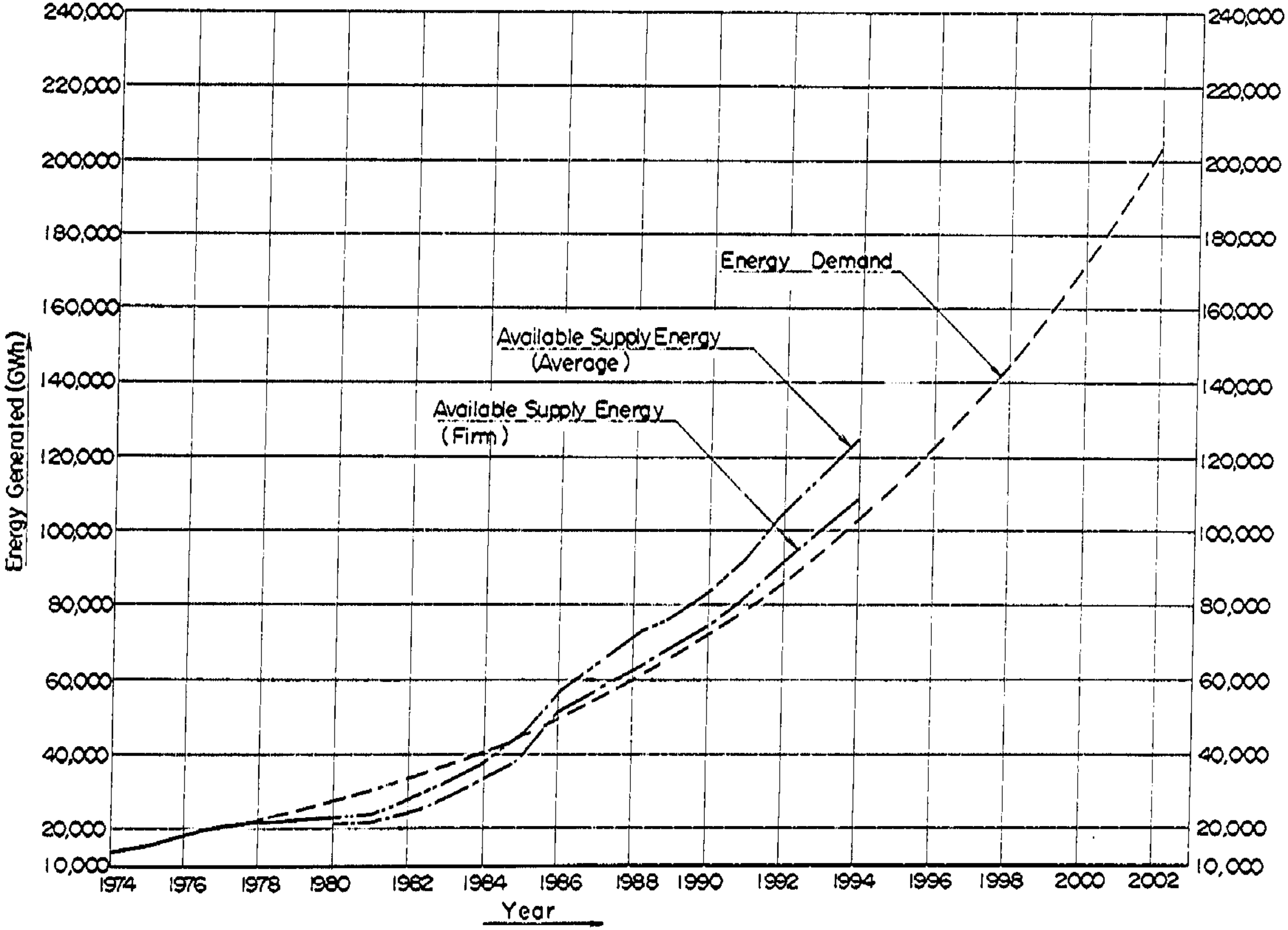
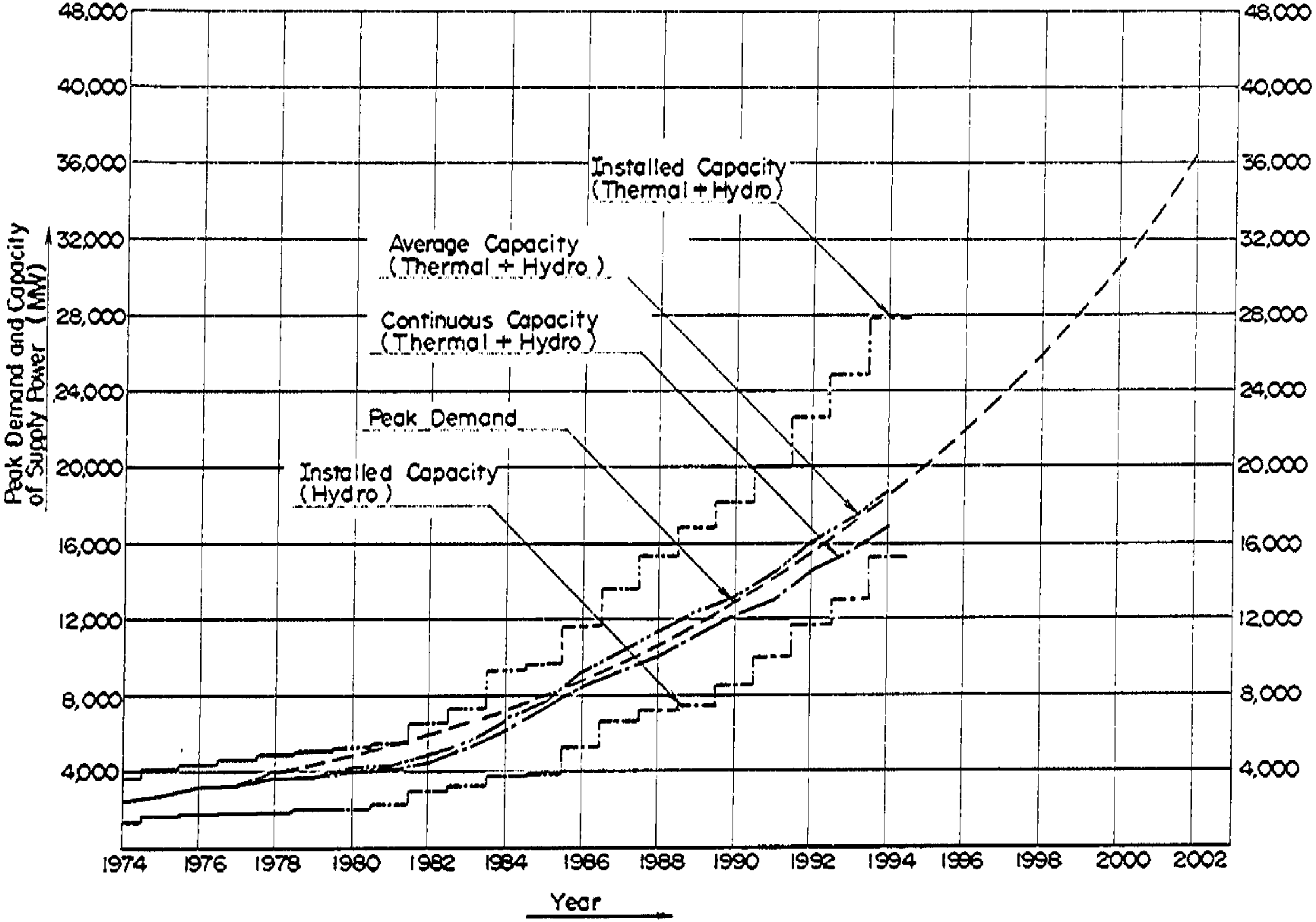


Fig. 5-7 Demand Forecast : Power



CHAPTER 6

HYDROLOGY

CHAPTER 6 HYDROLOGY

LIST OF FIGURES

LIST OF TABLES

CHAPTER 6 HYDROLOGY

6.1 Outlines of Meteorology and Hydrology

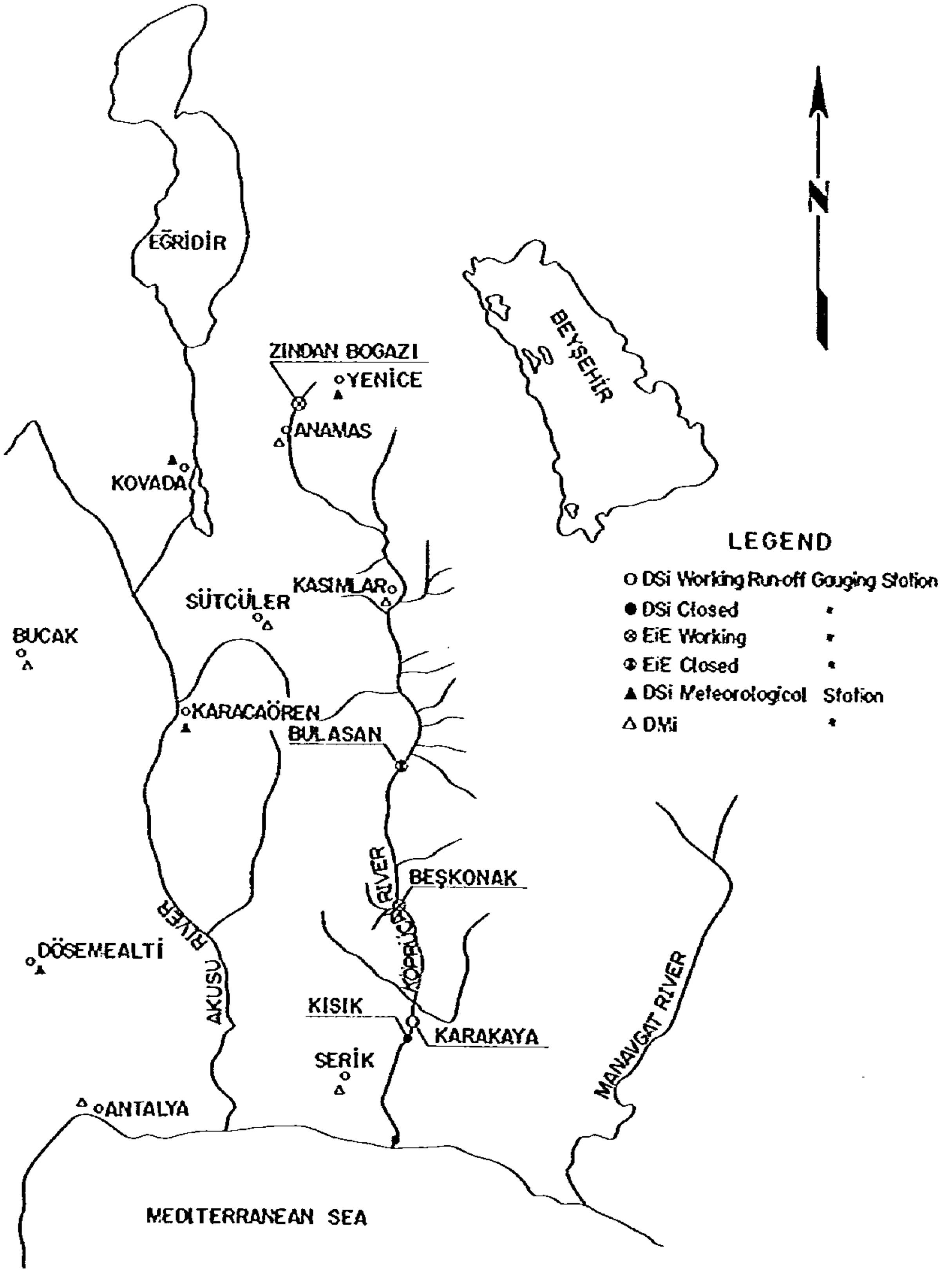
The Beskonak project is located approximately 40 km from the mouth of the Köprücay River with a catchment area of 1,980 km^2. It takes up about 80% of the Köprücay River basin.

The annual runoff at the project site is 2.63×10^9 m^3 and the annual avarage precipitation is 1,100 mm for the catchment area. The specific runoff per 100 km^2 is 4.22 m^3/sec and it is rather favorable value than another sites in Turkey. The annual mean temperature at Antalya is 18.6°C, the number of days of rainfall being about 90 days through the year.

6.2 Runoff Gauging Stations and Meteorological Gauging Stations

There are 6 runoff gauging stations in the Köprücay River basin, the three of which, Bulasan, Kisik and so on, are presently not in use. There are numerous meteorological gauging stations in the Köprücay River basin and its surroundings. At Antalya station, precipitation, air temperature, humidity, evaporation, vapor pressure, wind, insolation time, etc., are being measured. Precipitation is being measured at 11 gauging stations headed by Serik and Beskonak. The locations of runoff gauging stations and meteorological gauging stations are shown in Fig. 6-1.

Fig. 6-1 Run-off G.S. & Meteorological G.S. in Köprüçay Basin



6.3 Estimation of Runoff at Project Site

6.3.1 River Runoff

The catchment area of the Beskonak project site is 1,980 km^2 according to a 1/25,000 scale topographical map. The catchment area of Beskonak gauging station is 2,072.8 km^2 (January 1940 - September 1962), 1,960.8 km^2 (October 1962 - September 1963), and 1,942.4 km^2 (October 1963 to date). The catchment area ratios of the gauging station to the project site are 104.7%, 99.0% and 98.1%, for the respective periods.

The Oluk-köprü springs of about 2 km long are located approximately 15 km upstream of the dam site. According to the studies in the past, it was reported that the volume of springing was estimated to be at least about 30 m^3/sec during dry season, and to be two or three times during rainy season. Due to these springs, a distinct correlation does not exist between precipitation in the catchment area and the river discharge. Strictly speaking, in computation of runoff at the project site, it should be considered that resources of river discharge be separated into spring water and runoff due to precipitation. However, since the catchment areas of Beskonak G.S and the project site are almost the same, the runoff estimations at the project site were performed by using the catchment area ratio without overestimating the spring volume.

6.3.2 Applied Runoff Gauging Station

The runoff data (monthly) at Beskonak G.S used for computing the discharges at the dam site are shown in Appendix A-2.

6.3.3 Period Considered for Runoff Estimation

Observations have been performed since Jan. 1940 at Beskonak G.S. It was judged that the runoff data (Jan. 1940 - Sep. 1940) were not reliable compared with another data. The data were not applied in runoff estimation.

It was decided that a period as long as possible was adoted for runoff estimation, and the period for estimation was selected to be the 40 years from Oct. 1940 to Sept. 1980.

6.3.4 Runoff Estimations

The runoff at the dam site was computed by the equations below according to the method based on the catchment area ratio, in addition, taking into consideration the Degirmenözü-Beskonak and Yilanli irrigation projects (intake: 3.10 m^3/sec, intake period: June - September) shown in Fig. 9-1.

$$Q_{Beskonak} = \begin{cases} R \cdot Q_{BGS} & ; \text{ (Oct.1 - May 31)} \\ R \cdot Q_{BGS} - 3.10 & ; \text{ (June 1 - Sept. 30)} \end{cases}$$

where,

$$R = \begin{cases} 0.955 : \text{Oct. 1940 - Sept. 1962} \\ 1.010 : \text{Oct. 1962 - Sept. 1963} \\ 1.019 : \text{Oct. 1963 - Sept. 1980} \end{cases}$$

$Q_{Beskonak}$: runoff at Beskonak dam site

Q_{BGS} : runoff at Beskonak gauging station

R : catchment area ratio

The runoffs at the dam site during the 40-year period from 1940 to 1980 are shown in Table 6-1.

Table 6-1 Monthly Inflow at Beskonak Dam Site

Unit: $10^6 m^3$

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Total
1941	132.80	163.43	605.02	578.51	376.04	376.61	235.90	237.60	163.09	134.32	112.49	102.05	3,277.86
1942	144.45	151.32	183.31	435.39	454.44	456.90	358.25	284.29	177.58	131.08	110.30	93.64	3,077.92
1943	126.61	230.01	283.19	460.71	241.36	222.39	338.33	276.63	170.68	124.97	103.55	91.81	2,670.24
1944	118.44	121.72	225.87	357.72	519.71	502.71	334.32	307.69	208.60	155.00	122.93	103.94	3,133.71
1945	115.52	199.87	298.70	433.07	319.04	279.09	334.63	326.95	193.93	141.04	115.09	93.95	2,851.90
1946	144.23	123.93	541.33	314.02	379.85	359.60	394.19	371.12	259.10	185.08	147.15	104.30	3,323.95
1947	121.33	97.33	457.01	375.78	491.81	277.75	219.85	202.62	130.79	93.93	71.16	62.86	2,607.26
1948	72.00	167.39	425.42	473.14	450.16	236.40	255.10	246.09	165.78	139.17	79.33	64.20	2,779.18
1949	67.42	61.12	99.07	134.70	143.54	408.78	317.31	285.33	149.43	102.40	71.38	59.55	1,905.03
1950	63.88	75.76	129.23	182.10	106.83	160.20	243.47	250.08	133.90	82.41	59.67	51.87	1,539.31
1951	59.54	56.82	83.69	361.69	174.69	367.55	349.17	330.46	243.73	195.34	161.94	144.94	2,536.84
1952	181.86	110.93	141.18	269.34	374.54	306.01	271.69	249.25	169.62	119.39	95.67	73.12	2,361.45
1953	81.80	255.85	1,086.68	851.87	432.31	382.95	334.34	322.29	229.68	160.45	113.32	94.17	4,356.95
1954	59.73	88.02	83.17	212.91	237.08	319.95	275.81	267.95	145.64	102.13	78.93	65.59	2,081.92
1955	84.95	153.84	354.95	487.65	313.82	259.30	237.19	181.41	123.38	92.78	76.01	69.13	2,439.32
1956	81.24	115.08	133.66	190.14	379.55	355.05	263.48	222.17	138.31	94.90	72.32	65.69	2,110.97
1957	67.99	97.58	125.75	151.97	152.51	289.75	171.05	183.21	125.56	81.48	63.77	58.73	1,574.34
1958	70.04	81.70	183.71	278.10	282.78	426.93	338.85	245.50	173.12	121.28	77.67	70.92	2,850.67
1959	71.33	62.47	312.57	632.61	253.45	169.90	182.42	155.39	121.59	89.65	66.95	51.76	2,190.10
1960	81.45	94.40	185.29	442.87	190.70	195.15	265.11	203.34	124.34	90.48	77.45	71.49	2,022.08
1961	81.61	77.01	245.17	254.58	451.34	197.45	326.45	117.26	103.45	83.00	71.67	65.50	2,145.51
1962	73.47	74.35	120.26	176.29	473.12	366.65	245.70	207.50	134.52	103.31	86.24	80.56	2,166.93
1963	102.69	93.93	478.58	510.74	493.20	320.74	284.62	300.14	212.06	138.53	106.49	83.23	3,129.78
1964	101.27	92.25	215.32	119.97	223.47	282.52	172.86	149.21	128.33	97.20	79.76	72.34	1,734.50
1965	81.10	84.91	131.09	302.63	549.16	445.17	455.15	414.21	213.01	127.25	102.53	91.60	3,048.92
1966	100.28	97.23	535.95	1,038.63	410.65	333.32	413.06	297.54	192.33	143.54	119.57	99.22	3,839.72
1967	101.43	99.95	377.82	350.01	234.93	276.87	430.89	305.63	175.94	134.13	112.87	93.51	2,699.93
1968	113.70	222.29	367.91	577.44	330.19	545.43	308.97	254.05	159.17	123.21	107.78	117.94	3,228.06
1969	113.03	165.84	390.83	578.93	311.08	379.58	350.45	358.37	202.31	145.97	119.97	104.43	3,250.85
1970	109.39	100.83	485.17	574.95	543.40	455.26	301.55	255.67	178.04	151.02	113.27	100.91	3,371.44
1971	119.08	139.61	195.36	199.85	311.01	338.74	281.59	242.85	160.95	111.82	94.09	84.08	2,279.07
1972	84.45	130.38	307.53	154.57	219.69	233.69	138.65	190.81	141.06	115.25	95.22	85.92	1,557.22
1973	100.52	113.32	53.91	122.75	234.32	335.35	239.81	226.40	137.09	102.37	86.57	76.65	1,954.06
1974	91.76	84.34	156.75	266.47	262.53	335.44	200.70	181.43	118.04	91.93	82.60	82.37	1,954.44
1975	95.86	104.95	360.27	445.26	334.07	350.74	379.05	384.73	223.40	141.69	113.48	87.74	3,021.29
1976	145.36	277.58	268.48	318.43	241.72	119.70	350.10	245.57	160.16	121.47	100.17	87.04	2,455.78
1977	145.86	123.20	510.61	230.55	213.23	245.38	314.75	239.23	134.91	102.19	90.21	87.84	2,439.55
1978	95.69	93.16	140.19	573.55	697.73	397.06	359.51	314.32	186.26	130.81	105.95	101.40	3,185.53
1979	139.25	179.24	370.60	695.33	422.73	251.23	229.39	250.14	217.34	134.43	102.23	83.65	3,032.15
1980	121.20	268.03	336.44	455.52	249.06	301.78	340.15	260.93	152.18	111.34	92.57	82.92	2,652.09
Ave.	102.76	127.80	302.28	403.87	340.38	325.55	301.91	260.95	167.37	121.05	95.49	84.93	2,634.84

6.4 Precipitation

The annual rainfall distribution in the Köprücay River basin and its surroundings is shown in Fig. 6-2.

The project area is situated in a relatively heavy rainfall zone in Turkey, and especially in the vicinity of the dam site annual precipitation is more than 1,500 mm.

Table 6-2 shows the seasonal variation of the annual precipitation in the Köprücay basin and its surroundings. Approximately one half of the annual precipitation occurs in the three month period of the winter (December - February), with the heaviest rainfall of about 220 mm in January. July and August have the least precipitation with about 10 mm.

The monthly average rainfalls at the gauging stations in the catchment area and the surroundings are given in Fig. 6-3, the precipitation observation periods in Fig. 6-4, and rainfall data in Appendix A-2.

Fig. 6-2 Isohyetal Map of Annual Mean Precipitation

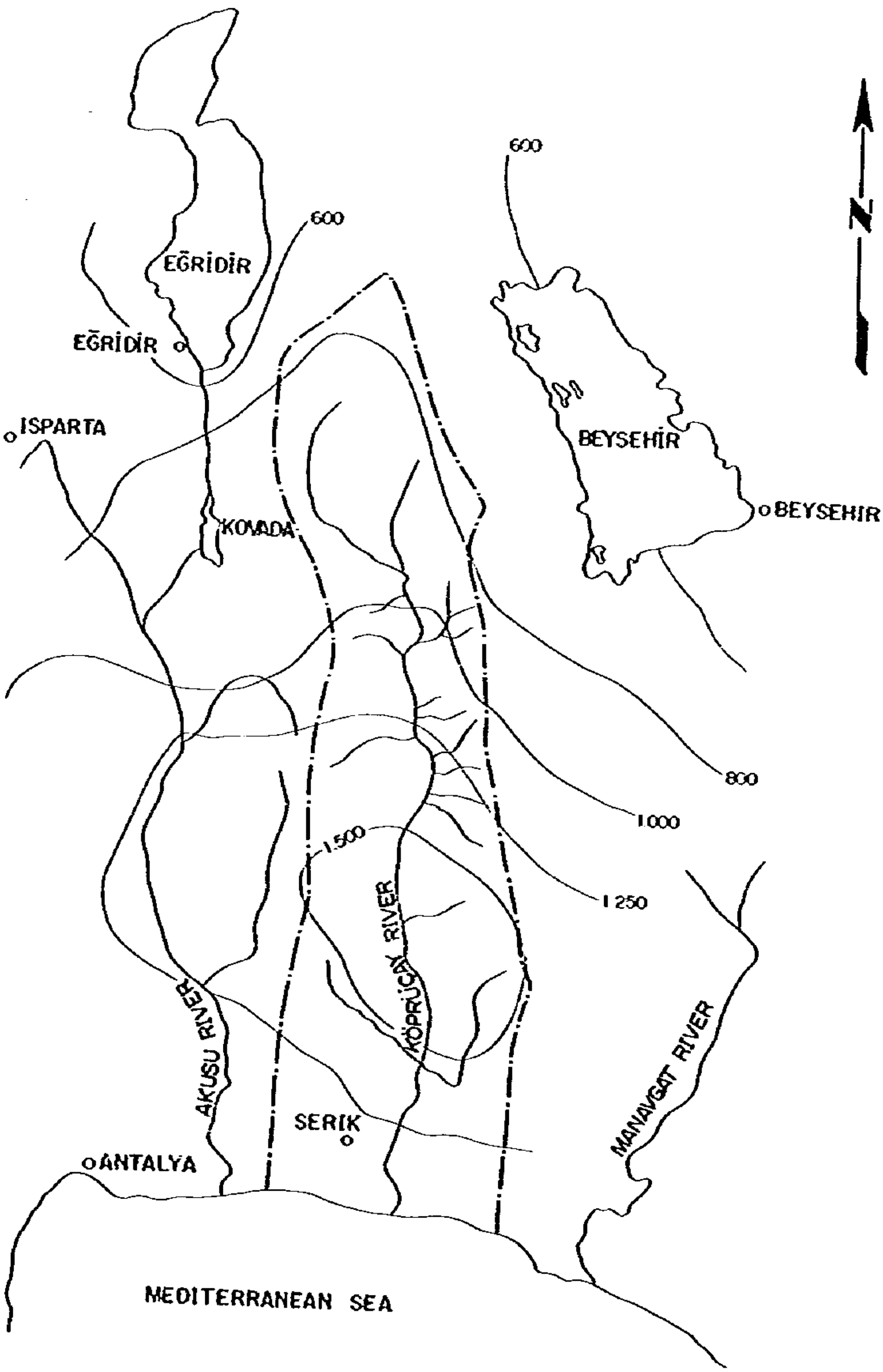


Table 6-2 Seasonal Variations of Annual Average Precipitation within and around Köprücay Basin

Station Name	Annual Average Precipitation (mm)	Spring Mar.,Apr.,May (mm)	Spring (%)	Summer Jun.,Jul.,Aug. (mm)	Summer (%)	Autumn Sept.,Oct.,Nov. (mm)	Autumn (%)	Winter Dec.,Jan.,Feb. (mm)	Winter (%)
YENICE	861.2	247.0	28.7	51.7	6.0	148.0	17.2	414.3	48.1
ANAMAS	852.1	241.9	28.4	54.8	6.4	155.3	18.2	400.2	47.0
KASIMLAR	1,128.4	237.3	21.0	89.0	7.9	209.4	18.6	592.7	52.5
BESKONAK	1,545.5	290.5	18.8	43.4	2.8	308.1	19.9	903.5	58.5
ANTALYA	1,067.2	163.5	15.3	14.1	1.3	189.3	17.7	700.3	65.6
KOVADA	1,311.1	332.8	25.4	67.4	5.1	202.4	15.4	708.7	54.1
CARACAÖREN	1,390.3	311.9	22.4	44.6	3.2	261.5	18.8	772.2	55.5
SERIK	1,040.8	168.4	16.2	14.8	1.4	189.4	18.2	668.1	64.2
DÖSEMEALTI	1,098.5	229.3	20.9	29.0	2.6	140.9	12.8	699.4	63.7
SÜTCÜLER	895.1	249.4	27.9	62.2	6.9	172.7	19.3	410.7	45.9
DEREBUCAK	1,003.5	238.7	23.8	37.3	3.7	200.4	20.0	527.1	52.5

Fig. 6-3 (I) Monthly Average Precipitation within and around KÖPRÜÇAY Basin

( ) : Annual Mean Precipitation (mm)

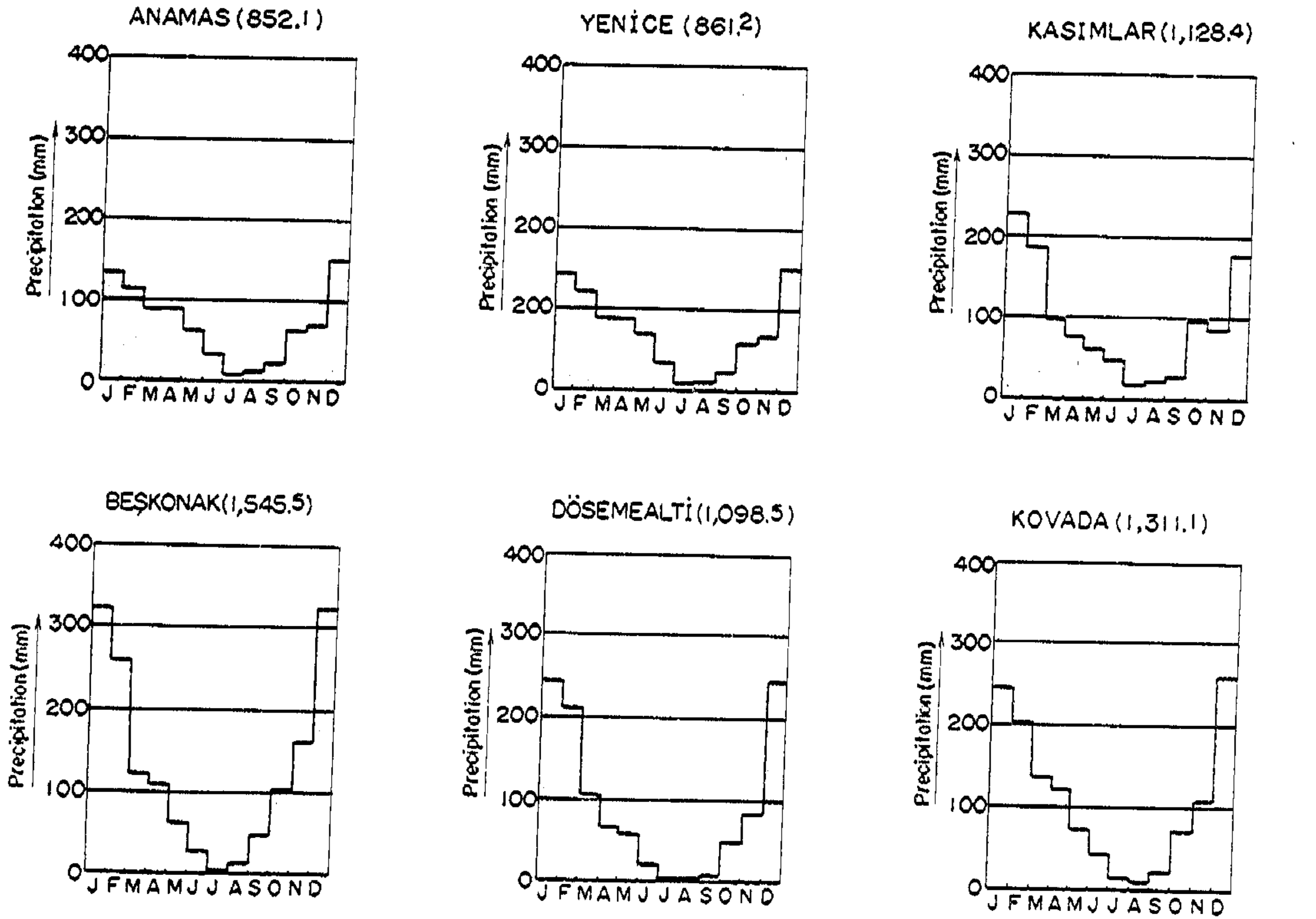


Fig. 6-3 (2) Monthly Average Precipitation within and around KÖPRÜÇAY Basin

( ) : Annual Mean Precipitation (mm)

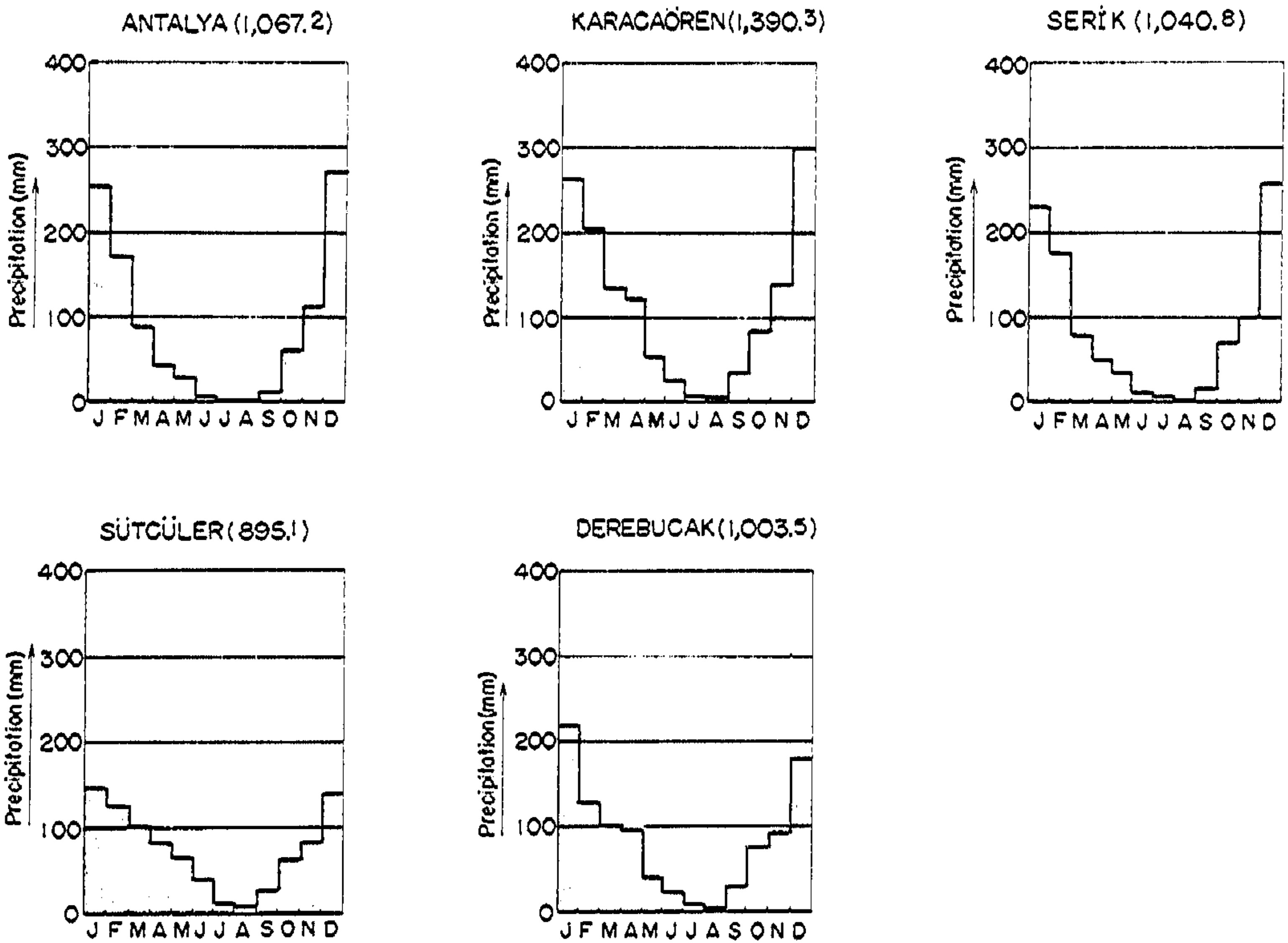
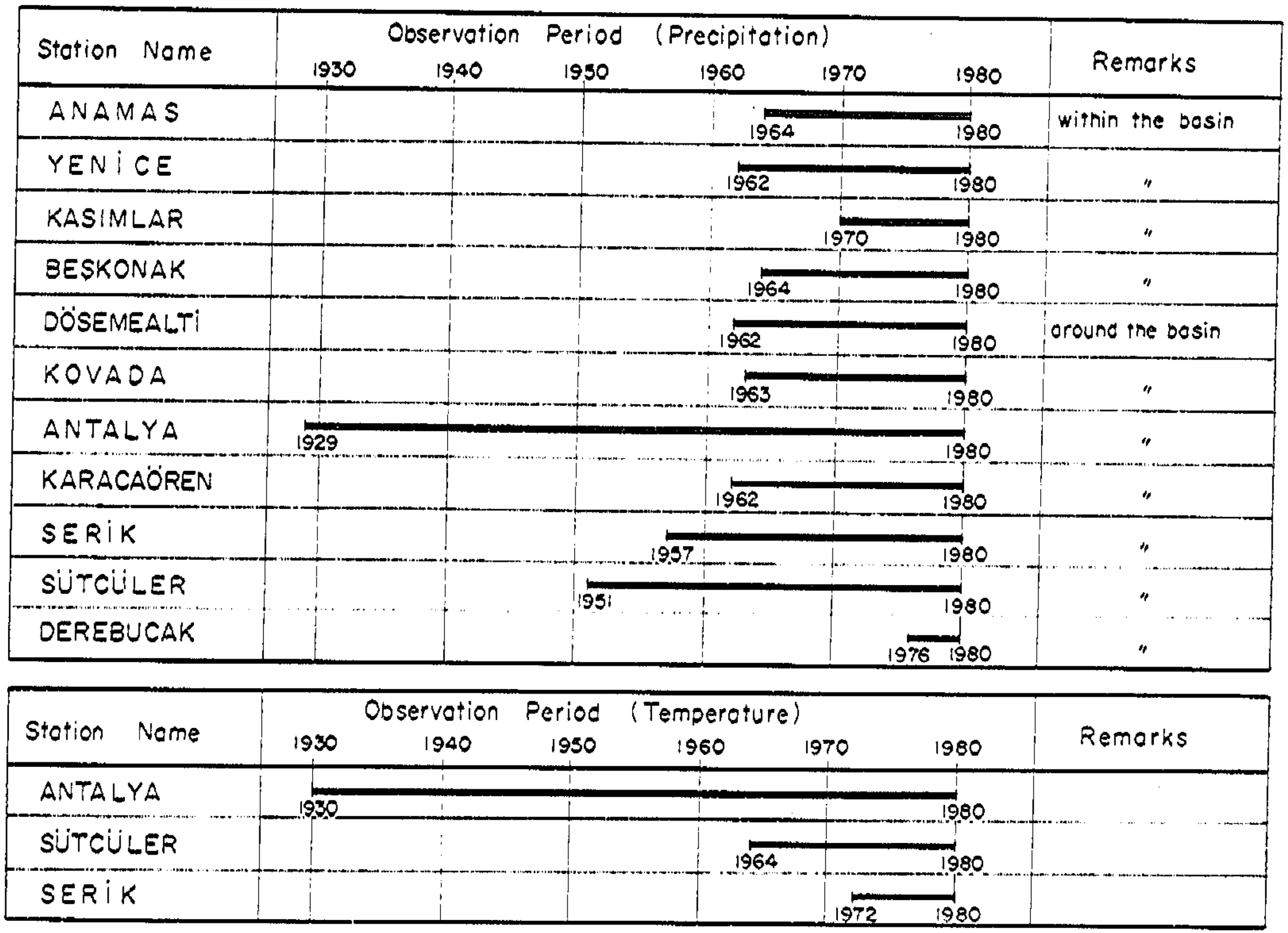


Fig. 6-4 Existing Precipitation and Temperature Data



6.5 Temperature

Table 6-4 shows the observation periods of gauging stations in the vicinity of the project site.

Temperature data (monthly maximum, monthly minimum, monthly average) are shown in Appendix A-2.

According to the records at Antalya station, which is located approximately 70 km southwest of the project site, the annual mean temperature is 18.6°C, the maximum and minumum temperatures 44.6°C and -4.6°C respectively.

6.6 Evaporation

Evaporation newly occuring as a result of provision of the reservoir is estimated to be the difference between evaporation from the water surface and the evapotranspiration through vegetation prior to construction of the reservoir.

The observation data of Antalya station were used for computation of the evaporation from the Beskonak reservoir. The monthly average evaporation was determined based on data of the 18-year period from January 1963 to December 1980. Using a correction factor of 0.70 in consideration of evapotranspiration through vegetation, the evaporation after construction of the reservoir was obtained. The results are indicated in Table 6-3. The observation data of evaporation at Antalya station are given in Appendix A-2.

Table 6-3 Monthly Evaporation from Beskonak Reservoir

(unit : mm)

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
Evaporation	51.2	49.7	70.5	88.3	114.1	160.8	186.0
Month	Aug.	Sept.	Oct.	Nov.	Dec.	Total	
Evaporation	167.9	138.5	95.9	59.6	52.6	1,235.1	

6.7 Sedimentation

The sedimentation volume was calculated using the suspended load concentration data at Beskonak G.S.

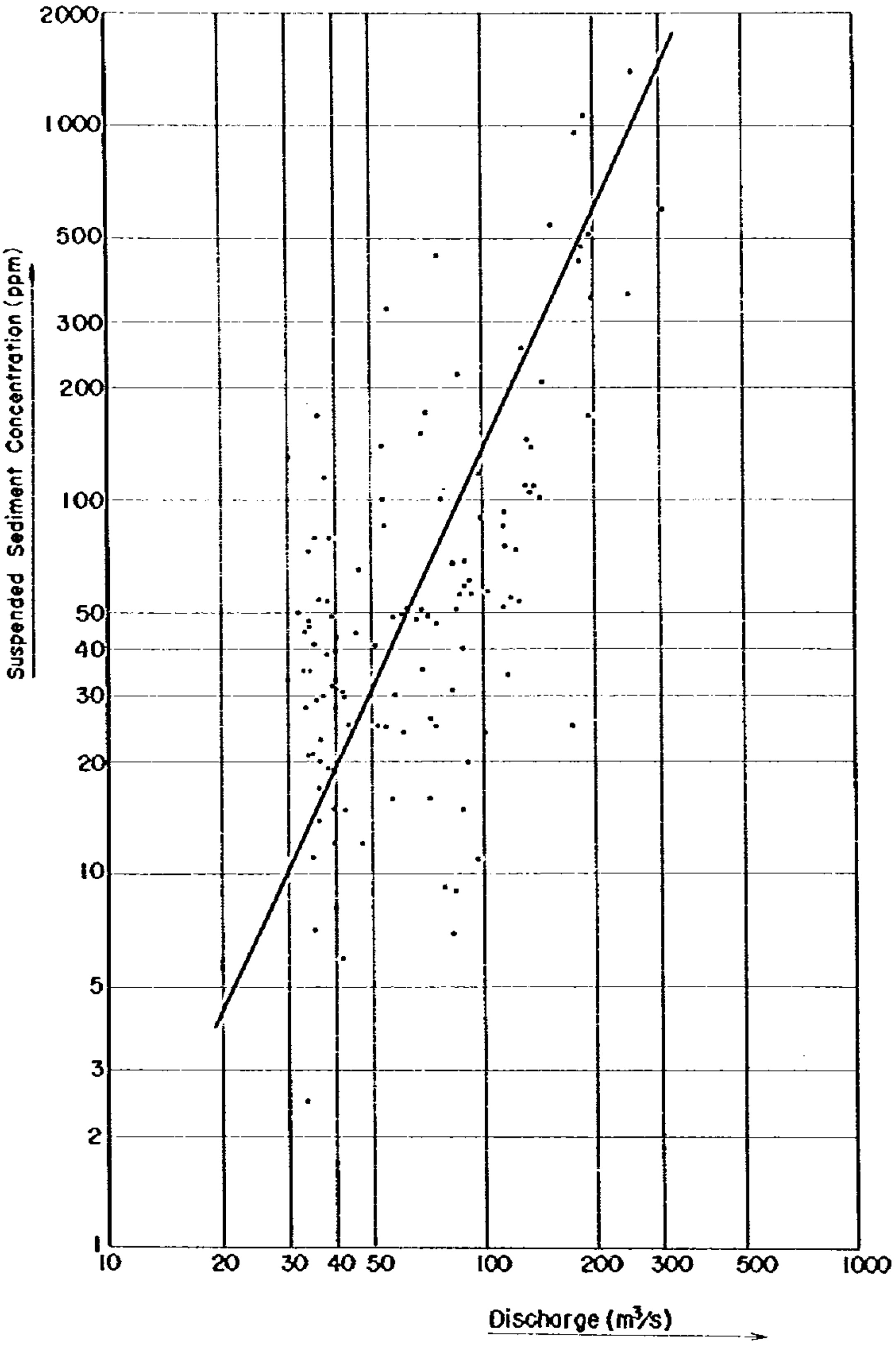
Measurements of suspended load concentrations and runoffs of the Köprücay River were performed by DSI for a total of 123 days during 1969 - 1980, and according to the measurement records, the maximum was 1,391 ppm, the minimum 2.5 ppm, and the averge 112 ppm.

Fig. 6-5 shows the correlation between suspended load concentration and river runoff expressed as logarithms. Assuming that the correlation is also valid for the dam site located approximately 8 km downstream of the gaging station, sedimentation volume was calculated by electronic computer using the 40-year dam inflows estimated in 6.3.4. The annual specific suspended load was calculated to be 402.6 $m^3/km^2/yr$. Considering bed load to be 20% of the suspended load, the annual specific sedimentation would be 483 $m^3/km^2/yr$ (= 402.6 x 1.2).

About 100 years would be required until the sediment level reaches the elevation of the power intake sill. It is considered that problems due to sediment will not arise during the service life of the power station.

The measured data of suspended load concentration and river runoffs are shown in Appendix A-2.

Fig. 6-5 Sediment Rating Curve at Beşkonak Gauging Station



6.8 Design Flood Discharge

Regarding the design flood discharge for dam and its spillway, in view of the economic and social importance of this Project, it is thought necessary to study the probable maximum flood (PMF).

The PMF, which was obtained from limited hydrological and meteorological data, was compared with statistical probable flood discharge calculated by flood frequency analysis. It was made sure whether the former would be appropriate for the design flood discharge for dam and spillway.

6.8.1 Probable Maximum Precipitation (PMP)

Fig. 6-4 indicates the observation periods of precipitation at 11 meteorological gaging stations located in the Köprücay River basin and neighboring river basins.

For the period of 1970 to 1980, during which the records of the 4 stations in the Köprücay basin are complete, 10 major storms were selected. These were taken as the data for PMP computation. The average precipitation in the basin during the storms was calculated by the Thiessen method. The results are given in Table 6-4.

Table 6-4 Area Average Rainfall during Selected Historical Storms

Storm No.	Date of Storm Occurrence	Rainfall Data (mm)				Area Average Value of Rainfall (mm)
		ANAMAS Sta.	YENICE Sta.	KASIMLAR Sta.	BESKONAK Sta.	
1	Feb. 21,'70	20.0	20.9	97.0	146.0	84.9
2	Nov. 22,'71	54.4	61.8	72.3	120.0	80.0
3	Dec. 11,'71	102.5	89.5	107.8	24.7	82.6
4	Jan. 30,'73	42.7	53.3	104.4	157.0	99.7
5	Dec. 16,'74	38.8	50.8	101.5	85.5	79.1
6	Jan. 31,'75	51.8	80.5	108.2	104.7	93.7
7	Dec. 13,'76	95.6	85.8	60.4	47.7	66.9
8	Dec. 27,'77	25.6	23.1	84.9	92.0	67.2
9	Feb. 19,'78	12.4	12.1	31.4	201.2	69.0
10	Jan. 4,'80	43.3	39.7	85.8	109.0	77.5

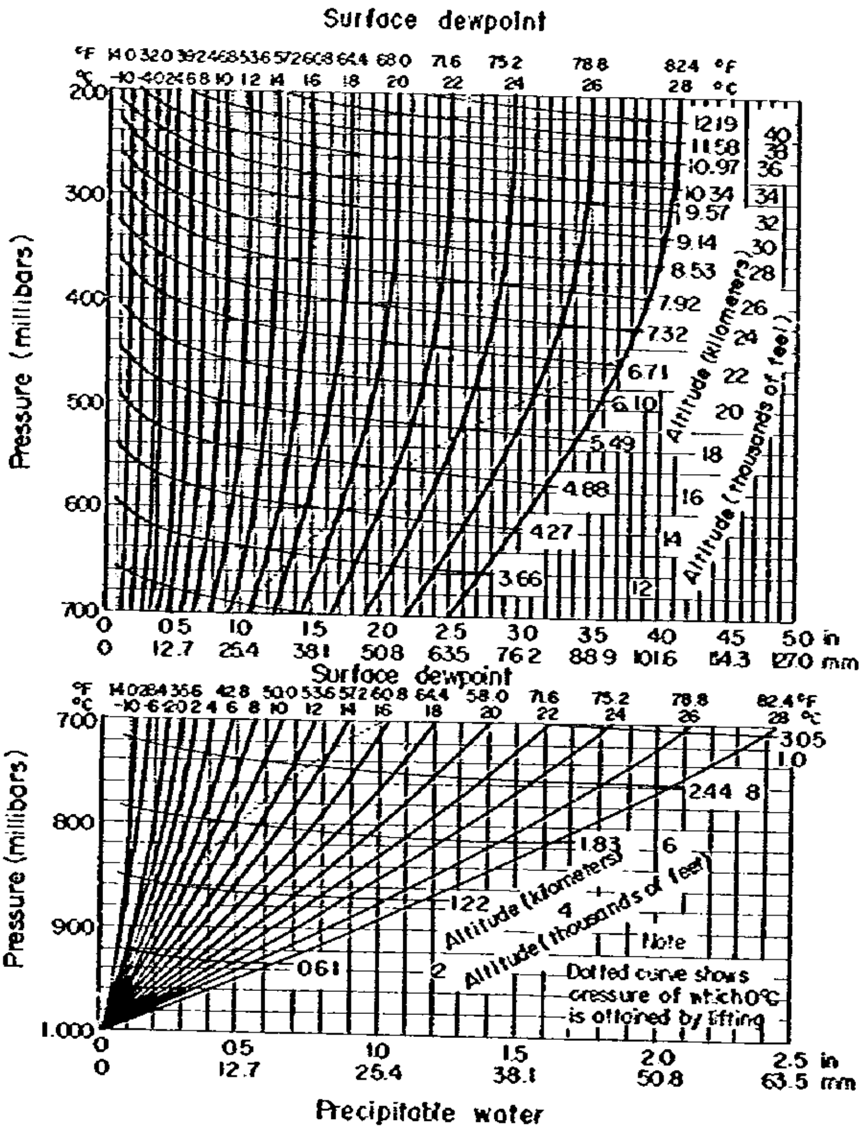
(1) Precipitable Water of Major Storms

The precipitable waters for the 10 major storms listed in Table 6-4 were computed by the procedure described below.

The 12-hour (or 24-hour) persisting dew point is generally used in calculation of the precipitable water. Since records of dew point temperatures were not available in the project area, the daily average vapor pressure of Antalya was adopted and converted to daily average dew point temeprature.

The daily average dew point temperature at Antalya on the day when a major storm occured in the project area, was converted to a value on a 1,000 mb plane. The nomograph prepared by U.S. Weather Bureau (see Fig. 6-6) was used to obtain the precipitable water. To add a note, the topographical barrier was put as EL. 1,200 m taking into consideration the topography of the Koprucay River basin.

Fig. 6-6 Depths of Precipitable Water in a Column of Air



Depths of precipitable water in a column of air of any height above the 1000-millibar level as a function of the 1000-millibar dewpoint, assuming saturation and pseudo-adiabatic lapse rate.
(U.S National Weather Service.)

(2) Maximum Precipitable Water

For the maximum precipitable water to be used in maximizing a major storm, it was considered reasonable to adopt the value of the month in which the storm was born. The maximum daily average vapor pressure of each month at Antalya was examined during 1930 - 1980, and maximum precipitable water was calculated by month in a same manner shown in (1).

(3) Probable Maximum Precipitation (PMP)

The probable maximum precipitation (PMP) was computed multiplying the Adjustment Factor (AF) by the average precipitation in the basin during the storm. The AF is to be calculated using the following equation.

$$AF = \frac{\text{Maximum Precipitable Water (mm)}}{\text{Precipitable Water During Storm (mm)}}$$

The 10 major storms were maximized given in Table 6-5.

As a result of calculations, the storm of January 30, 1973 showed PMP = 237 mm, the maximum value among the major storms. This value was adopted as the 24-hour PMP for the catchment area of the dam site.

Table 6-5 Storm Maximization for Selected Historical Storms

Storm No.	Date of Storm Occurrence	Area Average Value of Rainfall (mm)	Adjustment Factor	Probable Maximum Precipitation (mm)
1	Feb. 21,'70	84.9	2.37	201
2	Nov. 22,'71	80.0	1.97	158
3	Dec. 11,'71	82.6	1.76	145
4	Jan. 30,'73	99.7	2.38	237
5	Dec. 16,'74	79.1	2.02	160
6	Jan. 31,'75	93.7	2.43	228
7	Dec. 13,'76	66.9	1.48	99
8	Dec. 27,'77	67.2	2.67	179
9	Feb. 19,'78	69.0	1.92	132
10	Jan. 4,'80	77.5	2.54	197

6.8.2 Preparation of Unit Hydrograph

The observed hydrographs at Beskonak G.S (1973 - 1980) and the daily rainfall data (Yenice, Anamas, Kasimlar, Beskonak) in the catchment area were studied in order to preparate unit hydrographs. The observed hydrographs are shown in Appendix A-2.

The 5 storms, of which peak runoffs were relatively large and during which rainfall occured uniformly over the catchment area, were selected in Fig. 6-7. These storms were taken as data for preparing a unit hydrograph at the dam site. The selected 5 floods had all occured in other than the snowmelt period, and it is reasonable to consider that these floods had occured due to rainfall only.

These 5 observed hydrographs were separated into direct runoff and base flow. The runoff coefficient was computed from the ratio of direct runoff to total runoff. The effective rainfall was estimated by the method how water losses ratio was constant. Since hourly rainfall data were not available during storms in the basin, the hourly rainfall distribution was estimated referring to the data recorded at Antalya.

The data of direct runoff and effective rainfall calculated by the above procedure were statistically processed (linear analysis method) and individual unit hydrographs were prepared under the following conditions:

Rainfall duration : 6 hr

Rainfall intensity : 10 mm

The results are shown in Fig. 6-8. The ordinates of the 5 unit hydrographs in Fig. 6-8 were arithmetically averaged. A slight amount of adjustment was made of the peak runoff, and the unit hydrograph at the dam site was prepared. The result is shown in Fig. 6-9.

Further, using Snyder's concept of "Synthetic Unit Hydrograph", the unit hydrograph at the dam site was made in consideration of the physical conditions of the upstream basin of the dam. The result is shown in Fig. 6-10.

Strictly speaking, the unit hydrograph in Fig. 6-9 is not at the dam site, but at Beskonak G.S. However, the both sites are only about 8 km apart and it was judged that the unit hydrograph in Fig. 6-9 could be applied to the dam site.

On comparison of the unit hydrographs in Figs. 6-9 and 6-10, there is a slight difference in the peak runoffs, but they are considered to be approximately equal.

The unit hydrograph in Fig. 6-9 with the larger peak runoff was adopted as that at the dam site in consideration of the fact that the unit hydrograph would be used for calculation of the design flood discharge for dam and spillway.

Fig. 6-7 Observed Flood Hydrographs at Beşkonak G.S

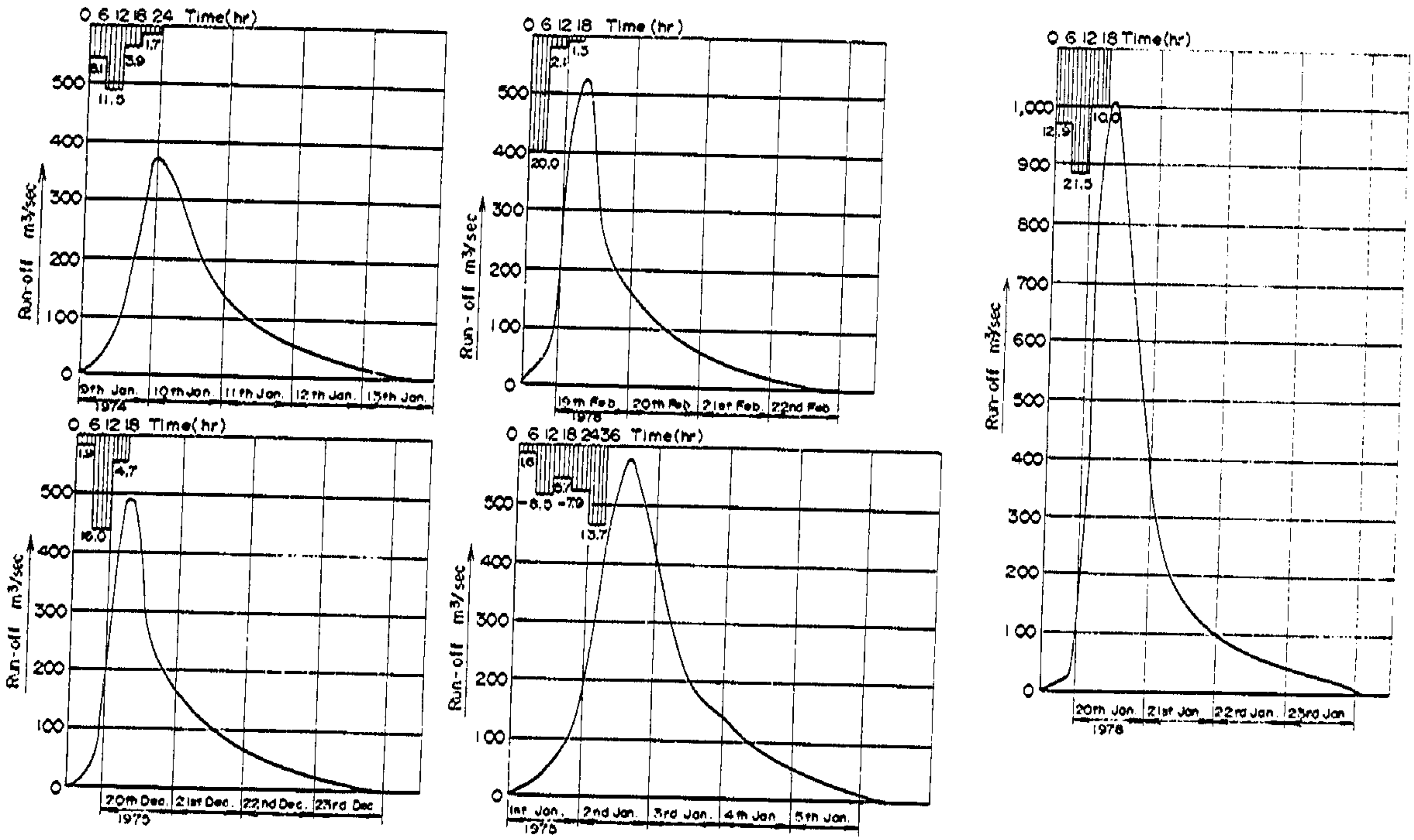


Fig. 6-8 Unit Hydrograph of 6 hours duration and 10mm run off depth

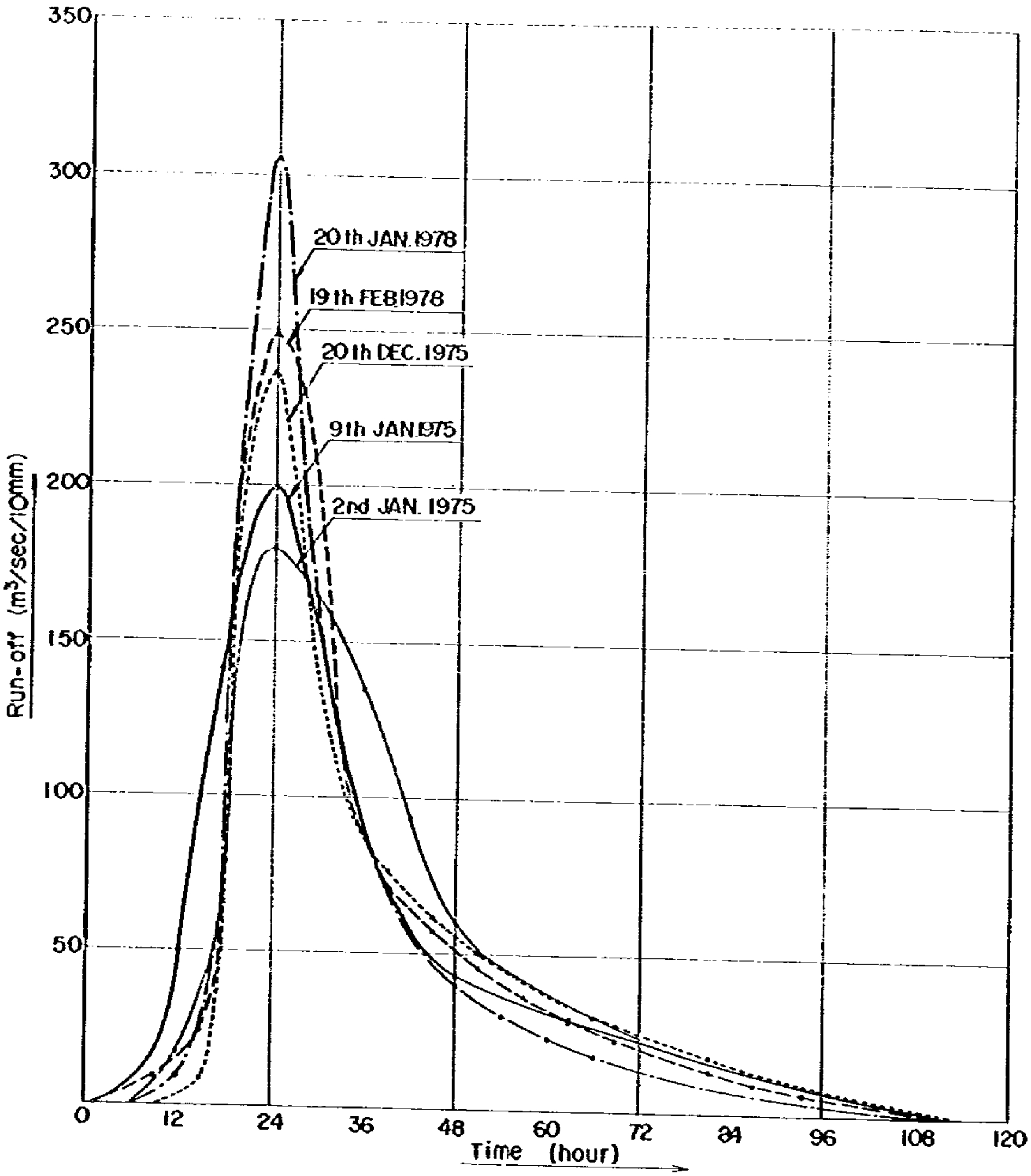
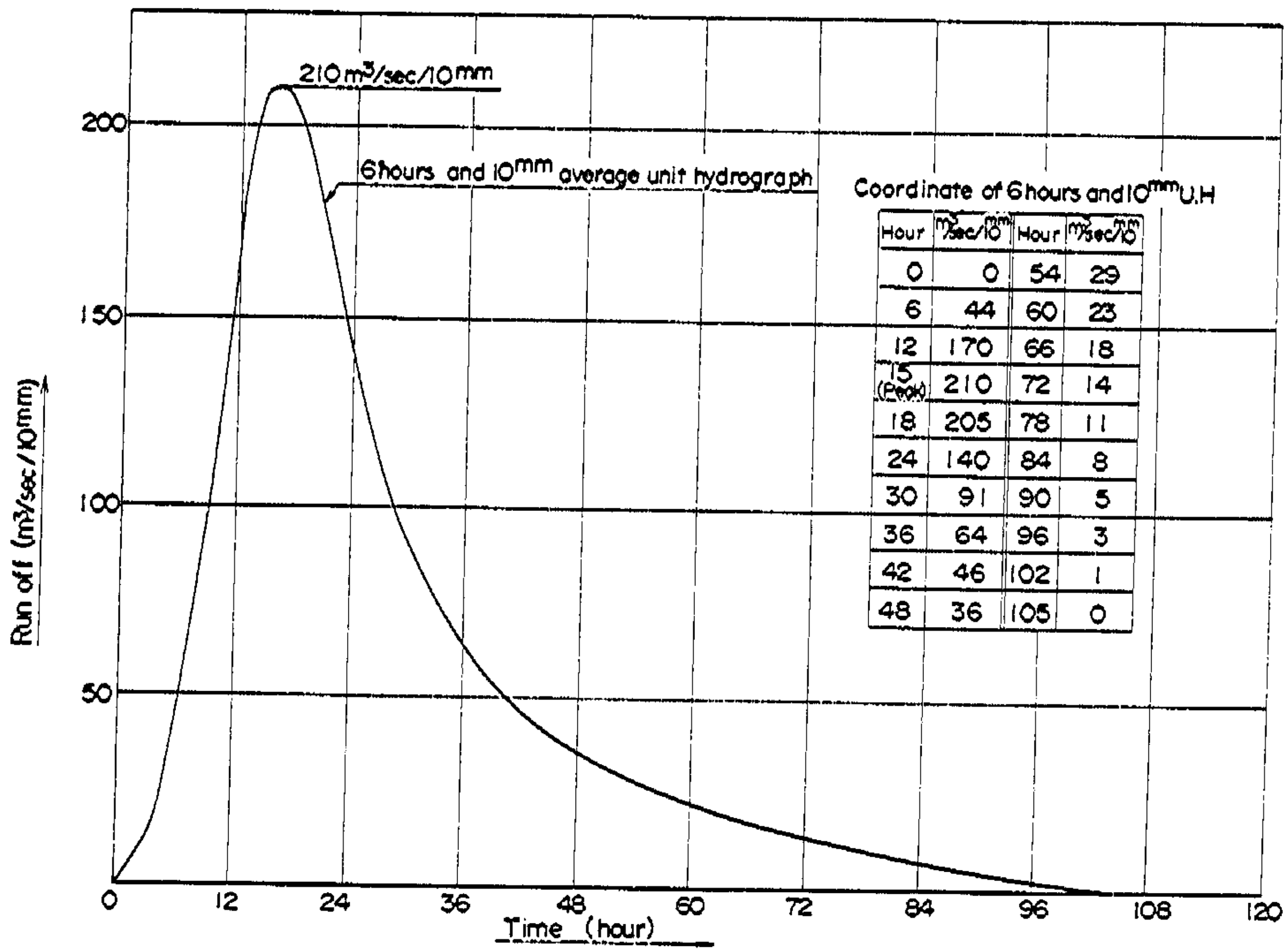


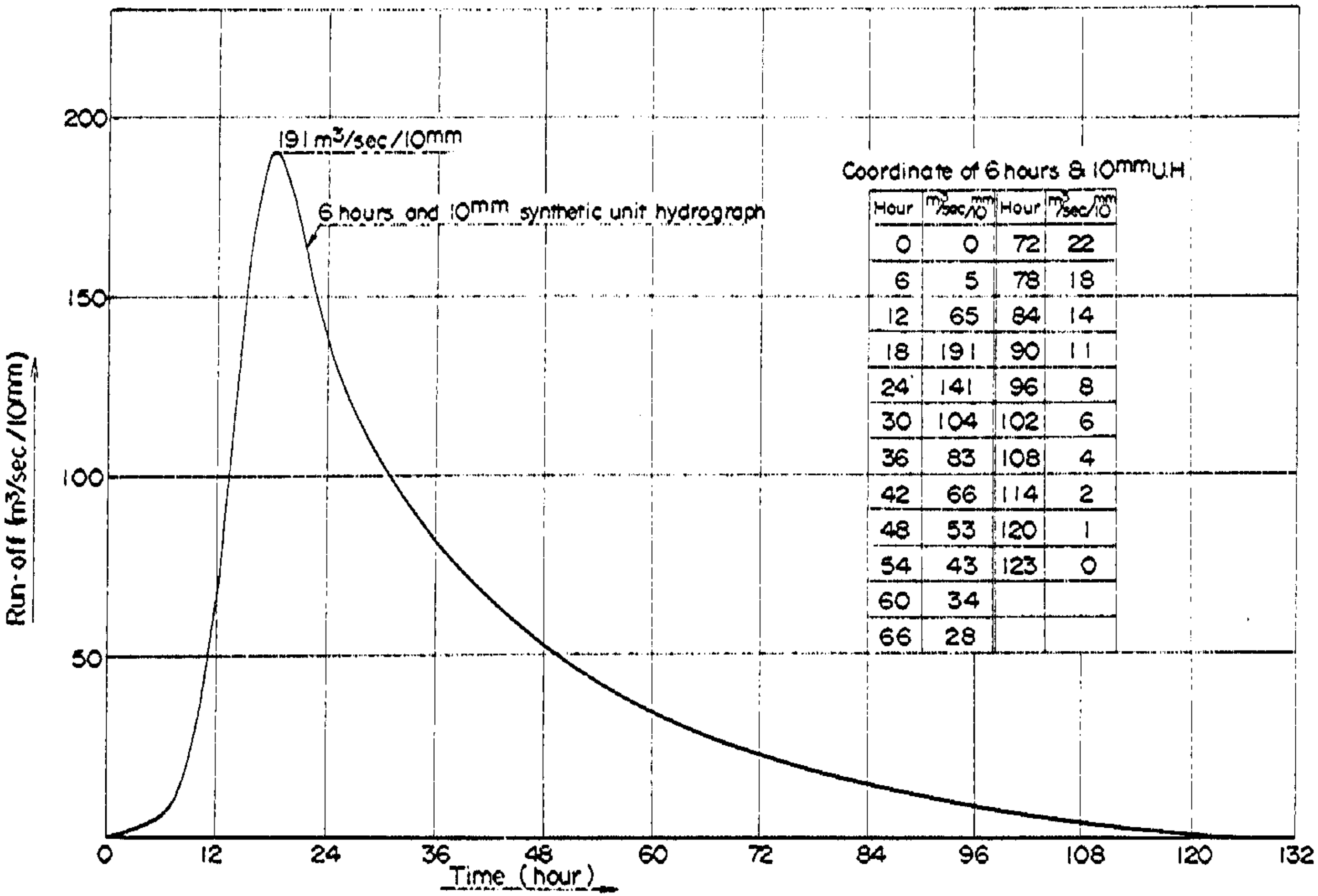
Fig. 6-9 Unit Hydrograph at Beşkonak Dam-Site



Coordinate of 6hours and 10mm U.H

Hour	m3/sec/10mm	Hour	m3/sec/10mm
0	0	54	29
6	44	60	23
12	170	66	18
15 (Peak)	210	72	14
18	205	78	11
24	140	84	8
30	91	90	5
36	64	96	3
42	46	102	1
48	36	105	0

Fig. 6-10 Synthetic Unit Hydrograph at Beskonak Dam Site



Coordinate of 6 hours & 10mm U.H

Hour	$m^3/sec/10^{mm}$	Hour	$m^3/sec/10^{mm}$
0	0	72	22
6	5	78	18
12	65	84	14
18	191	90	11
24	141	96	8
30	104	102	6
36	83	108	4
42	66	114	2
48	53	120	1
54	43	123	0
60	34		
66	28		

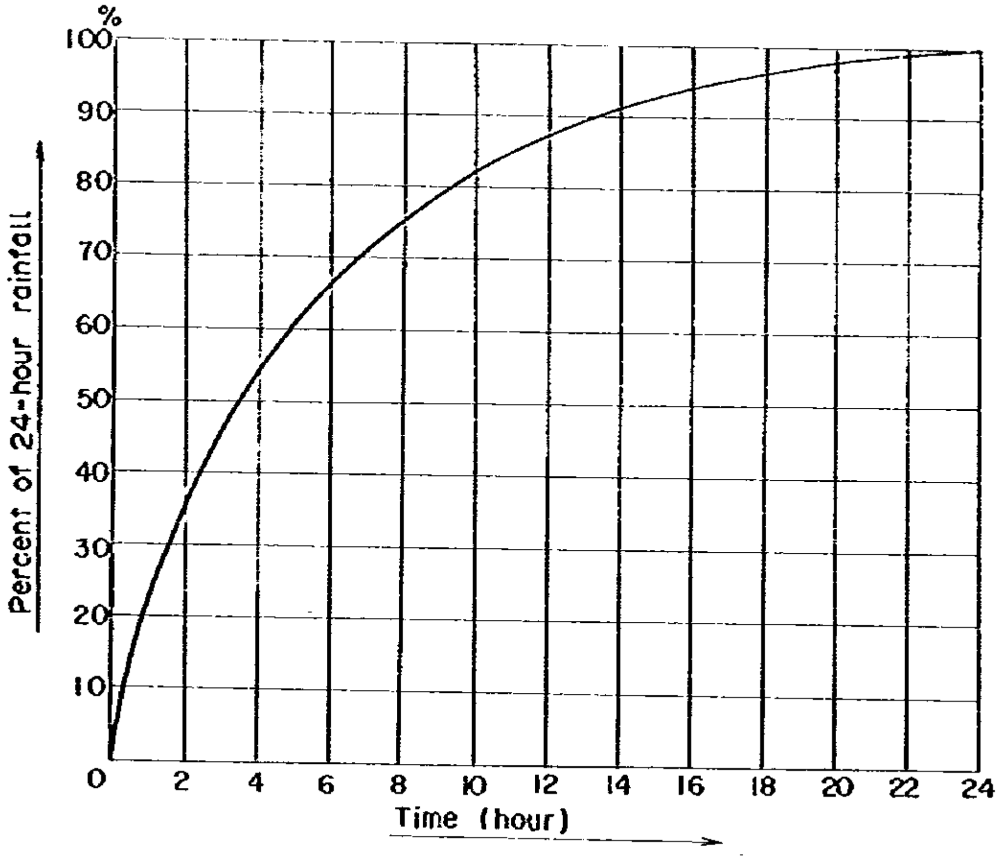
6.8.3 Time Distribution of PMP

Since hourly rainfall observations had not been carried out at the meteorological gauging stations within the catchment area, the time distribution of PMP was estimated using the hourly rainfall data observed at Antalya. A study of typical time distribution curve of 24-hour rainfall at Antalya was made in "Oymapinar Dam and Hydroelectric Project - Second Phase Final Report - 1969", and data of that report were used in this study. Fig. 6-11 shows the time distribution curve of 24-hour rainfall at Antalya. The most critical storm sequence of PMP was decided in Table 6-6 on the basis of this time distribution curve.

Table 6-6 Most Critical Storm Sequence

Hour	0 - 6	6 - 12	12 - 18	18 -24	Total
%	4	9	21	66	100
PPM (mm)	9.5	21.3	49.8	156.4	237

Fig. 6-11 Time Distribution of 24-hour Rainfall at Antalya



Hours	0	2	4	6	8	10	12	14	16	18	20	22	24
%	0	35	54	66	75	82	87	91	94	96	98	99.2	100
Increment	—	35	19	12	9	7	5	4	3	2	2	1.2	0.8

6.8.4 Effective Rainfall

Assuming a 2 mm uniform hourly loss, effective rainfall duration was estimated in Table 6-7.

Table 6-7 Effective Rainfall Duration of PMP

(mm)

Hour	0 - 6	6 - 12	12 - 18	18 -24	Total
Total Rainfall	9.5	21.3	49.8	156.4	237
Loss	12.0	12.0	12.0	12.0	
Effective Rainfall	0	9.3	37.8	144.4	191.5

6.8.5 Flood Hydrograph

Using the unit hydrograph at the dam site prepared in 6.8.2, the flood hydrograph was prepared for the effective rainfall of PMP calculated in 6.8.4

6.8.6 Snowmelt

Since snowfall data in the project area were insufficient, the snowfall and snowmelt data for the Kayraktepe and Oymapinar projects, facing the Mediterranean Sea similarly to the Beskonak project, were used in calculating discharge of the Koprucay River due to snowmelt.

In the catchment area and surroundings of the Kayraktepe project,

(1) The snowmelt season is from the middle of February to the middle of May

(2) The maximum river discharge due to snowmelt occurs in March-April

(3) In March-April the snow cover in the catchment area is an elevation of above 1,500 m

and it was judged that snowmelt phenomena would be roughly the same in the catchment area of the Beskonak project.

Of the catchment area of the Beskonak project, the area above the snow cover elevation of 1,500 m is 580 km^2, and mean elevation is 1,800 m.

The maximum temperature of 10-day duration in March at Antalya was examined based on observtion data during 1930 - 1980. This value was converted to that at 1,800 m, and was taken as the probable maximum temperature. As for the maximum rate of snowmelt runoff it was taken as 0.401 mm/°C-day referring to the Kayraktepe project.

Table 6-8 indicates the results of calculations of the maximum river discharge due to snowmelt.

Table 6-8 Maximum Snowmelt Runoff for the Catchment Area of Beskonak Dam Site

Days	Maximum Daily Temperature Duration (°C)	Temperature at Mean Elevation Snow Cover 1,800 m (°C)	Temperature Arranged in Design Pattern (°C)	Product of Temperature with Maximum Rate of Snow-melt (0.401) (cm)	Daily Snowmelt ($10^6 m^3$)	Daily Snowmelt Discharge (m^3/sec)
1	15.0	7.2	7.2	2.8872	16.7	193
2	17.1	9.3	9.3	3.7293	21.6	250
3	15.2	7.4	12.4	4.9724	28.8	333
4	16.1	8.3	12.0	4.8120	27.9	323
5	16.8	9.0	11.0	4.4110	25.6	296
6	20.2	12.4	10.4	4.1704	24.2	280
7	19.8	12.0	9.0	3.6090	20.9	242
8	18.2	10.4	8.7	3.4887	20.2	234
9	18.8	11.0	8.3	3.3283	19.3	223
10	16.5	8.7	7.4	2.9674	17.2	199

6.8.7 Base Flow

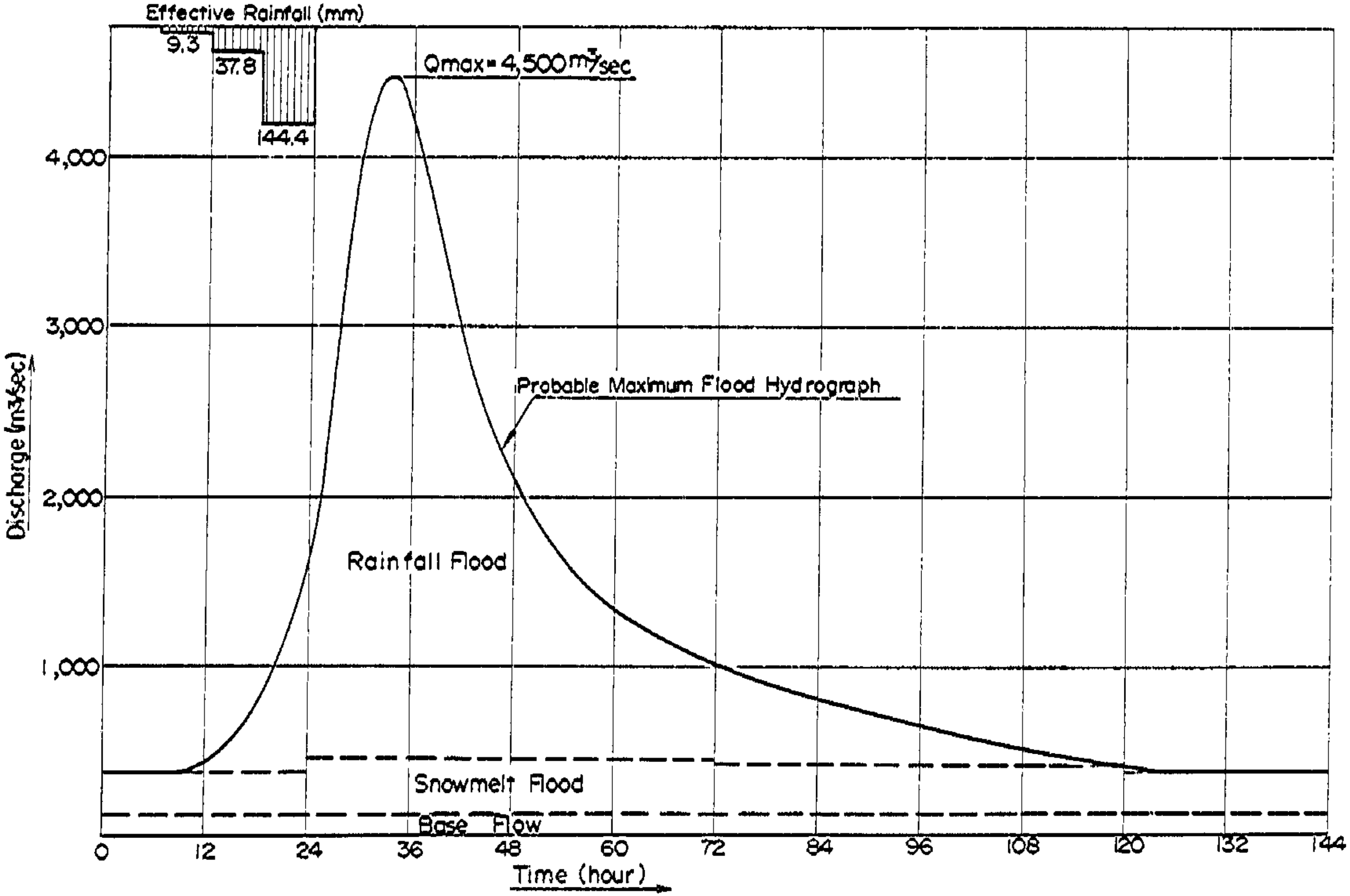
The daily mean runoff at Beskonak G.S. was examined in the snowmelt period (February - May), and a value of 120 m^3/sec was obtained as the base flow at the dam site.

6.8.8 Probable Maximum Flood (PMF)

The hydrograph of the probable maximum flood (PMF) at the dam site was prepared by superposing one on another the hydrographs of PMP, snowmelt, and base flow. The result is indicated in Fig. 6-12.

From this hydrograph a value of 4,500 m^3/sec was obtained as the probable maximum flood discharge at the dam site.

Fig. 6-12 Probable Maximum Flood Hydrograph



6.8.9 Statistical Probable Flood

The aunnual maximum peak runoffs, which were recorded during the 40-year period from 1940 to 1979 at Beskonak G.S. (see Table 6-9), indicate a minimum of 318 m^3/sec (March 1949, January 1950) and a maximum of 2,200 m^3/sec (December 1977).

Gumbel's extreme value distribution was adopted to perform flood frequency analysis. The result was obtained in Fig. 6-13. Adopting the regression equation shown in Fig. 6-13, the value of PMF = 4,500 m^3/sec computed in 6.8.8 is thought to correspond to a 5,000-year return period flood.

Further, from this flood frequency curve, the 5-year return period flood of 1,250 m^3/sec was adopted as the design flood discharge for the diversion tunnel in consideration of dam type (concrete) and its construction period.

6.8.10 Flood Analysis

On the most critical condition that PMF occurs at H.W.L 155.00 m, flood analysis was performed. In consideration of the regulating capcity of the reservoir, the spillway capacity curve and flood water level of the reservoir were calculated against the hydrograph of PMF. The result is shown in Fig. 6-14.

Table 6-9 Annual Peak Discharge at Beskonak G.S

Year	Date of Occurance	Annual Peak Discharge (m^3/sec)
1940	Feb.	1,607.8
41	Jan.	776.0
42	Jan.	1,352.0
43	Dec.	581.6
44	Dec.	684.0
45	Nov.	598.0
46	Dec.	1,003.8
47	Dec.	728.0
48	Feb.	1,156.0
49	Mar.	317.8
50	Jan.	317.8
51	Jan.	832.2
52	Feb.	516.6
53	Dec. 25	1,622.4
54	Feb. 19	400.0
55	Jan. 12	548.8
56	Nov. 27	516.0
57	Mar. 2	280.2
58	Jan. 9	1,032.8
59	Jan. 5	969.8
60	Dec. 31	557.0
61	Feb. 5	468.0
62	Feb. 16	822.0
63	Dec. 12	863.0
64	Dec. 15	349.0
65	Feb. 17	1,486.0
66	Jan. 21	1,486.0
67	Dec. 23	536.0
68	Jan. 3	798.0
69	Dec. 29	923.0
70	Dec. 17	775.0
71	Feb. 18	413.0
72	Dec. 12	764.0
73	Feb. 26	752.0
74	-	-
75	Jan. 30	1,400.0
76	Nov. 24	1,260.0
77	Jan. 13	2,200.0
78	Jan. 20	1,200.0
79	Jan. 14	850.0

Year: Hydrological Year consists of the period during October - September

Fig. 6-13 Flood Frequency Curve at Beşkonak G.S

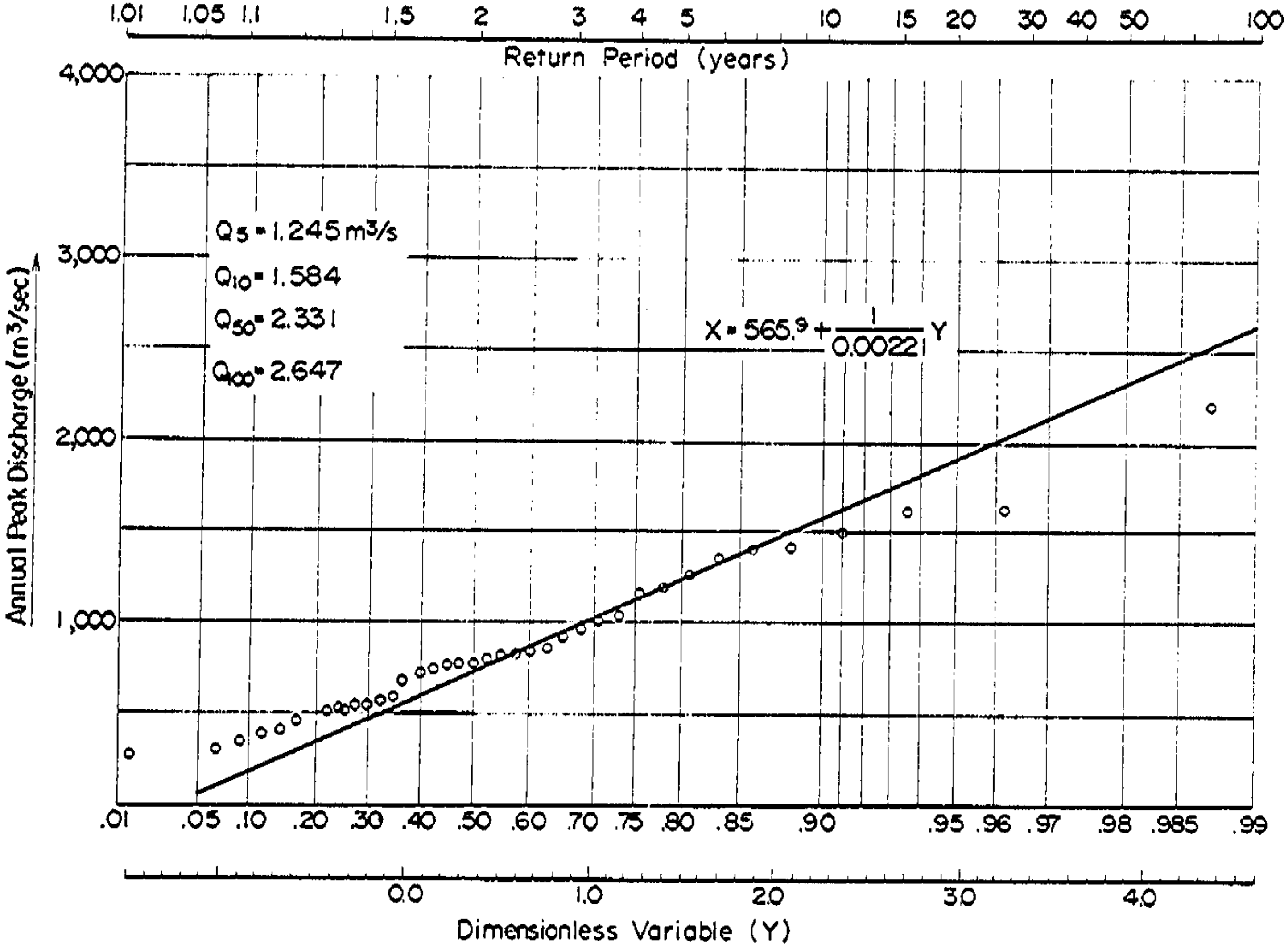


Fig.6-14 Spillway Discharge Curve