CHAPTER 4. PRESENT STATE OF ELECTRIC ENTERPRISE

CHAPTER 4. PRESENT STATE OF ELECTRIC ENTERPRISE

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CHAPTER 4. PRESENT STATE OF ELECTRIC ENTERPRISE

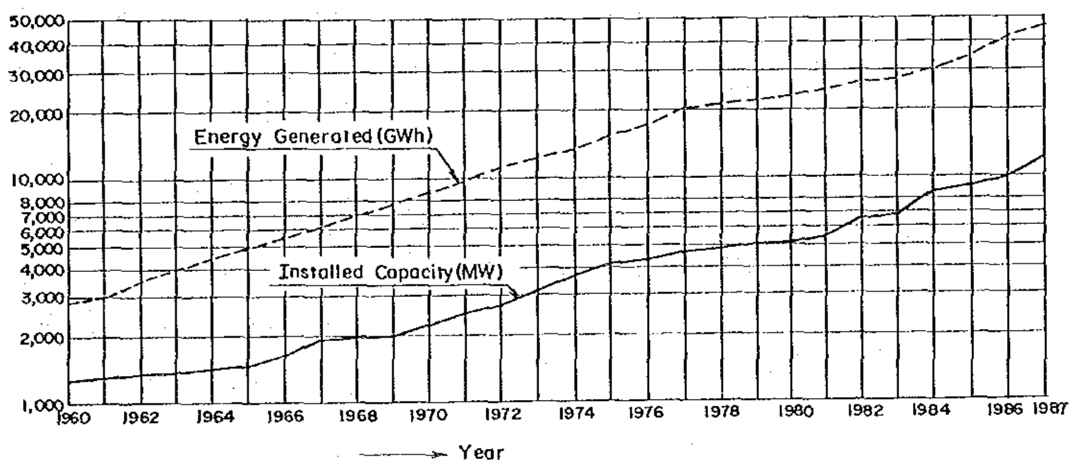
4.1 Present Status of Electric Power

The national economy of the Republic of Turkey, which had been in a state of recession after the first oil crisis, started to recover gradually since 1980, owing to international assistance and the determined efforts for economic reconstruction by the Republic of Turkey itself.

A great deal of emphasis is placed on the development of electric power, which is regarded as one of the important pillar for the economic reconstruction. In particular, the power generation capacity is being steadily expanded, with hydroelectric power development playing the central role.

The past trend of the total installed generation capacity and the total amount of electricity generation are illustrated in Fig. 4-1.

Fig. 4-1 Installed Capacity and Energy Generated



The installed capacity as of 1987 was 12,492 MW, which consisted of 60% thermal power and 40% hydro power.

The annual energy generation was 44,353 GWh (except for import), of which the hydroelectric power accounts for 42%.

The annual power generation per capita is 840 kWh. Although this figure is low as compared to per capita consumption of 5,000 to 7,000 kWh in the highly industrialized countries, the growth of power generation in Turkey is large. The annual growth rate was over 10% before the first oil crisis. Thereafter, the growth rate declined to a relatively low level of 4 to 5% due to deteriorated economic conditions, but after 1980, high growth rates of 5 - 9% were recorded reflecting the recovery of economic activities.

This rapid growth of electric demand had caused shortage in the supply capacity, and the Republic of Turkey started import of electricity from USSR in 1979, and from Iraq in 1988. This import of electricity still continues today. However, Power import from Bulgaria since 1975 had stopped in 1986.

The amount of electricity import is becoming decrease after recorded peak of 2,653 GWh in 1984, though the Turkish government is still planning of import 1,600 GWh energy per year upto 1996.

Also, there is strong latent demand for electric power, and it can be estimated that the future growth rate will even exceed 10% for a few years. The electric power development projects are being aggressively implemented to meet this future demand.

According to the power development plan, large hydroelectric and thermal power plants will be completed and connected to the Turkish national power grid in succession in the period around 1989 to 1993, including Anbari Thermal Power Plant (1,073 MW) and hydroelectric power plants such as Kayraktepe (420 MW) and Ataturk (2,400 MW).

On the other hand the development of Elbistan A Thermal Power Plant was put off in 1995.

More emphasis is placed on hydroelectric power projects from the point of view of effective utilization of water resources, which is a genuine indigenous primary energy source of Turkey. Thus it is planned to bring the ratio of hydro power to thermal power 45:55 by the year 2000.

In the long-range plan, imported coal-fired thermal plant is also expected to play an important role. It is planned to commission the first imported coal-fired plant (1,400 MW) in 1992, and a total of 14 imported coal-fired plants (8,170 MW) will start operation in succession before 2005.

Power consumption in 1987 by categories was 62% in mining and manufacturing industries, 36% in agriculture, commerce and household uses, and 2% in transportation. These ratio have not changed substantially in the past 10 years.

The power system in the Republic of Turkey is interconnected throughout the country.

The major transmission system consists of 380 kV lines (6,606 km), 154 kV lines (17,057 km) and 66 kV lines (1,793 km). The 66 kV lines and 34.5 kV lines are used for local transmission systems.

Nearly 3,000 villages are newly under electrification service from year to year.

The rate of electrification of households is around 94% at present.

As of August 1, 1988, the electric rate in the Republic of Turkey is determined by the following two different rate systems, and a consumer can select one of them at his option.

(1) 2-Stage Rate System

(a) kW rate : Monthly rate of 3,100 TL per kW of electric demand.

(b) kWh rate : 79.0 TL per kWh.

(c) Time band rates: Daytime ; 79.0 TL/kWh. 6 - 17 hrs
Peak hours; 115.0 TL/kWh. 17 - 22 hrs
Nighttime ; 54.0 TL/kWh. 22 - 6 hrs

(This rate is applied to a consumer having contract capacity exceeding 700 kW.)

(2) Uniform Rate System: 87.0 TL/kWh

4.2 Electric Power Enterprise

Electric power administration in the Republic of Turkey is planned and operated by the following three government organizations.

(1) Electric Power Development Planning and Investigation: (EIE)

EIE: General Directorate of Electrical Power Resources Survey and Development Organization

(2) Construction of dams and hydroelectric power plants: (DSI)

DSI: General Directorate of State Hydraulic Works

(3) Operation of hydroelectric power plant, construction and operation of thermal power plant, transmission and distribution: (TEK)

TEK: Turkish Electricity Authority

While both of EIE and TEK are under the jurisdiction of MENR (Ministry of Energy and Natural Resources), DSI is under the control of Ministry of Public Works and Resettlement.

Most of the electric enterprises are state owned, and powerplants and power system operated by TEK, although there are some privately owned enterprises.

EIE is an organization entrusted with the tasks of conducting surveys and formulating plans for electric power development. EIE carries out investigations of power development sites, and determines their scales, and implementation schedule taking into consideration predicted future power demand and supply.

DSI is an organization established in 1953 with 25 regional offices throughout the country, and is in charge of construction and operation of dams for flood control, irrigation and drainage, and supply of domestic and industrial water, and in addition construction of hydroelectric power plants. With regard to hydroelectric power projects, there are cases where DSI implements them independently.

TEK is an electric power enterprise which undertakes construction, maintenance and operation of thermal power plants, and transmission lines, and maintenance and operation of hydroelectric power stations constructed by DSI. Of the entire power generating capacity in the Republic of Turkey, 88% is operated by TEK. The remaining 12% consists of municipally-owned power plants and plants operated by private enterprises.

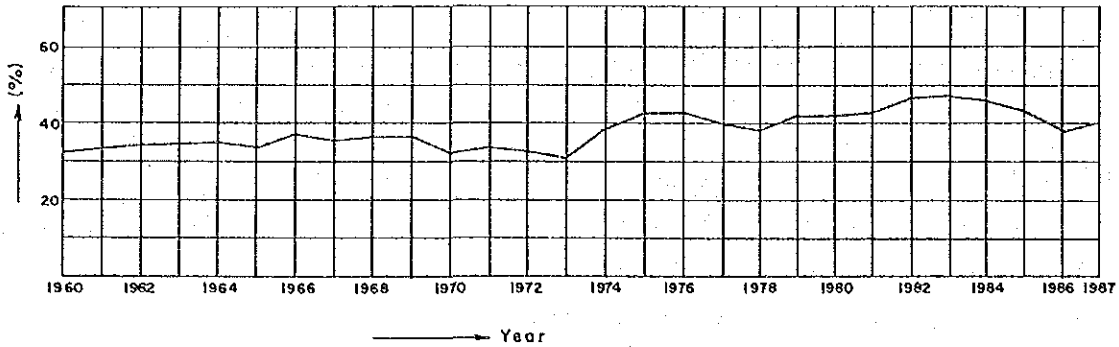
There are three patterns for power distribution - one is territory directly supplied by TEK, two is distribution undertaken by municipal organizations supplied with power by TEK, and three is areas supplied by Electricity and Gas Services. Since the service areas of these three patterns of distribution overlap at places, study is underway to remedy this situation from the standpoint of rationalization.

4-3 Present Status of Power Supply Facilities

The past trend of the power generation capacity in Turkey, and the ratio of hydroelectric power in the total installed capacity are presented in Table 4-1 and Fig. 4-2 respectively for each year. The ratio of hydroelectric power is 40% of the total capacity (5,003 MW) as of 1987. The hydroelectric power plants, including Karakaya (1,800 MW) and Altinkaya (700 MW) which were commissioned after 1987, play very important roles in power system.

The present policy of the Government of Turkey, which places priority on domestic energy source utilization with the objective of improving international balance of trade, is not expected to change in the future, and the development of imported coal-fired thermal power plant as well as hydroelectric power will be promoted.

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



The major power plants in operation are listed in Table 4-2.

As discussed before, the transmission line voltages in Turkey is 380 kV and 154 kV. The 220 kV transmission voltage is also used for interconnection with the power system of U.S.S.R.

The major transmission lines are listed in Table 4-3.

Total length of Keban-Golbasi Line and Golbasi-Umraniya Line extend over a distance of 900 km, being the trunk line that spans central Turkey. This line interconnects the large power sources in the East and the load centers in the West.

The past trends in the expansion of total lengths of transmission lines and distribution lines are given in Table 4-4.

4.4 Present Status of Power Demand and Supply

Energy generation output of Republic of Turkey was 44,353 GWh in 1987, and it became about 2.2 times that of 10 years ago.

Annual energy growth rate is 8.3%. The trend of total energy generation output is shown in Table 4-5.

Table 4-1 Installed Generating Capacity

Year	Operated by TEK (MW)			Operated by Others (MW)			Total (MW)		
	Thermal	Hydro	Total	Thermal	Hydro	Total	Thermal	Hydro	Total
1970	905	534	1,439	605	191	796	1,510	725	2,235
1971	1,095	670	1,765	611	202	813	1,706	872	2,578
1972	1,188	690	1,878	631	202	833	1,819	892	2,711
1973	1,568	782	2,350	639	203	842	2,207	985	3,192
1974	1,643	1,191	2,834	640	258	898	2,283	1,449	3,732
1975	1,708	1,521	3,229	699	259	958	2,407	1,780	4,187
1976	1,771	1,614	3,385	720	259	979	2,491	1,873	4,364
1977	2,071	1,614	3,685	783	259	1,042	2,854	1,873	4,727
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	2,179	1,872	4,051	809	259	1,068	2,988	2,131	5,119
1981	2,345	2,097	4,442	836	259	1,095	3,181	2,356	5,537
1982	2,720	2,823	5,543	836	259	1,095	3,556	3,082	6,638
1983	2,938	2,998	5,936	758	241	999	3,696	3,239	6,935
1984	3,543	3,644	7,187	1,041	231	1,272	4,584	3,875	8,459
1985	4,148	3,644	7,792	1,096	231	1,327	5,244	3,875	9,119
1986	5,142	3,644	8,786	1,093	234	1,327	6,235	3,878	10,113
1987	6,291	4,720	11,011	1,198	283	1,482	7,489	5,003	12,493

Table 4-2 Major Power Plants in Operation

Hydro-Power Plants			Thermal Power Plants		
Site Name	Commission Date	Inatalled Cap. (MW)	Site Name	Commission Date	Inatalled Cap. (MW)
Sariyar	10/1956	160.0	Catalagzi	8/1948	129.0
Hazar-1	10/1957	20.1	Tuncbilek	4/1956	429.0
Kemer	10/1958	48.0	Anbarli	1/1967	630.0
Hilfanli	1/1960	128.0	Seydisehir	2/1972	105.0
Demirkopru	5/1960	69.0	Seyitomer	3/1973	450.0
Tortum	5/1960	26.2	Aliaga G.T	9/1975	120.0
Kesikkopru	2/1967	76.0	Soma-B	9/1981	660.0
Dogankent	4/1971	70.8	Yatagan	10/1982	630.0
Kovada2	6/1971	51.2	Elbistan	7/1984	1020.0
Gokcekaya	11/1973	278.4	Hamitabad	11/1985	400.0
Keban	2/1974	1330.0	Yenikoyl,2	1986,87	420.0
Has.Ugurlu	12/1979	500.0	Cayirhan	1987	300.0
Sua.Ugurlu	10/1982	46.0	Kangal	1987	300.0
Oymapinar	1/1984	540.0	Hamitabat	1987	200.0
Aslantas	5/1984	138.0	Catalagzi	1987	150.0
Almus	9/1985	27.0			
Altinkaya	7/1988	700.0			
Karakaya	11/1988	1800.0			

Note : H.P.Plants greater than 20MW are listed
Note : T.P.plants greater than 100MW are listed

Table 4-3 Major Transmission Lines on Operation

Location From-To	Nominal Volt. (KV)	Length (KM)	Conductor MCM(wire)	Name
Sincan-Urgup	380	266	954(3b)	Cardinal
Urgup-Elbistan	380	202	954(3b)	Cardinal
Se.tomer-Se.disehir	380	305	954(2b)	Rail
Erzin-Seydisehir	380	418	954(2b)	Rail
Ataturk-Yesilhisar	380	320	1272(3b)	Phesant
Karakaya-Keban	380	87	954(2b)	Cardinal
Hopa-USSR	220	15.7	954(1b)	Rail

Table 4-4 Transmission and Distribution Lines

Year	Transmission Lines				Total	Dist. lines
	380kv	220kv	154kv	66kv	(KM)	Under 34kv
1979	2870	93	11,393	2,436	16,792	161,678
1980	2870	93	12,937	2,447	18,347	188,781
1981	2918	93	12,818	2,418	18,247	198,869
1982	3679	93	13,388	2,279	19,439	213,473
1983	4068	93	14,247	2,301	20,709	228,039
1984	4485	15.7	15,184	2,302	21,987	250,743
1985	4995	15.7	16,472	2,179	23,662	279,014
1986	5767	15.7	17,458	2,006	25,247	310,481
1987	6606	87.5	17,975	1,919	26,588	345,509

Table 4-5 Gross Energy Generated

(1) TURKEY'S DEVELOPMENT OF GENERATION (*) (Million kWh)							
Year	Thermal	Hydraulic	Total	Supplied from Bulgaria	Supplied from U.S.S.R.	Total	Increase (%) (**)
1970	5 590	3 033	8 623	—	—	8 623	10.0
1971	7 171	2 610	9 781	—	—	9 781	13.4
1973	9 822	2 603	12 425	—	—	12 425	27.0
1975	9 719	5 904	15 623	096	—	15 719	26.0
1977	11 792	8 592	20 564	492	—	21 056	33.9
1979	12 218	10 304	22 522	653	391	23 566	11.9
1981	12 057	12 616	24 673	971	645	26 289	11.5
1983	16 004	11 343	27 347	1 520	701	29 568	12.4
1985	22 174	12 045	34 219	1 477	665	36 361	23.0
1986	27 822	11 873	39 695	58	718	40 471	11.3

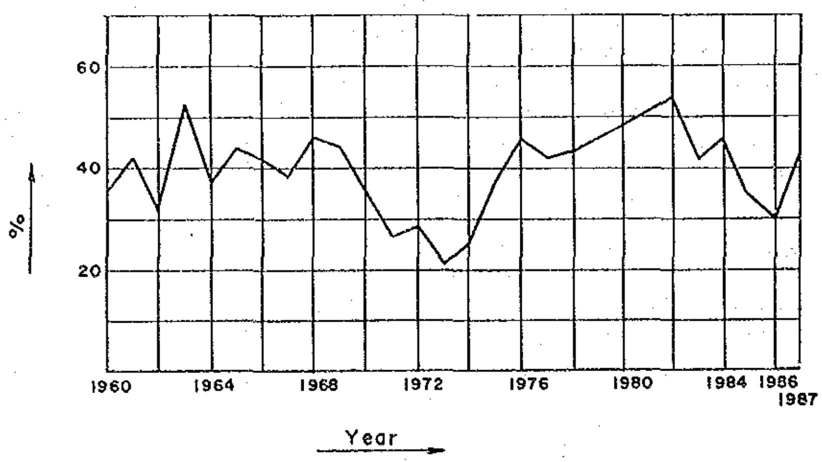
(*) TEK's input to the generation is 89.4 % in 1986
(**) Increase rates have been represented over the years in tabulation order.

(2) TEK'S DEVELOPMENT OF GENERATION (*) (Million kWh)				
Years	Thermal	Hydraulic	Total	Increase (%)
1970	3 915	2 358	6 273	19.0
1971	5 890	1 912	7 802	24.4
1973	8 223	2 036	10 259	31.5
1975	8 201	4 644	12 845	25.2
1977	9 802	7 428	17 230	34.1
1979	9 800	9 134	18 934	9.9
1981	9 463	11 125	20 588	8.7
1983	13 542	10 147	23 689	15.1
1985	19 257	10 992	30 249	27.7
1986	24 511	10 959	35 470	17.3

(*) Pre-commissioning generations included.

Transition of the hydro-energy ratio in gross generated energy is shown in Fig. 4-3. As we can see, the ratio is shifting up and down around 40%, and reached 42% in 1987.

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



Past trend of monthly peak demands is represented in Table 4-6. Normally peak load appears in December, whereas in 1978, 1980 and 1987 peaks were recorded in November and in 1983 peak occurred in September.

This is a reason of intentional restriction of power supply in December since 1978, when supply planning had become a serious problem. Average growth rate of annual maximum load is 8.4% in these ten years and the figure corresponds with the growth rate that of annual energy demand.

Typical daily load curve and TEK's annual energy balance are shown in Fig. 4-4 and Table 4-7 respectively.

Moreover, distribution of peak power and power cut are presented in Table 4-8, while the distribution of annual energy generated from 1981 to 1987 is shown in Table 4-9.

Among TEK's balance sheet of electric energy in 1987, imported energy held 1.2% (all from USSR) and other private utilities supplied 10.4%.

Transmission loss in TEK's EHV system is about 4% recording normal level, however, large distribution loss (12%) stands out.

On the other hand, considering the distribution of peak power load, hydro-power stations occupied 38.1% in share and especially contribution of large dam type hydro-power station were remarkable. Power import held 1.6% of total peak load.

Fig. 4-4 Typical Daily Demand Curve

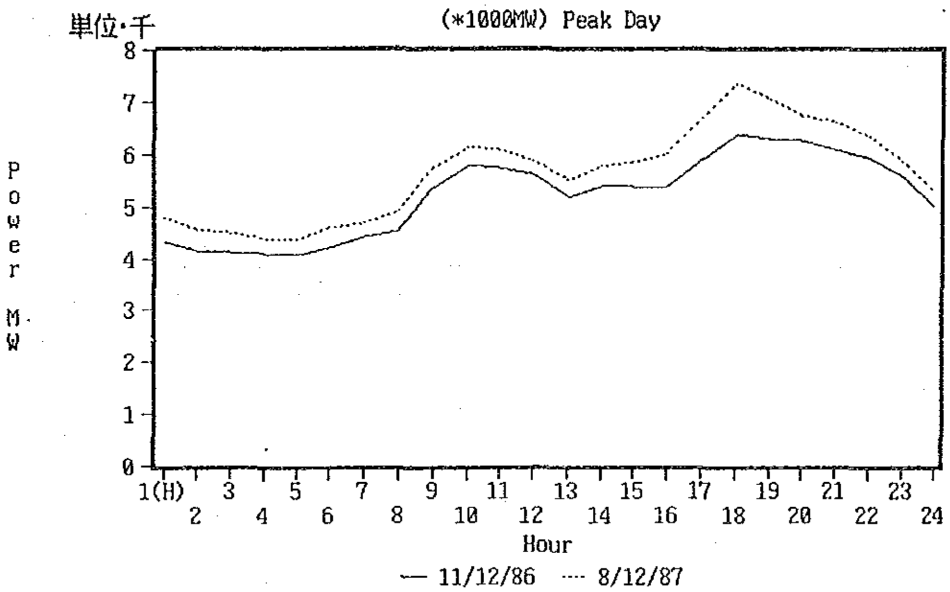


Table 4-6 Monthly Maximum Demand

YEAR	JAN.	FEB.	MAR.	APR.	MAY.	JUN.
1987	6,272	6,409	6,418	6,499	6,455	6,671
1986	5,660	5,794	5,823	5,872	5,896	5,833
1985	5,328	5,208	5,296	5,364	5,455	5,470
1984	4,615	4,831	4,818	4,872	5,000	4,954
1983	4,434	4,423	4,501	4,545	4,564	4,542
1982	4,080	4,097	4,132	4,196	4,210	4,307
1981	3,634	3,732	3,839	3,847	3,851	3,861

YEAR	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
1987	6,888	6,740	7,013	7,206	7,467	7,447
1986	6,154	6,281	6,380	6,330	6,305	6,434
1985	5,479	5,675	5,755	5,620	5,732	5,758
1984	5,029	5,161	5,412	5,436	5,450	5,457
1983	4,423	4,511	4,731	4,529	4,608	4,601
1982	4,264	4,347	4,510	4,412	4,477	4,513
1981	3,863	3,751	3,780	3,739	3,839	4,087

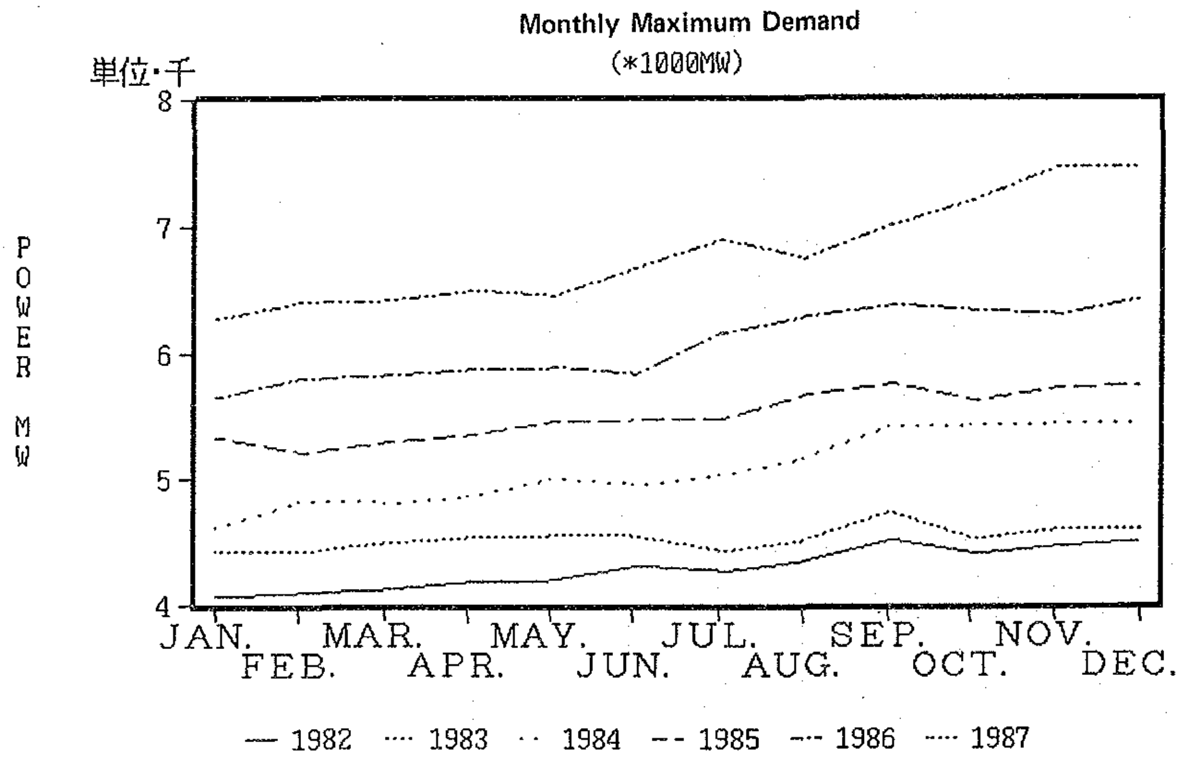


Table 4-7 TEKs Energy Balance

YEAR		1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Gross Generation	(GWH)	17,968	19,934	19,415	20,588	23,243	23,689	26,686	30,249	35,470	39,679
Power Plant Internal Consumption	(GWH)	1,060	1,117	1,074	1,099	1,212	1,463	1,632	2,110	2,607	2,387
Net Generation	(GWH)	16,908	17,817	18,341	19,489	22,031	22,226	25,054	28,139	32,863	37,292
Energy Purchased	(GWH)	912	1,172	1,484	1,752	1,895	2,484	2,948	3,627	2,446	2,367
Energy Supplied to the Network	(GWH)	17,820	18,989	19,824	21,241	23,926	24,710	28,002	31,766	35,309	39,659
Network Loss	(GWH) (%)	923 (5.2)	1,033 (5.4)	1,200 (6.1)	1,160 (5.6)	1,410 (6.1)	1,556 (6.6)	1,577 (5.9)	1,612 (5.1)	1,344 (3.8)	1,627 (4.1)
Energy Sold	(GWH)	16,897	17,956	18,624	20,081	22,516	23,154	26,425	30,154	33,965	38,032

Table 4-8 Meeting of the Peak

	TEK Power Plants (MW)	Non-TEK Power Plants (MW)	Total (MW)	Input of Sources to the Peak (%)
Power Plants with Dam	2 268.0	18.0	2 286.0	35.5
Rivers	96.8	68.3	165.1	2.6
Fuel-oil	639.0	353.7	992.7	15.4
Hard coal	82.6	9.8	92.4	1.5
Lignite	2 597.0	2.8	2 599.8	40.4
Diesel-oil	—	2.4		
Supplied from U.S.S.R.	—	100.0	100.0	1.6
Others (*)	195.7	—	195.7	3.0
TOTAL	5 879.1	555	6 434.1	100.0
Input %	91.4	8.6	—	—
Power cuts & Restriction	—	—	—	—

(*) TEK Geothermal and natural gas power plants 5 879.1 MW at 17.40 hours on 11 December 1986.

Table 4-9 Distribution of Electrical Energy Generated

Years	Hard coal (%)	Lignite (%)	Oil Products (%)	Other Fuels (%)	Hydraulic (%)	(Million kWh)
1970	16.0	16.7	32.1	—	35.2	8 623
1971	14.9	15.6	42.8	—	26.7	9 781
1973	12.1	14.0	52.9	—	21.0	12 425
1975	9.1	17.2	35.9	—	35.8	15 623
1977	6.2	17.5	34.5	—	41.8	20 565
1979	4.7	23.8	25.8	—	45.7	22 522
1981	3.6	21.3	24.0	—	51.1	24 673
1983	2.9	28.5	27.1	—	41.5	27 347
1985	2.1	41.8	20.7	0.2 (*)	35.2	34 219
1986	2.0	47.0	17.6	3.5 (*)	29.9	39 695

(*) TEK Geothermal & Natural Power Plants

CHAPTER 5. DEMAND FORECAST AND POWER SUPPLY PROGRAM

CHAPTER 5. DEMAND FORECAST AND POWER SUPPLY PROGRAM

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CHAPTER 5. DEMAND FORECAST AND POWER SUPPLY PROGRAM

5.1 Demand Forecast

5.1.1 Trends in Power Demand and Economic Growth

The statistics on GDP, power demand, and population of Turkey from 1965 to 1987 are given in Table 5-1. The period of 1979 - 1980 was one of a decline in the economy due to the Second Oil Shock, and although there was a temporary negative growth, the Turkish economy has rapidly become a lively one again since 1984.

From 1984, the economic growth rate has continuously maintained a level of 5 percent or higher, and especially, the government targets were exceeded in 1986 and 1987 with 8.2 and 6.8 percent, respectively.

Meanwhile, the population growth rate fell to the 2.0 percent level in the latter part of the 1970s from the 2.5 percent level up to that time, but on entering the 1980's, the former level is being regained.

Under such circumstances, the power demand has been growing steadily every year, and double-digit growth rates have been recorded since 1986.

5.1.2 Energy Demand Forecast by TEK

The results of energy demand forecast is shown in Table 5-2.

It is estimated that the growing rate of energy demand will be maintained at the level of 10% up to the year 2000.

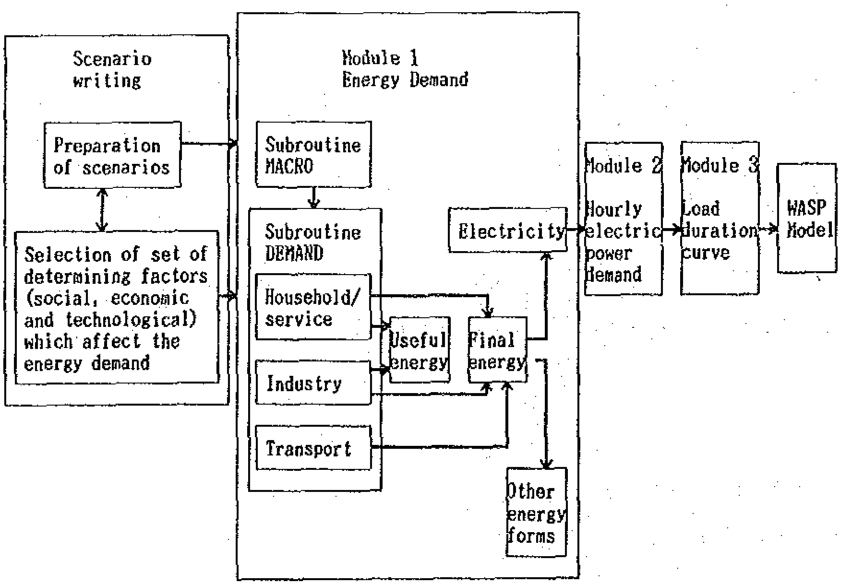
The demand forecast being used in TEK, named MAED (Model of Analysis of the Energy Demand) is based on a piling up scheme according to individual industrial demand by a scenario.

The general structure of the MAED is shown schematically in Fig. 5-1. In the figure Module 1 is a main program package, calculates total energy demand in a country or a district. The WASP model on the right is a program for long term power development plan, developed by IAEA. This program runs succeeding the demand data from the MAED.

In the MAED model, the energy demand is calculated according to a scenario which may itself be subdivided in to two subscenarios. One is linked to the socio-economic system and describes the fundamental characteristics of the social and economic development of the country. The other relates to the technical factors which must be taken into account when dealing with energy, e.g. the efficiency of final energy utilization or the penetration of the market by the various energy forms.

This module incorporates two subroutines: one macro-economic subroutine (MACRO) calculates the level of activity in the production sectors taken into account and the other subroutine (DEMAND) calculates the energy demand for each category of final use. The demand by category is estimated separately for three major sectors of economic activity: households/services, industry/agriculture, and transport. The various individual demands are combined at the end of the program in order to obtain the overall demand for the country. These two sub-routines combine to form a systematic framework through which the effect on energy demand of any economic, technical or social change can be quantified and evaluated.

Fig. 5-1 THE MAED MODEL



5.1.3 *Power Demand Forecast by Macroscopic Technique*

(1) Outline of Macroscopic Technique

This technique is a statistical macroscopic method focusing on the correlation between per capita power demand and economic growth rate, details being obtained from "Method of Long Range Demand Forecast of Energy for Developing Countries from World-wide Standpoint," EPDC, Sept. 1985.

The outline is as given below.

Firstly, the record of the country concerned up to that time is plotted in a graph based on the demand path chart of electric power on average of the whole world, Fig. 5-2, and the per capita GNP and its growth rate, Fig. 5-3. Normally, in case of a developing country, the pattern is that of starting from the low side and gradually approaching the average growth curve for the world.

Next, with the point (year) of intersection with the average curve on extension of these performance values as the basis, the thinking is that it is a desirable form of growth from a long-term and global viewpoint for growth to continue subsequently along the average growth curve.

Of course, a case of higher growth ("High Case" in the graph) than the average growth in the world is conceivable depending on the country, but it was considered that this average curve would be approached when seen from a long-term point of view.

In the case of Turkey, it is estimated from past data that the average growth rate curve will be reached around 1988 - 89.

(2) Calculation Conditions

(a) Forecast Period: 20 years

The start-up of Goktas Power Plant is planned to be around the year 2002 according to the Master Plan of the DSI and taking into consideration an allowance of 5 or 6 years, energy demands are forecasted up to 2008 for 20 years from 1988.

(b) Reference Year: 1988

Considering the record for the past 7-year period (1980 - 87), the year 1988 when it is estimated that the world average growth curve of Fig. 5-2 will be reached was taken as the reference year for long-term forecasting. Further, since the power demand and the GNP performance for 1988 are not available at the present time, these were supplemented by the method of least squares.

Judging by the state of the Turkish economy in recent years, it will be reasonable there will not be much error in considering the estimate for 1988 as the reference for long-term prediction.

(c) Per Capita GDP: US$1,651 (in 1988)

This was estimated from the OECD Annual Report for 1987. However, the exchange rate between the Turkish lira and the U.S. dollar in 1980 and escalation since then were considered in the prices.

(d) Population : 54,166,000 (1988 Estimate)

The population was estimated assuming the growth rate to be 2.5 percent based on the estimated figure of $52,845 \times 10^3$ for 1987 according to the 1986 data of the Prime Ministry Directorate of Statistics, Republic of Turkey. It was assumed that the growth rate of 2.5 percent would be the same up to the year 2008.

(e) Per Capita Electric Power Demand: 931 kWh (in 1988)

The electric energy demand forecast for 1988, 50,429 GWh, obtained by the method of least squares was divided by the population of that year of $54,166 \times 10^3$.

(f) Annual Load Factor: 67 - 70%

With the present annual load factor as a reference, estimates were made as follows assuming that peak load would gradually become steep.

1988 - 1990 : Lf = 70%
1991 - 1995 : Lf = 69%
1996 - 2000 : Lf = 68%
2001 - 2008 : Lf = 67%
*Lf : Load factor

(3) Forecast Results

The results of load forecasts by the macroscopic method are shown in Table 5-3 and Fig. 5-4.

The values are low as a whole compared with the forecasts of TEK. The difference, in 2008, is about 12 percent in terms of energy demand, but when grasped in terms of annual development, there is a difference of a lag of 1½ years, and there is a relatively good correlation between the two. The differences in forecast results of TEK and JICA are small, but in the demand and supply balance plan, the demand forecast results of TEK which are on the larger side are to be adopted taking into consideration a margin of safety.

5.1.4 Demand of Cukurova Electric Power Company (CEAS)

According to data obtained from CEAS, the demand of the Cukurova Power System in 1987 was 3,679 GWh (540 MW in terms of consumer-end power), making up close to 7 percent of the demand of all of Turkey. Table 5-4 shows the power demand forecast for the Cukurova System. Although there is scatter depending on the year, the growth rates in the latter part of the 1980s are 10 to 14 percent, 8 percent in the 1990s, and 9 percent after 2000, and the trend is more or less in agreement with the growth of Turkey as a whole. This is a reason for the proportion of the Cukurova System's demand in relation to the entire TEK demand being 6 to 7 percent and unchanged from year to year (Fig. 5-5)

On the other hand, with regard to supply capability, there is an absolute shortage, and since 1978 the system has had to rely on power bought from TEK. This trend will not be changed even when Sir Power Plant owned by CEAS is commissioned in 1990.

As a further note, whereas the power demand of entire Turkey is of winter-type peak on average, it is a summer-type peak for Cukurova Electric Power because of a Mediterranean climate.

5.1.5 Prediction of Future Load Pattern

In studying the future kW peak balance it is necessary to have a grasp of the seasonal and hourly characteristics of power demand. The results of forecasting the future load pattern based on analyses of the past demand in Turkey are given below.

(1) Peak Months : December

Although there are places such as Adana and other cities of the Mediterranean coastal area that now already have summertime peaks, when seen from the point of view of Turkey as a whole, the lighting load in the wintertime is still more dominant than the air-conditioning load in the summertime. With the rapid load increase at annual growth rates of 8 to 10 percent added to this, taking from January to December, November and December are the months when maximum peaks occur.

This trend will remain unchanged for the time being, and in 5.2, Demand and Supply Program, December was considered as the month of maximum peak occurrence.

(2) Daily Load Curve

The daily load pattern will naturally differ according to the season, but here, the load pattern on the day of occurrence of the annual maximum peak in December will be described.

According to past records, the daily maximum peak in December has occurred around the hour 18:00, which is the lighting peak time. The daily load factor is about 75 to 80 percent.

A typical representative daily load curve forecast in studying the future kW peak balance is shown in Fig. 5-6 (1), and the daily load duration curve in Fig. 5-6 (2). The daily load factor was considered as 77 percent and the midnight load factor 59 percent.

5.2 Power Supply Program

5.2.1 Electric Power Development Program

The economically developable hydroelectric potential of the Republic of Turkey as of 1986 was evaluated as being 33,600 MW and average annual energy production of 122,000 GWh. Approximately 20 percent of the above has been developed so far.

The electric power development program from 1988 to 2008 is shown in Table 5-5.

If the imported coal-burning thermal power stations planned for the early 1990s are developed on schedule, the installed power generating capacity in 2000 A.D. will be triple that as of 1988 and reach 42,723 MW (see Table 5-5 (2)). The dependable energy will also become triple and be increased to 189,000 GWh.

Regarding thermal, the imported natural gas combined thermal stations such as Hamitbat and Ambarli near Istanbul will have been developed in succession around 1990, and from 1992, imported coal-burning thermals presented by Iskenderum (Yumurtalik), Tekirdeg, and Aliaga will be central in development.

Meanwhile, lignite-burning thermals centered on Elbistan Thermal have been pushed back from the late 1990s to the early 2000s, while similarly, development of nuclear has also been changed to 2006 A.D. or later. Details of these electric power development projects are given in Appendix A-1.

Of the total facilities in 2000 A.D., the proportion made up by hydro will be approximately 44 percent (in case there will not be the imported coal-burning thermals of 1992-1993), and this condition is shown in Fig. 5-7. Further, as indicated in Fig. 5-8, the amount of hydro-power energy developed will increase yearly with up to 80 percent of the developable hydro energy by 2005, and hydro power will be contributing greatly to power supply as a domestic energy resource.

5.2.2 Demand and Supply Balance

The electric power supply program at TEK consists of the two parts of a short-range plan for the next five years, and a long-range plan for the period after five years for 20 years.

Of the above, the short-range plan includes detailed calculations of the supply capabilities of private electric power companies outside of TEK, and the years and months of commissioning of privately-owned power generation plants and major power stations. Furthermore, the projects at three sites of imported coal-burning thermal power stations scheduled for start-ups in the beginning of the 1990s are incorporated as parameters.

The projects for imported coal-burning thermals are given in Table 5-6.

Table 5-6 Imported Coal-Fired Power Plant during 1992 — '93

Site	Unit capacity x number	Year and month of start-up
A	350 MW x 4 units	1992 - Jan, Apr, Jul, Oct
B	500 MW x 2 units	1993 - Aug, 1994 - Feb
C	480 MW x 2 units	1993 - Jan, Jul

On the other hand, in the long-range supply plan, the optimum electric power development programming technique called WASP (Wien Automatic System Planning package) developed by the International Atomic Energy Agency (IAEA) has been employed. With WASP, an electric power development schedule of minimum cost satisfying a given reliability level is calculated for a 20-year period using the unit power generation costs, fault ratios, and construction period values set for each type of power generation.

The reliability target adopted this time assumes a loss of load probability (LOLP) of two days annually.

The electric power development program of TEK was used as reference basically for the development scheme of Goktas Hydroelectric Power

Plant, however peak output of hydro-power plants was modified. The demand and supply balances were considered with the results obtained in demand forecasts for kW and kWh. From analyses of load patterns of Turkey in 5.1.5, the kW balance was considered for the day of occurrence of maximum peak in December, the peak month, estimated to be comparatively close to low water level. On the other hand, the kWh balance was considered for total annual energy demand.

(1) Conditions of Study

(a) Thermal Power Station

o Output Decrease and Retirement	5% each of all installed capacity as of 1988 is considered to be decreased equally in the next 20 years.
o Fault	In considering the kW balance, 1 unit of maximum capacity is assumed to be stopped on the day of maximum peak. However, the fault is considered to be eliminated within several days, not affecting the energy production plan for the year.
o Utility Factor	68.5% (annual operating time; 6,000 hr)
o Generating Capability	Rated capacity subtract station service (station service ratio taken to be 5%)
o Repair Plan	Repairs not to be made in peak months.

Other than the above, whether or not the imported coal-burning thermal power stations scheduled for development at the beginning of the 1990s exist was made a parameter in formulating the supply plan.

(b) Hydro Power Station

o Retirement	Not considered in the 20-year supply plan.
o Fault	One unit of maximum capacity is assumed to be stopped on the day of maximum peak.

However, the fault is considered to be eliminated within several days, not affecting the energy production plan for the year.

o Discharge Fluctuation — Discharge fluctuation was considered as follows for annual kWh and kW balances of the peak day.

i) Annual kWh Balance

In view of operating experience of TEK, both the annual average energy and the annual firm energy for the past 10 years were considered.

ii) kW Balance of Peak Day

Large-capacity reservoir-type hydroelectric power stations are main in Turkey. The operating policy of TEK aiming for effective utilization of these hydroelectric power stations having flexible output adjustment capabilities was considered, and the following kW balance plan was set up:

In effect, the concept is for supply capability of hydro to be distributed in order of priority to peak load, middle load, and base load in accordance with the daily load duration curve, with the shortage for supplying the base load filled by thermal units.

With this technique it will be necessary to know the durations of peak operation at all hydroelectric power stations per day, and it was forecast from the average peak operation duration times of the main hydroelectric power stations of Turkey in December as seen from TEK operation data that they would be as follows:

Peak duration time: December in a dry year 6 - 8 hr

(c) Electric Power Importation

Imports are not considered in the kW peak balance, but are counted in annual energy balance.

The importation plans for 1987 to 1996 are the following:

From the USSR: 1,200 GWh annually (interconnection capacity 200 MW)

From Iraq : 400 GWh annually (interconnection capacity 70 MW)

(2) Results of Study

The results of the foregoing studies are given in Table 5-7 (1) - (4) and Fig. 5-9 (1) - (8).

(a) Case of No Imported Coal Thermals in 1992-1993

The kW balance, when considering hydro peak duration time as 6 hours in a dry year, shows that a reserve capacity will become less than 10 percent from 1,994 to 1,996 (see Table 5-7 (1)).

And also, in the annual energy balance, in case it turns out to be a dry year, the kWh reserve capacity falls to less than 10 percent for the 11-year period from 1993 to 2003. Even when considered in terms of normal-water years, the kWh reserve capacity will be less than 20 percent from 1994 to 2001, and in case there is trouble with thermal power stations over a long period of time, concern about the supply program will remain. (Table 5-7 (3)).

(b) Case of Development of Imported Coal Thermals in 1992-1993

Even when hydro is grasped as dependable peak capacity of a dry year, close to 25 percent in kW reserve capacity and about 13 to 20 percent in kWh reserve capacity can be secured. (Table 5-7 (2), (4)).

Development of the imported coal-burning thermals (total: 2,860 MW) of the early 1990s will have the effect of guaranteeing a kWh margin equal to that of an average discharge year in case of no imported coal-burning thermal even if the year turns out to be a dry year.

In view of the above, it can be said that the imported coal-burning thermal power station plan being promoted by the Turkish Government will contribute greatly to the energy balance of the early 1990s.

Further, since the energy situation will be tight around 2000 A.D., there is much expected of domestic power resources of high reliability such as Goktas Hydroelectric Power Station being developed.

5.2.3 Supply Plan of Cukurova Electric Power

Cukurova Electric Power is a private electric power company with its service area spread over three provinces around Adana. Goktas Hydroelectric Power Plant is to be developed inside Cukurova Electric Power territory, and since in view of the demand and supply balance of Cukurova Electric Power there is a high probability of Goktas power being applied to the power demand of this region, a study was made of the demand and supply balance of the region.

(1) Electric Power Development Program

The electric power generating facilities of Cukurova Electric Power in 1988 consisted of the following:

(Hydro Power Stations)

Kadincik I	70 MW
Kadincik II	56 MW
Seyhan	60 MW
Yuregir	6 MW
Subtotal	192 MW

(Thermal Power Station)

Mersin	106 MW
Total	298 MW

Meanwhile, the estimated peak demand of 1988 was 633 MW, and the shortage was being filled through purchases from TEK. The electric power development program and the maximum power balance after 1988 are shown in Table 5-8 and Fig. 5-10. After commissioning of the hydroelectric power stations of Sir (282 MW) and Berke (168 MW), which will be facilities owned by Cukurova Electric Power, the ratio of self-sufficiency in electric power will be maintained above 50-percent, but from 1998 the ratio will again fall below the 50-percent level.

(2) Significance of Goktas Hydro Development

Considered on the basis of the physical development schedule, the start-up of Goktas Hydroelectric Power Station is thought will be around 2000 A.D. at the earliest, a time when the proportion of the generating facilities of all Turkey made up by hydro will temporarily fall (see Fig. 5-7), and it will be desirable for commissioning of Goktas Hydroelectric Power Station to be as early as possible in the 2000s.

Compared with the peak duration time for entire Turkey (6 to 8 hours in wintertime), it is shorter, about 5 hours in the summer (See Fig. 5-11) and 6 to 7 hours in the winter, for the Cukurova System with its smaller service area. Considering the load characteristics of Cukurova Electric Power having such peak characteristics and the future increase in peak demand, it will be reasonable for the peak duration of Goktas Hydroelectric Power Station to be made about 6 hours at minimum throughout the year taking into account a slight allowance.

Table 5-1 Basic Data for Demand Forecast

(at the price levels and exchange rates of 1980)

YEAR	GDP US$		Energy Demand*		Population		GDP/Capita		Energy/capita	
	(Billion)	Rate (%)	(Gwh)	Rate (%)	(Thousand)	Rate(%)	US$	Rate(%)	Kwh	Rate(%)
1965	25.47		4,953		31,151		817.6		159.0	
1966	28.46	11.7	5,551	12.1	31,934	2.51	891.2	9.0	173.8	9.3
1967	29.74	4.5	6,217	12.0	32,750	2.56	908.1	1.9	189.8	9.2
1968	31.73	6.7	6,936	11.6	33,585	2.55	944.8	4.0	206.5	8.8
1969	33.42	5.3	7,838	13.0	34,442	2.55	970.3	2.7	227.6	10.2
1970	35.05	4.9	8,623	10.0	35,321	2.55	992.3	2.3	244.1	7.3
	AVE.Rate	6.6	AVE.Rate	11.7	AVE.Rate	2.54	AVE.Rate	4.0	AVE.Rate	9.0
1971	38.23	9.1	9,781	13.4	36,215	2.53	1055.6	6.4	270.1	10.6
1972	40.74	6.6	11,242	14.9	37,132	2.53	1097.2	3.9	302.8	12.1
1973	42.54	4.4	12,425	10.5	38,072	2.53	1117.4	1.8	326.4	7.8
1974	46.16	8.5	13,477	8.5	39,036	2.53	1182.5	5.8	345.2	5.8
1975	49.61	7.5	15,719	16.6	40,078	2.67	1237.8	4.7	392.2	13.6
	AVE.Rate	7.2	AVE.Rate	12.8	AVE.Rate	2.56	AVE.Rate	4.5	AVE.Rate	10.0
1976	53.92	8.7	18,615	18.4	40,915	2.09	1317.9	6.5	455.0	16.0
1977	56.25	4.3	21,057	13.1	41,768	2.08	1346.7	2.2	504.1	10.8
1978	57.86	2.9	22,347	6.1	42,640	2.09	1356.9	0.8	524.1	4.0
1979	57.35	-0.9	23,566	5.5	43,530	2.09	1317.5	-2.9	541.4	3.3
1980	56.92	-0.7	24,617	4.5	44,438	2.09	1280.9	-2.8	554.0	2.3
	AVE.Rate	2.8	AVE.Rate	9.5	AVE.Rate	2.09	AVE.Rate	0.7	AVE.Rate	7.3
1981	59.40	4.4	26,289	6.8	45,540	2.48	1304.3	1.8	577.3	4.2
1982	62.36	5.0	28,325	7.7	46,688	2.52	1335.7	2.4	606.7	5.1
1983	64.67	3.7	29,583	4.4	47,864	2.52	1351.1	1.2	618.1	1.9
1984	68.38	5.7	33,267	12.5	49,070	2.52	1393.5	3.1	677.9	9.7
1985	71.89	5.1	36,361	9.3	50,306	2.52	1429.1	2.5	722.8	6.6
	AVE.Rate	4.8	AVE.Rate	8.1	AVE.Rate	2.51	AVE.Rate	2.2	AVE.Rate	5.5
1986	77.81	8.2	40,469	11.3	51,546	2.46	1509.5	5.6	785.1	8.6
1987	83.10	6.8	44,925	11.0	52,845	2.52	1572.5	4.2	850.1	8.3

* Demands include imported energy

Table 5-2 Energy Demand Forecast by TEK

YEAR	ENERGY		POWER		LOAD
	(GWH)	Rate(%)	(MW)	Rate(%)	FACTOR(%)
1989	57,925	-	9,250		
1990	64,910	12.1	10,370	12.1	71.5
1991	71,885	10.7	11,480	10.7	71.5
1992	79,200	10.2	12,650	10.2	71.5
1993	87,260	10.2	13,940	10.2	71.5
1994	96,140	10.2	15,485	11.1	70.9
1995	105,930	10.2	17,060	10.2	70.9
1996	115,710	9.2	18,695	9.6	70.7
1997	126,790	9.6	20,485	9.6	70.7
1998	138,940	9.6	22,450	9.6	70.6
1999	152,250	9.6	24,600	9.6	70.7
2000	166,830	9.6	26,955	9.6	70.7
2001	177,020	6.1	28,825	6.9	70.1
2002	189,310	6.9	30,825	6.9	70.1
2003	202,450	6.9	32,965	6.9	70.1
2004	216,500	6.9	35,255	6.9	70.1
2005	231,530	6.9	37,700	6.9	70.1
2006	247,600	6.9	40,320	6.9	70.1
2007	264,790	6.9	43,115	6.9	70.1
2008	283,170	6.9	46,110	6.9	70.1
2009	302,830	6.9	49,310	6.9	70.1
2010	323,850	6.9	52,730	6.9	70.1

Fig. 5-1 The MADE Model

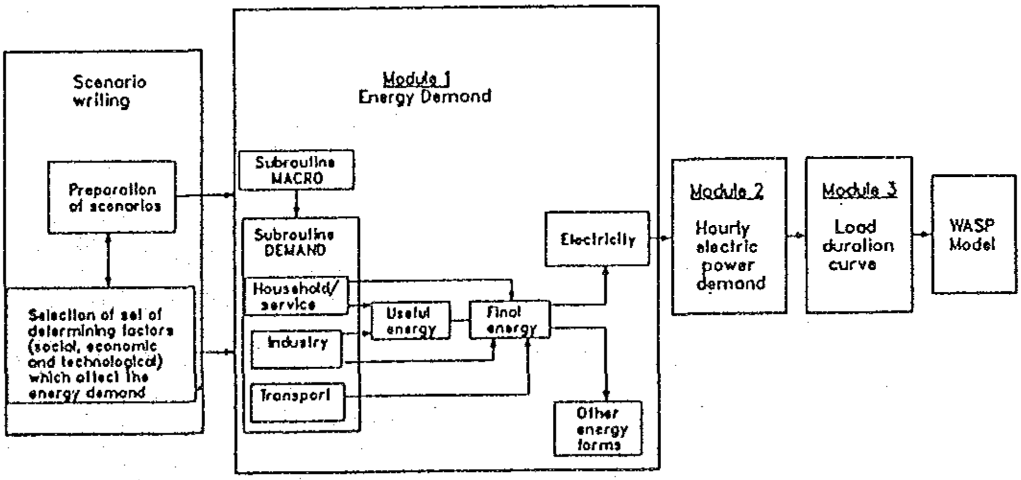


Fig. 5-2 Demand Pass Chart

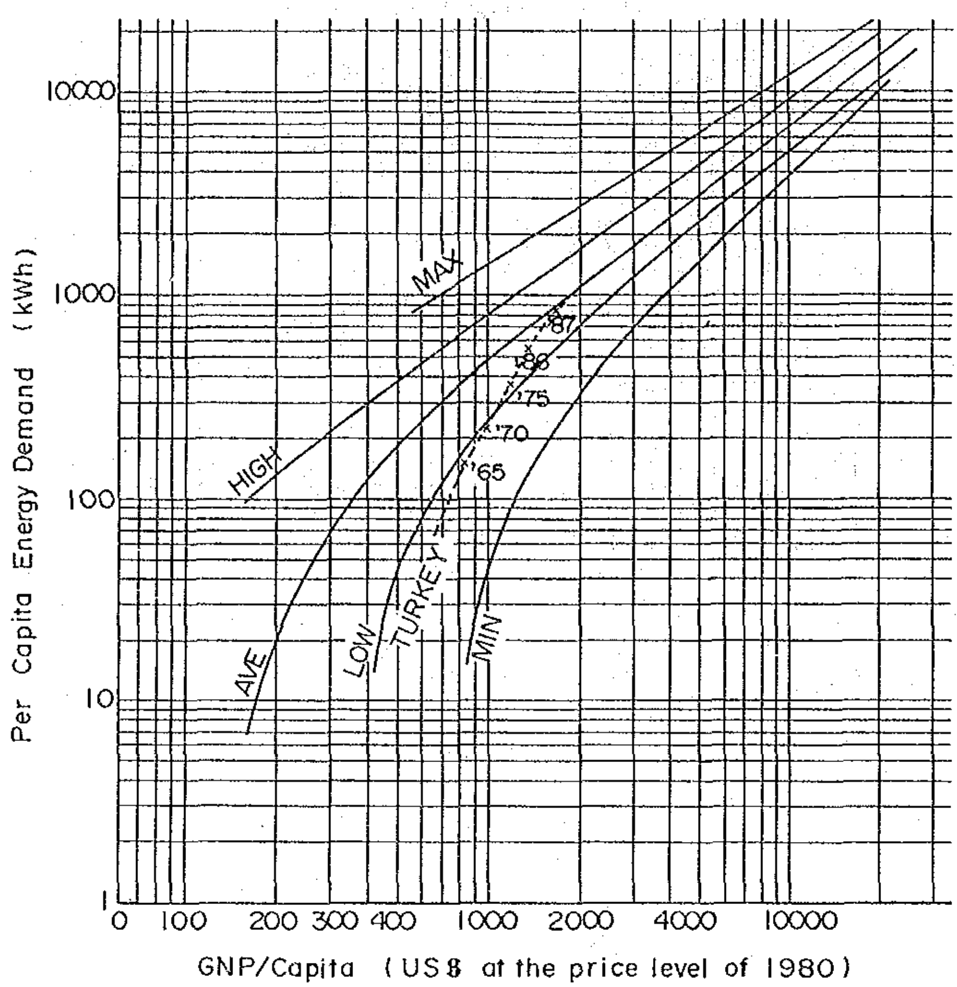


Fig. 5-3 GNP/Capita and its Growth Rate

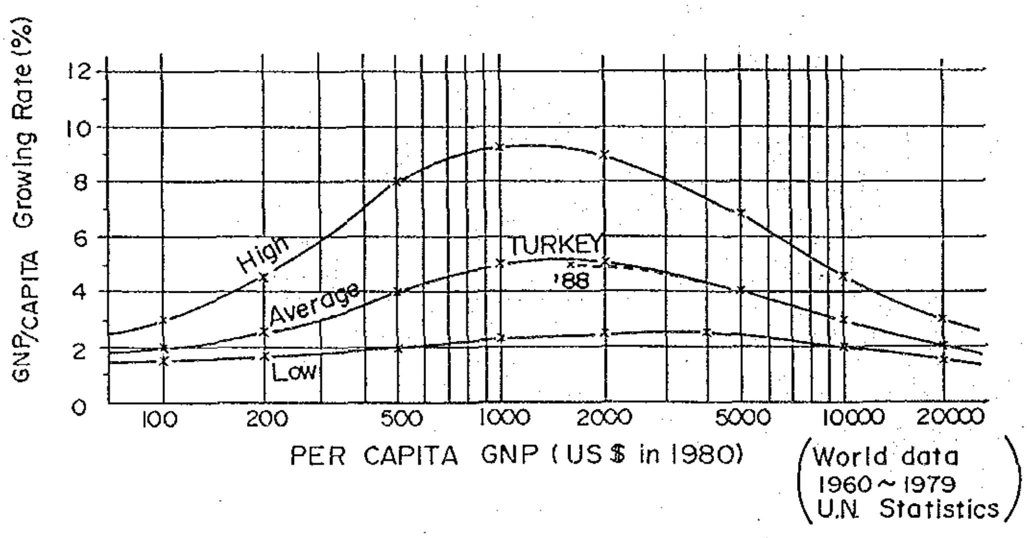


Table 5-3 DEMAND FORECAST BY MACRO METHOD

(at the price levels and exchange rates of 1980)

YEAR	GNP US$		Energy Demand		Population		GDP/Capita		Energy/capita		POWER
	(Billion)	Rate (%)	(Gwh)	Rate (%)	(Thousand)	Rate(%)	US$	Rate(%)	Kwh	Rate(%)	MW
1988	89.45	-	50,429	-	54,166	2.5	1651.4	5.13	931.0	-	8252.1
1989	96.39	7.8	56,520	12.1	55,520	2.50	1736.0	5.11	1018.0	9.3	9248.8
1990	103.84	7.7	63,049	11.6	56,908	2.50	1824.7	5.08	1107.9	8.8	10317.2
1991	111.85	7.7	68,708	9.0	58,331	2.50	1917.5	5.06	1177.9	6.3	11406.3
1992	120.44	7.7	74,802	8.9	59,789	2.50	2014.4	5.02	1251.1	6.2	12418.0
1993	129.65	7.6	81,360	8.8	61,284	2.50	2115.6	4.99	1327.6	6.1	13506.7
1994	139.52	7.6	88,413	8.7	62,816	2.50	2221.1	4.94	1407.5	6.0	14677.6
1995	150.08	7.6	95,981	8.6	64,386	2.50	2330.9	4.90	1490.7	5.9	15933.9
1996	161.36	7.5	104,089	8.4	65,996	2.50	2445.0	4.84	1577.2	5.8	17534.0
1997	173.41	7.5	112,739	8.3	67,646	2.50	2563.4	4.79	1666.6	5.7	18991.1
1998	186.25	7.4	122,033	8.2	69,337	2.50	2686.2	4.73	1760.0	5.6	20556.8
1999	199.94	7.3	131,921	8.1	71,070	2.50	2813.3	4.67	1856.2	5.5	22222.4
2000	214.50	7.3	142,453	8.0	72,847	2.50	2944.6	4.60	1955.5	5.3	23996.5
2001	229.98	7.2	153,653	7.9	74,668	2.50	3080.0	4.53	2057.8	5.2	26269.5
2002	246.41	7.1	165,553	7.7	76,535	2.50	3219.6	4.46	2163.1	5.1	28304.0
2003	263.83	7.1	178,172	7.6	78,449	2.50	3363.1	4.38	2271.2	5.0	30461.5
2004	282.27	7.0	191,528	7.5	80,410	2.50	3510.4	4.30	2381.9	4.9	32744.9
2005	301.78	6.9	205,663	7.4	82,420	2.50	3661.5	4.22	2495.3	4.8	35161.4
2006	322.39	6.8	220,579	7.3	84,480	2.50	3816.1	4.14	2611.0	4.6	37711.5
2007	344.13	6.7	236,311	7.1	86,592	2.50	3974.1	4.06	2729.0	4.5	40401.2
2008	367.03	6.7	252,861	7.0	88,757	2.50	4135.2	3.97	2848.9	4.4	43230.7

Fig. 5-4(1) DEMAND FORECAST OF TURKEY

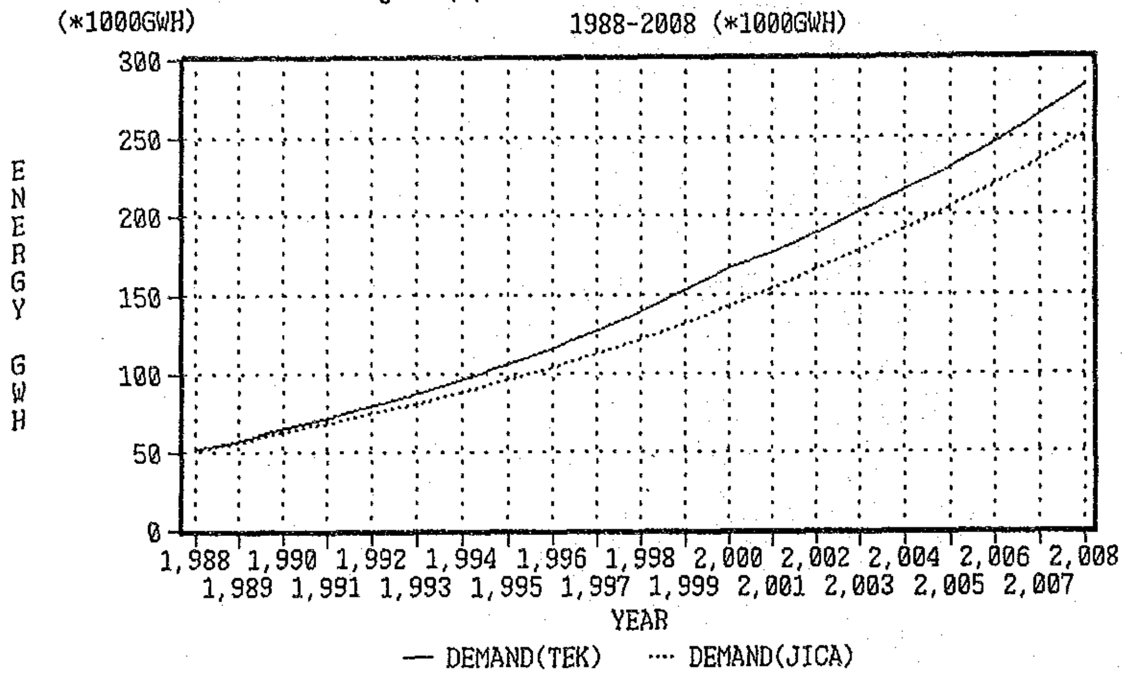


Fig. 5-4(2) PEAK POWER FORECAST

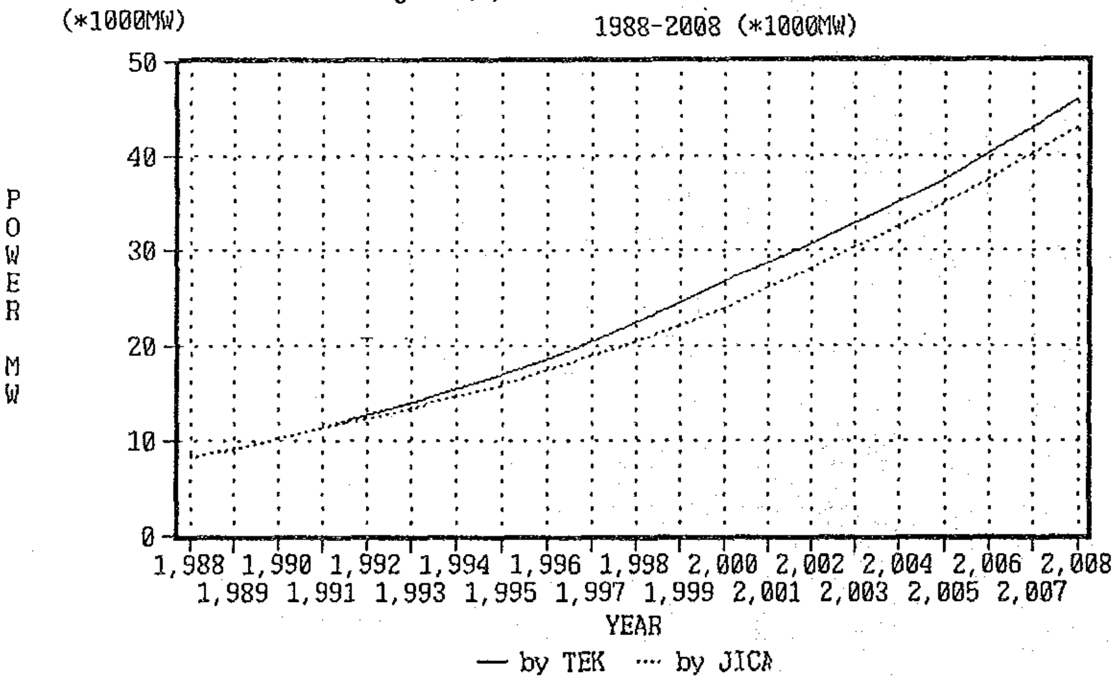


Table 5-4 Cukurova Power Co. Demand Forecast

YEAR	1988	1989	1990	1991	1992	1993
PEAK LOAD (MW)	633.0	701.3	805.0	875.4	947.5	1,057.1
ANNUAL LOAD FACTOR	0.654	0.654	0.654	0.654	0.654	0.654
ENERGY DEMAND (GWH)	3,626.5	4,017.8	4,611.9	5,015.2	5,428.3	6,056.2
DEMAND (GWH) TEK	51,620.0	57,925.0	64,910.0	71,885.0	79,200.0	87,260.0
Share to TEK (%)	7.0	6.9	7.1	7.0	6.9	6.9
CEAS DEM. GROWTH RATE	9.7	10.8	14.8	8.7	8.2	11.6

YEAR	1994	1995	1996	1997	1998	1999
PEAK LOAD (MW)	1,129.9	1,219.9	1,307.5	1,403.7	1,506.5	1,639.4
ANNUAL LOAD FACTOR	0.654	0.654	0.654	0.654	0.654	0.654
ENERGY DEMAND (GWH)	6,473.2	6,988.9	7,490.7	8,041.9	8,630.8	9,392.2
DEMAND (GWH) TEK	96,140.0	105,930.0	115,710.0	126,790.0	138,940.0	152,250.0
Share to TEK (%)	6.7	6.6	6.5	6.3	6.2	6.2
CEAS DEM. GROWTH RATE	6.9	8.0	7.2	7.4	7.3	8.8

YEAR	2000	2001	2002	2003	2004	2005
PEAK LOAD (MW)	1,784.1	1,941.6	2,112.9	2,300.9	2,503.6	2,723.9
ANNUAL LOAD FACTOR	0.654	0.654	0.654	0.654	0.654	0.654
ENERGY DEMAND (GWH)	10,221.2	11,123.5	12,104.9	13,181.9	14,343.2	15,605.3
DEMAND (GWH) TEK	166,830.0	177,020.0	189,310.0	202,450.0	216,500.0	231,530.0
Share to TEK (%)	6.1	6.3	6.4	6.5	6.6	6.7
CEAS DEM. GROWTH RATE	8.8	8.8	8.8	8.9	8.8	8.8

Fig. 5-5 Energy Demand TEK & CEAS

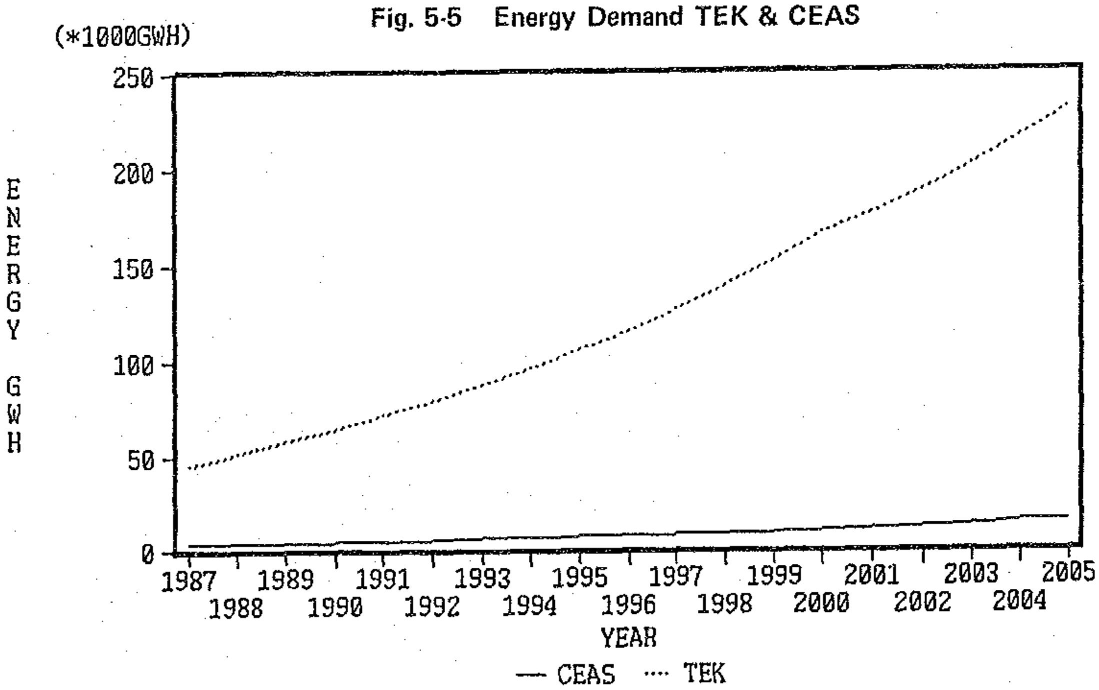


Fig. 5-6 (1) Daily Load Curve

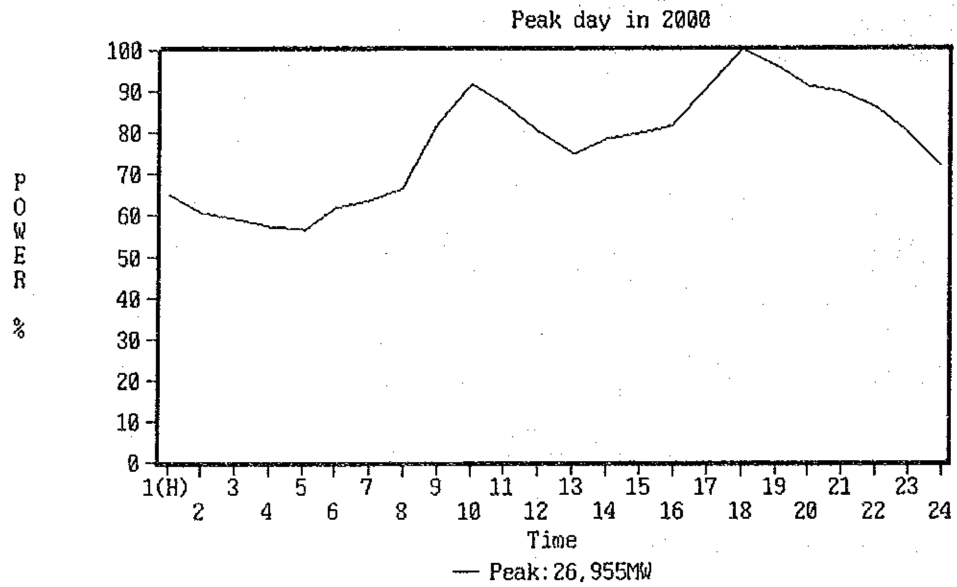


Fig. 5-6 (2) Load Duration Curve in 2000

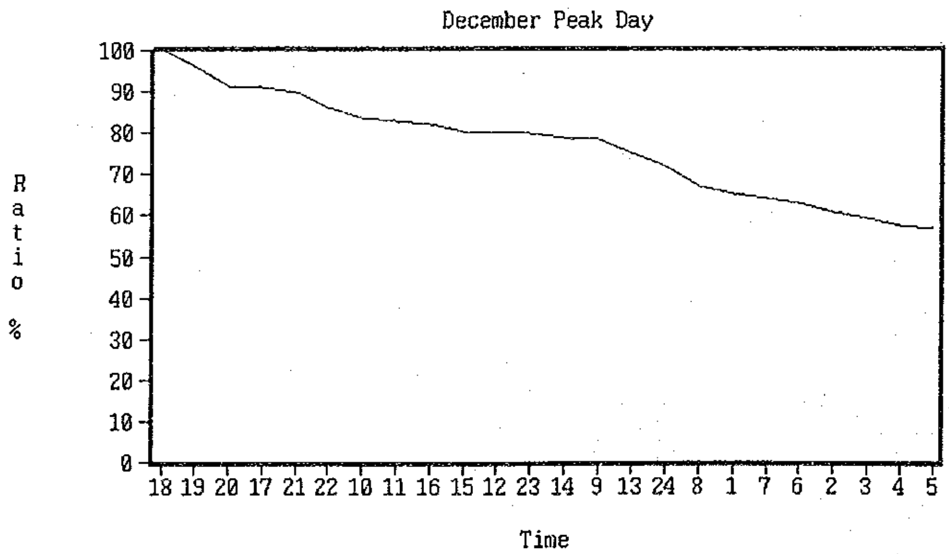


Fig. 5-7 Ratio of Hyd. P. Plant in Total

Installed Capacity (%)

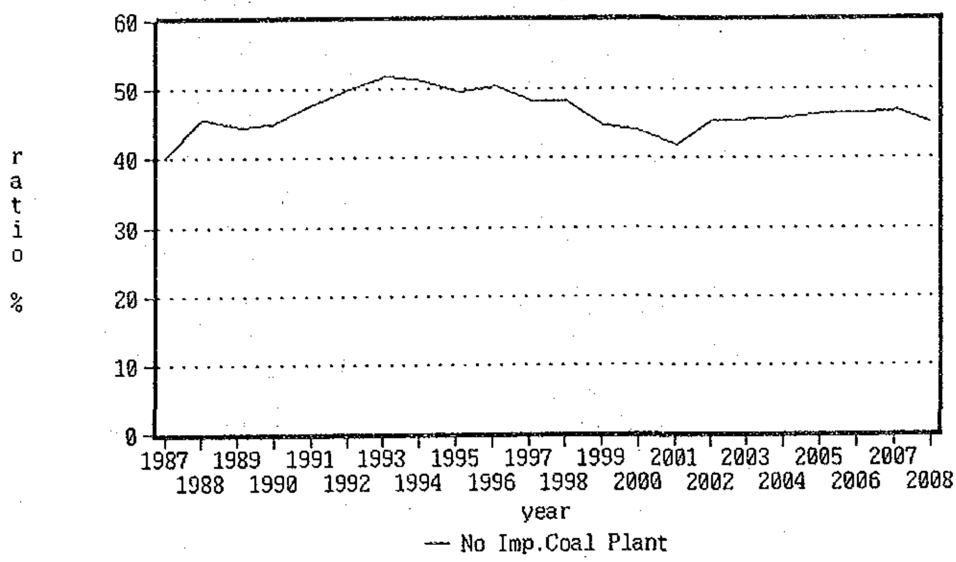


Fig. 5-8 Utilization of Hydroelectric

Potential of Turkey (%)

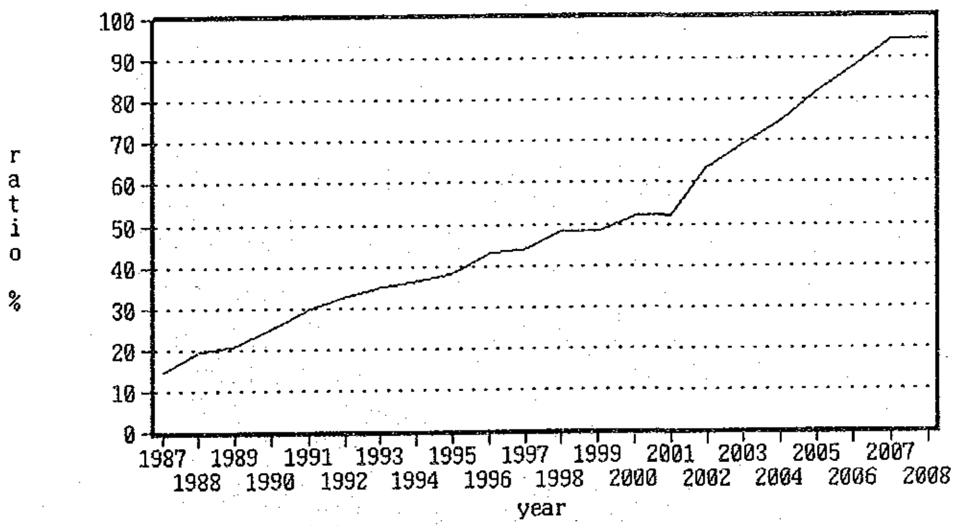


Table 5-5 (1) Construction Schedule of Power Plant in Turkey

Without Imported Coal Fired Power Plant (1992-'93)

Year	Peak Demand (MW)	Hydro P. Plant Total	Hydro P. Plant New plant	Thermal Power Plant Total	Thermal Power Plant New plant	Thermal Power Plant Retirement	Total capacity	Resreve margin(%)	Hydro P. ratio(%)
1987	7,467	5,003	1,125	7,489	-	-	12,492	67.3	40.0
1988	8,358	6,586	1,583	7,830	778	437	14,416	72.5	45.7
1989	9,250	7,010	424	8,722	1,055	163	15,732	70.1	44.6
1990	10,370	8,406	1,396	10,205	1,483	-	18,611	79.5	45.2
1991	11,480	10,046	1,640	10,940	735	-	20,986	82.8	47.9
1992	12,650	10,999	953	11,000	60	-	21,999	73.9	50.0
1993	13,940	11,819	820	11,000	0	-	22,819	63.7	51.8
1994	15,485	12,262	648	11,677	677	-	23,939	54.6	51.2
1995	17,060	12,934	672	13,107	1,430	-	26,041	52.6	49.7
1996	18,695	14,501	1,567	14,244	1,310	173	28,745	53.8	50.4
1997	20,485	14,851	350	15,884	1,990	350	30,735	50.0	48.3
1998	22,450	16,271	1,420	17,504	1,620	-	33,775	50.4	48.2
1999	24,600	16,271	0	20,049	2,545	-	36,320	47.6	44.8
2000	26,955	17,469	1,198	22,394	2,345	-	39,863	47.9	43.8
2001	28,825	17,469	0	24,284	1,890	-	41,753	44.8	41.8
2002	30,825	21,409	3,940	25,809	1,525	-	47,218	53.2	45.3
2003	32,965	23,338	1,929	27,779	1,970	-	51,117	55.1	45.7
2004	35,255	25,157	1,819	29,754	1,975	-	54,911	55.8	45.8
2005	37,700	27,500	2,343	31,744	1,990	-	59,244	57.1	46.4
2006	40,320	29,448	1,948	33,894	2,150	-	63,342	57.1	46.5
2007	43,115	31,692	2,244	35,854	1,960	-	67,546	56.7	46.9
2008	46,110	31,692	0	38,884	3,030	-	70,576	53.1	44.9

* Following Imported Coal Fired Plants are not included
1992, 1400MW (3,424GWH/year)
1993, 1460MW (11,352GWH/year)

Table 5-5 (2) Construction Schedule of Power Plant in Turkey

With Impoted Coal Fired Plant(1992-'93)

Year	Peak Demand(MW)	Hydro P. Plant		Thermal Power Plant			Total capacity	Resreve margin(%)	Hydro P. ratio(%)
		Total	New plant	Total	New plant	Retirement			
1987	7,467	5,003	1,125	7,489	-	-	12,492	67.3	40.0
1988	8,358	6,586	1,583	7,830	778	437	14,416	72.5	45.7
1989	9,250	7,010	424	8,722	1,055	163	15,732	70.1	44.6
1990	10,370	8,406	1,396	10,205	1,483	-	18,611	79.5	45.2
1991	11,480	10,046	1,640	10,940	735	-	20,986	82.8	47.9
1992	12,650	10,999	953	12,400	1,460	-	23,399	85.0	47.0
1993	13,940	11,819	820	13,860	1,460	-	25,679	84.2	46.0
1994	15,485	12,262	648	14,537	677	-	26,799	73.1	45.8
1995	17,060	12,934	672	15,967	1,430	-	28,901	69.4	44.8
1996	18,695	14,501	1,567	17,104	1,310	173	31,605	69.1	45.9
1997	20,485	14,851	350	18,744	1,990	350	33,595	64.0	44.2
1998	22,450	16,271	1,420	20,364	1,620	-	36,635	63.2	44.4
1999	24,600	16,271	0	22,909	2,545	-	39,180	59.3	41.5
2000	26,955	17,469	1,198	25,254	2,345	-	42,723	58.5	40.9
2001	28,825	17,469	0	27,144	1,890	-	44,613	54.8	39.2
2002	30,825	21,409	3,940	28,669	1,525	-	50,078	62.5	42.8
2003	32,965	23,338	1,929	30,639	1,970	-	53,977	63.7	43.2
2004	35,255	25,157	1,819	32,614	1,975	-	57,771	63.9	43.5
2005	37,700	27,500	2,343	34,604	1,990	-	62,104	64.7	44.3
2006	40,320	29,448	1,948	36,754	2,150	-	66,202	64.2	44.5
2007	43,115	31,692	2,244	38,714	1,960	-	70,406	63.3	45.0
2008	46,110	31,692	0	41,744	3,030	-	73,436	59.3	43.2

Fig. 5-9 (1) Power Balance (Hydro peak = 8 hrs)

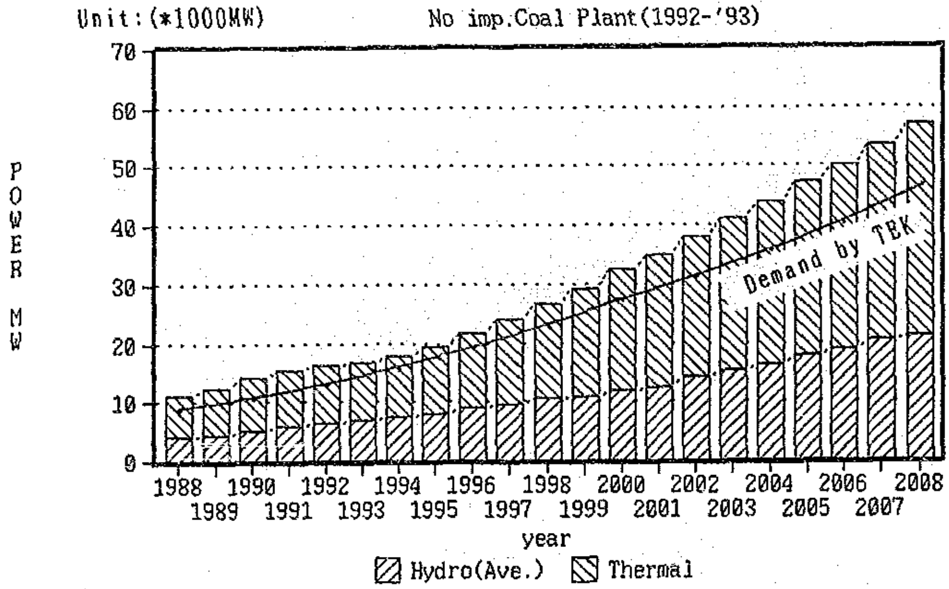


Fig. 5-9 (2) Power Balance (Hydro peak = 6 hrs)

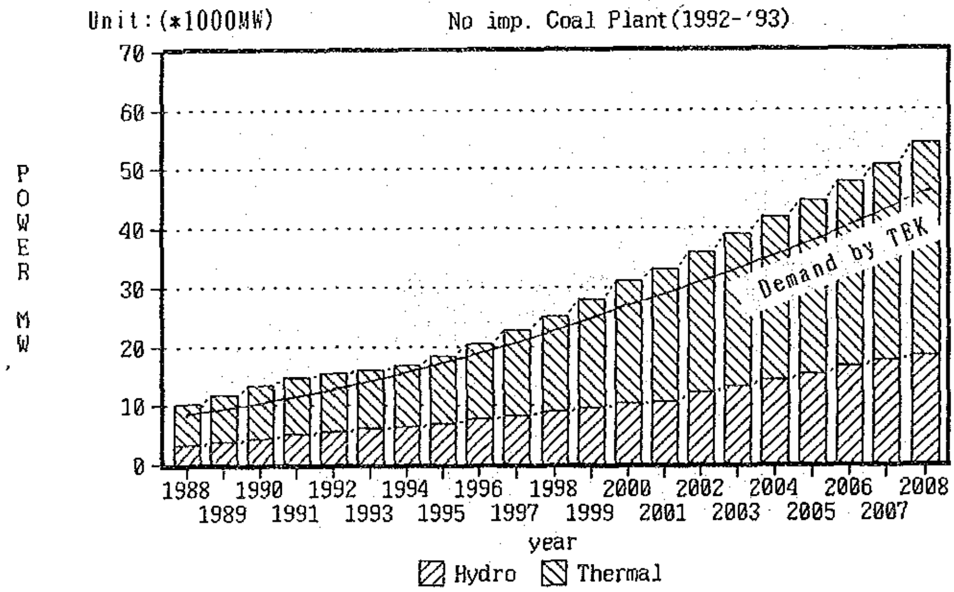


Fig. 5-9(3) MW Power Balance (Hydro peak = 8 hrs)

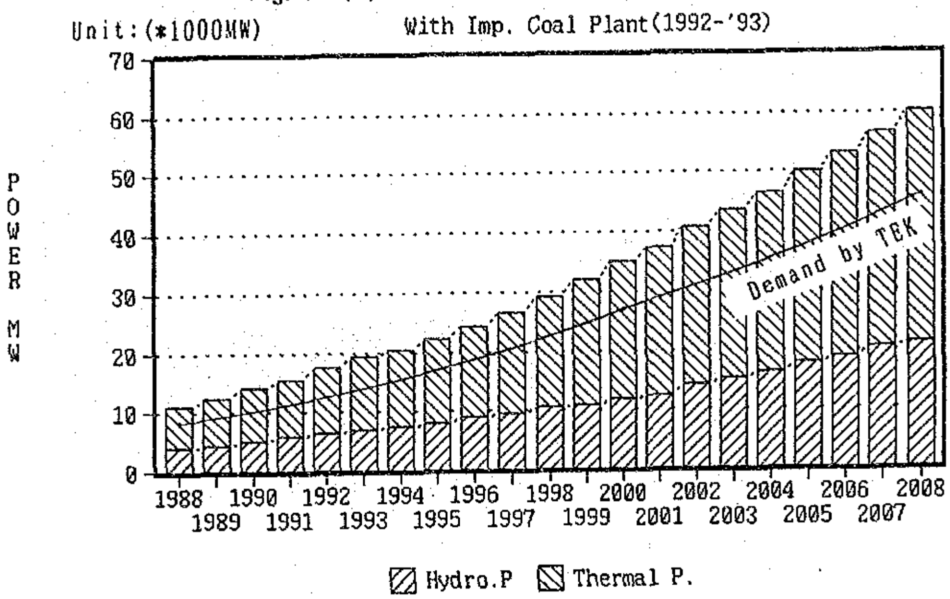


Fig. 5-9(4) MW Power Balance (Hydro peak = 6 hrs)

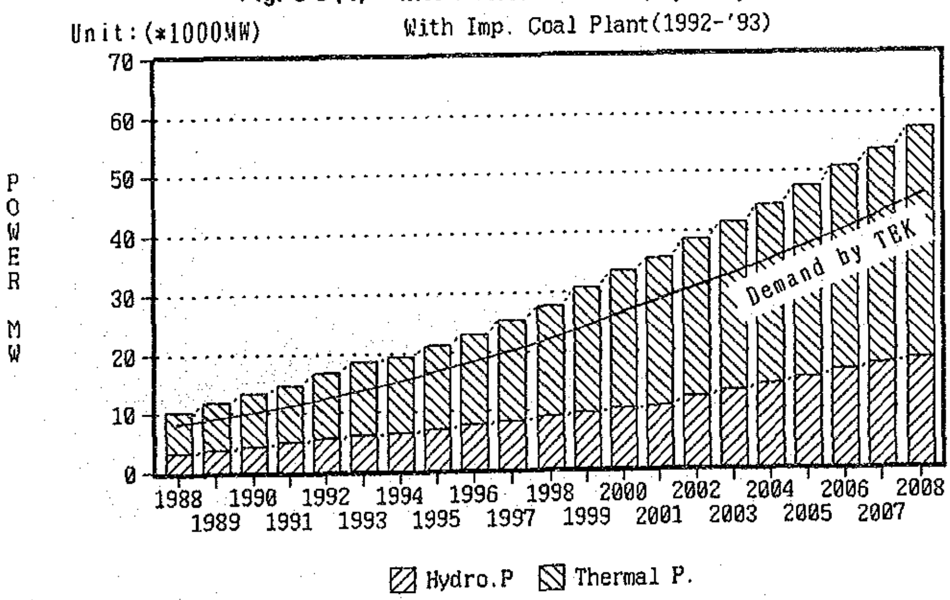


Fig. 5-9(5) Ave. Energy Balance in Turkey
No Imp. Coal Plant (1992–'93)

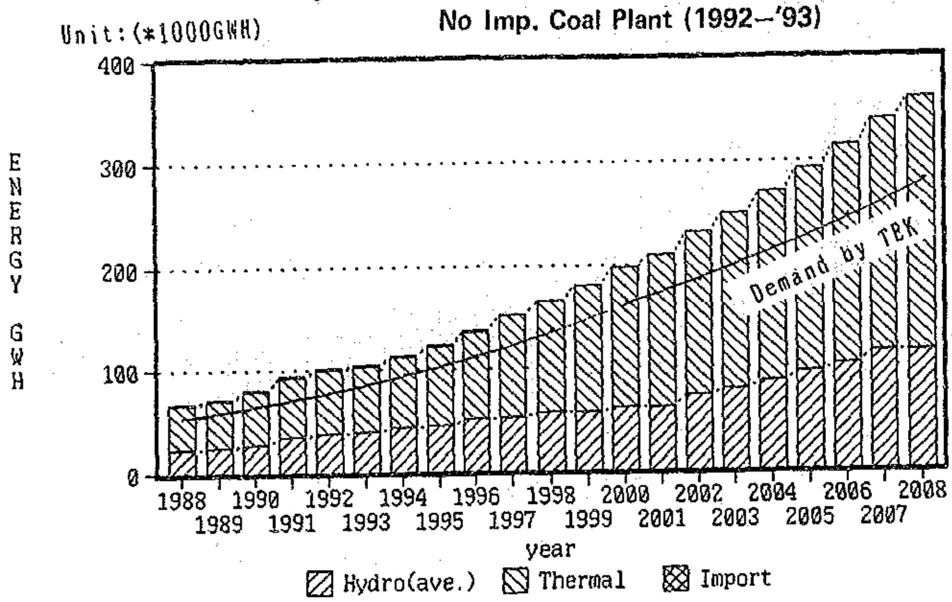


Fig. 5-9(6) Firm Energy Balance Turkey
No Imp. Coal Plant (1992–'93)

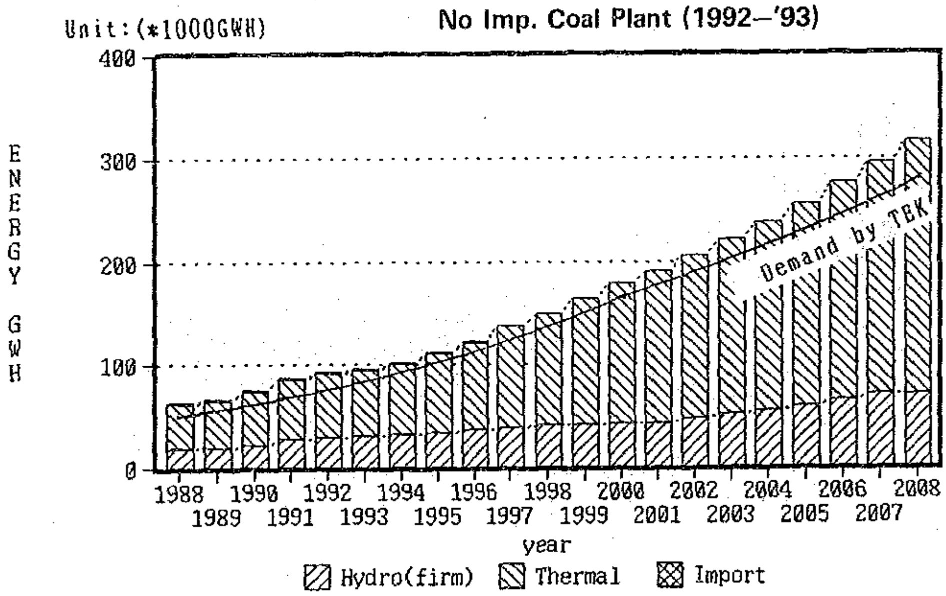


Fig. 5-9 (7) Ave. Energy Balance in Turkey With Imp. Coal Plant (1992–'93)

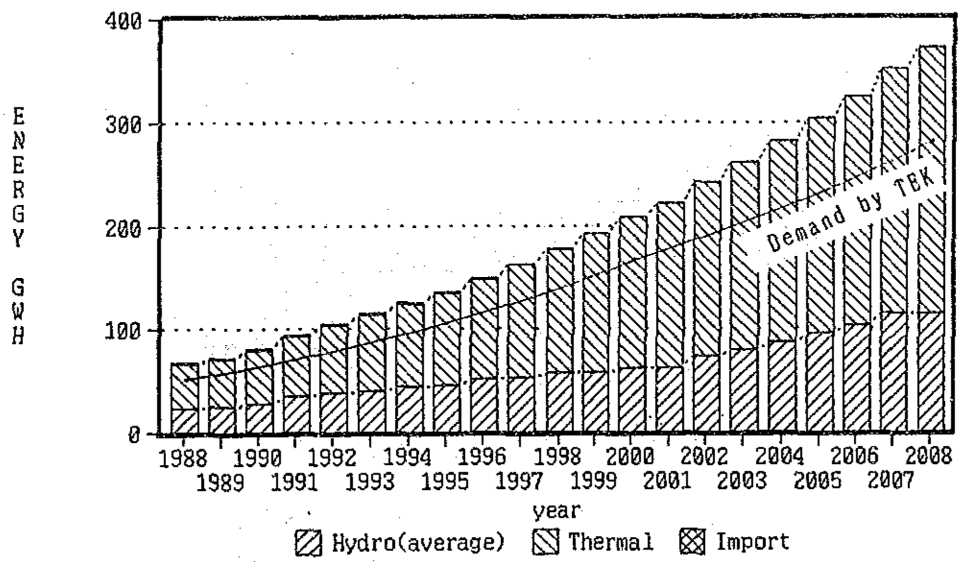


Fig. 5-9 (8) Firm Energy Balance Turkey With Imp. Coal Plant (1992–'93)

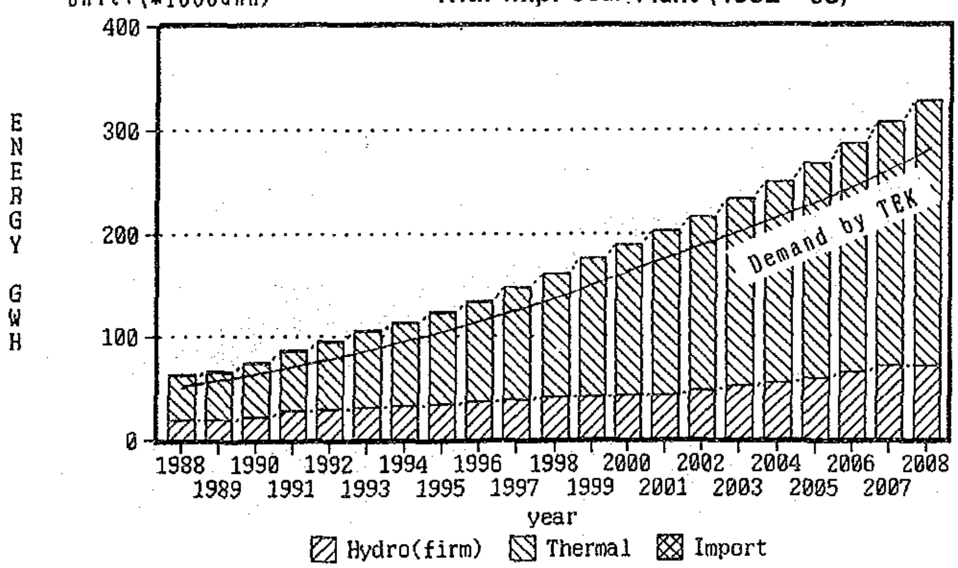


Table 5-7 (1) Available Power Balance in Turkey (MW)

No Imported Coal Fired plant (1992-'93)

Year	Peak Demand(MW)	Dep. Peak Hyd. Output		Thermal Available	HP+TP Tot. Cap(MW)		Reserve Margin(%)	
		Tp=8.0hr	Tp=6.0hr		Tp=8.0hr	Tp=6.0hr	Tp=8.0hr	Tp=6.0hr
1988	8,358	4,018	3,476	7,099	11,117	10,575	33.0	26.5
1989	9,250	4,364	3,778	7,946	13,033	11,724	40.9	26.7
1990	10,370	5,087	4,397	8,963	14,852	13,360	43.2	28.8
1991	11,480	5,889	5,073	9,662	16,138	14,735	40.6	28.4
1992	12,650	6,476	5,579	9,719	16,765	15,298	32.5	20.9
1993	13,940	7,046	6,077	9,719	17,268	15,796	23.9	13.3
1994	15,485	7,549	6,527	10,222	18,357	16,749	18.5	8.2
1995	17,060	8,135	7,041	11,460	19,595	18,501	14.9	8.4
1996	18,695	9,034	7,814	12,540	21,574	20,354	15.4	8.9
1997	20,485	9,562	8,280	14,431	23,993	22,711	17.1	10.9
1998	22,450	10,487	9,081	15,970	26,457	25,051	17.8	11.6
1999	24,600	10,977	9,506	18,388	29,365	27,894	19.4	13.4
2000	26,955	11,906	10,311	20,615	32,521	30,926	20.6	14.7
2001	28,825	12,312	10,663	22,411	34,723	33,074	20.5	14.7
2002	30,825	14,119	12,228	23,860	37,979	36,088	23.2	17.1
2003	32,965	15,255	13,211	25,731	40,986	38,942	24.3	18.1
2004	35,255	16,388	14,191	27,607	43,995	41,798	24.8	18.6
2005	37,700	17,731	15,352	29,498	47,229	44,850	25.3	19.0
2006	40,320	18,983	16,435	31,140	50,123	47,575	24.3	18.0
2007	43,115	20,374	17,638	33,002	53,376	50,640	23.8	17.5
2008	46,110	21,062	18,240	35,881	56,943	54,121	23.5	17.4

Hydro P.Plant Peak Duration Time in Average Year : 8hr
in Drought Year : 6hr

Table 5-7 (2) Available Power Balance in Turkey (MW)

With Imported Coal Fired Plant(1992-'93)

Year	Peak Demand(MW)	Hydro P. Plant		Thermal Available	HP+TP Tot. Cap(MW)		Reserve Margin(%)	
		Tp=8.0hr	Tp=6.0hr		Tp=8.0hr	Tp=6.0hr	Tp=8.0hr	Tp=6.0hr
1988	8,358	4,018	3,476	7,099	11,117	10,575	33.0	26.5
1989	9,250	4,364	3,778	7,946	12,310	11,724	33.1	26.7
1990	10,370	5,087	4,397	8,963	14,050	13,360	35.5	28.8
1991	11,430	5,889	5,073	9,662	15,551	14,735	35.5	28.4
1992	12,650	6,476	5,579	11,049	17,525	16,628	38.5	31.4
1993	13,940	7,046	6,077	12,436	19,482	18,513	39.8	32.8
1994	15,485	7,549	6,527	12,939	20,488	19,466	32.3	25.7
1995	17,060	8,135	7,041	14,177	22,312	21,218	30.8	24.4
1996	18,695	9,034	7,814	15,257	24,291	23,071	29.9	23.4
1997	20,485	9,562	8,280	17,148	26,710	25,428	30.4	24.1
1998	22,450	10,487	9,081	18,687	29,174	27,768	30.0	23.7
1999	24,600	10,977	9,506	21,105	32,082	30,611	30.4	24.4
2000	26,955	11,906	10,317	23,332	35,238	33,649	30.7	24.8
2001	28,825	12,312	10,669	25,128	37,440	35,797	29.9	24.2
2002	30,825	14,119	12,228	26,577	40,696	38,805	32.0	25.9
2003	32,965	15,255	13,211	28,448	43,703	41,659	32.6	26.4
2004	35,255	16,388	14,191	30,324	46,712	44,515	32.5	26.3
2005	37,700	17,731	15,352	32,215	49,946	47,567	32.5	26.2
2006	40,320	18,983	16,435	34,257	53,240	50,692	32.0	25.7
2007	43,115	20,374	17,638	36,119	56,493	53,757	31.0	24.7
2008	46,110	21,062	18,240	38,998	60,060	57,238	30.3	24.1

Hydro P.Plant Peak Duration Time in Average Year : 8hr
in Drought Year : 6hr

Table 5-7 (3) Available Energy Balance in Turkey

No Imported Coal P(1992-'93)

Year	Demand (GWH)	Dep. Peak Hyd. Output		Thermal	Import (GWH)	HP+TP+Imp. Eng(GWH)		Reserve Margin(%)	
		Average	Drought	Available		Average	Firm	Average	Firm
1988	51,620	23,113	18,490	42,205	1,600	66,918	62,295	29.6	20.7
1989	57,925	25,022	19,579	45,738	1,600	72,360	66,917	24.9	15.5
1990	64,910	28,516	22,265	51,767	1,600	81,883	75,632	26.1	16.5
1991	71,885	35,426	27,622	57,934	1,600	94,960	87,156	32.1	21.2
1992	79,200	38,846	29,765	61,732	1,600	102,178	93,097	29.0	17.5
1993	87,260	40,136	30,338	62,985	1,600	104,721	94,923	20.0	8.8
1994	96,140	43,726	31,896	68,475	1,600	113,801	101,971	18.4	6.1
1995	105,930	46,246	33,696	77,475	1,600	125,321	112,771	18.3	6.5
1996	115,710	51,536	37,351	84,845	1,600	137,981	123,796	19.2	7.0
1997	126,790	53,336	38,441	98,235	0	151,571	136,676	19.5	7.8
1998	138,940	58,154	41,173	107,685	0	165,839	148,858	19.4	7.1
1999	152,250	58,154	41,173	123,205	0	181,359	164,378	19.1	8.0
2000	166,830	61,644	42,233	135,415	0	197,059	177,648	18.1	6.5
2001	177,020	61,644	42,233	147,945	0	209,589	190,178	18.4	7.4
2002	189,310	73,153	47,049	157,445	0	230,598	204,494	21.8	8.0
2003	202,450	79,631	51,014	170,265	0	249,896	221,279	23.4	9.3
2004	216,500	87,641	55,134	182,955	0	270,596	238,089	25.0	10.0
2005	231,530	96,141	59,724	196,325	0	292,466	256,049	26.3	10.6
2006	247,600	103,896	64,644	210,725	0	314,621	275,369	27.1	11.2
2007	264,790	114,677	70,409	224,415	0	339,092	294,824	28.1	11.3
2008	283,170	114,677	70,409	245,655	0	360,332	316,064	27.2	11.6

Table 5-7 (4) Available Energy Balance in Turkey

With Imported Coal Plant (1992-'93)

Year	Demand (GWH)	Hydro P. Plant		Thermal	Import (GWH)	HP+TP+IMP	Tot. (GWH)	Reserve Margin(%)	
		Average	Firm	Available		Average	Firm	Average	Firm
1988	51,620	23,113	18,490	42,205	1,600	66,918	62,295	29.6	20.7
1989	57,925	25,022	19,579	45,738	1,600	72,360	66,917	24.9	15.5
1990	64,910	28,516	22,265	51,767	1,600	81,883	75,632	26.1	16.5
1991	71,885	35,426	27,622	57,934	1,600	94,960	87,156	32.1	21.2
1992	79,200	38,846	29,765	65,156	1,600	105,602	96,521	33.3	21.9
1993	87,260	40,136	30,338	74,337	1,600	116,073	106,275	33.0	21.8
1994	96,140	43,726	31,896	79,827	1,600	125,153	113,323	30.2	17.9
1995	105,930	46,246	33,696	88,827	1,600	136,673	124,123	29.0	17.2
1996	115,710	51,536	37,351	96,197	1,600	149,333	135,148	29.1	16.8
1997	126,790	53,336	38,441	109,587	0	162,923	148,028	28.5	16.8
1998	138,940	58,154	41,173	119,037	0	177,191	160,210	27.5	15.3
1999	152,250	58,154	41,173	134,557	0	192,711	175,730	26.6	15.4
2000	166,830	61,644	42,233	146,767	0	208,411	189,000	24.9	13.3
2001	177,020	61,644	42,233	159,297	0	220,941	201,530	24.8	13.8
2002	189,310	73,153	47,049	168,797	0	241,950	215,846	27.8	14.0
2003	202,450	79,631	51,014	181,617	0	261,248	232,631	29.0	14.9
2004	216,500	87,641	55,134	194,307	0	281,948	249,441	30.2	15.2
2005	231,530	96,141	59,724	207,677	0	303,818	267,401	31.2	15.5
2006	247,600	103,896	64,644	222,077	0	325,973	286,721	31.7	15.8
2007	264,790	114,677	70,409	235,767	0	350,444	306,176	32.3	15.6
2008	283,170	114,677	70,409	257,007	0	371,684	327,416	31.3	15.6

Table 5-8 MW Power Balance of Cukurova Po. Co.

year	Demand (MW)	Hydro P. Plant Total	Hydro P. Plant New Plant	Thermal P. Plant Total	Thermal P. Plant New Plant	Total Cap. (MW)	Power(MW) Deficit	Deficit (%)
1988	633.0	192.0	0.0	106.0	0.0	298.0	-335.0	-52.9
1989	701.3	192.0	0.0	106.0	0.0	298.0	-403.3	-57.5
1990	805.0	474.0	282.0	106.0	0.0	580.0	-225.0	-28.0
1991	875.4	474.0	0.0	106.0	0.0	580.0	-295.4	-33.7
1992	947.5	474.0	0.0	106.0	0.0	580.0	-367.5	-38.8
1993	1057.1	474.0	0.0	106.0	0.0	580.0	-477.1	-45.1
1994	1129.9	642.0	168.0	106.0	0.0	748.0	-381.9	-33.8
1995	1219.9	642.0	0.0	106.0	0.0	748.0	-471.9	-38.7
1996	1307.5	642.0	0.0	106.0	0.0	748.0	-559.5	-42.8
1997	1403.7	642.0	0.0	106.0	0.0	748.0	-655.7	-46.7
1998	1506.5	642.0	0.0	106.0	0.0	748.0	-758.5	-50.3
1999	1639.4	642.0	0.0	106.0	0.0	748.0	-891.4	-54.4
2000	1784.1	642.0	0.0	106.0	0.0	748.0	-1036.1	-58.1
2001	1941.6	642.0	0.0	106.0	0.0	748.0	-1193.6	-61.5
2002	2112.9	642.0	0.0	106.0	0.0	748.0	-1364.9	-64.6
2003	2300.9	642.0	0.0	106.0	0.0	748.0	-1552.9	-67.5
2004	2503.6	642.0	0.0	106.0	0.0	748.0	-1755.6	-70.1
2005	2723.9	642.0	0.0	106.0	0.0	748.0	-1975.9	-72.5

Development Project in 1990 Sir (282MW) Hydro.P
in 1994 Berke(168MW) Hydro.P

Fig. 5-10 Power Balance in CEAS

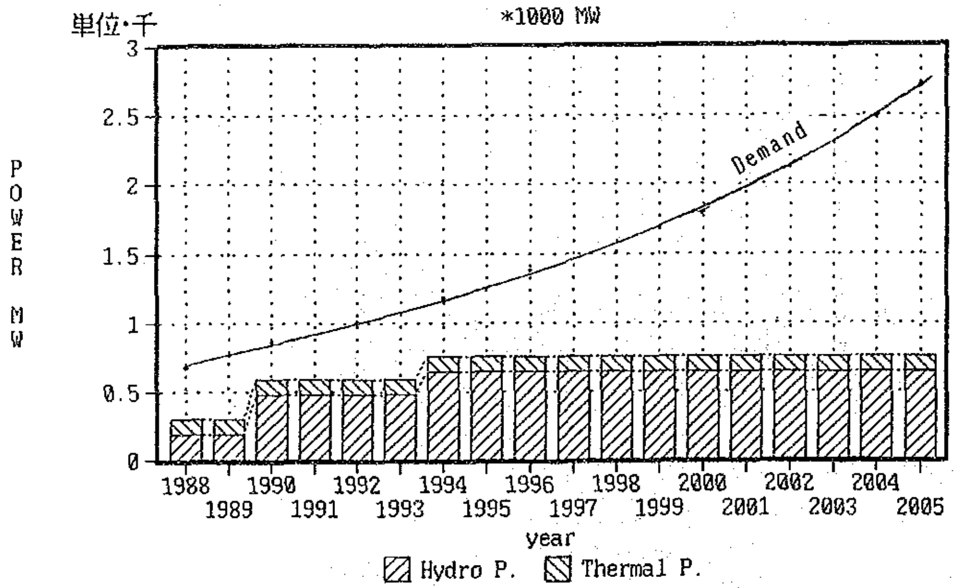
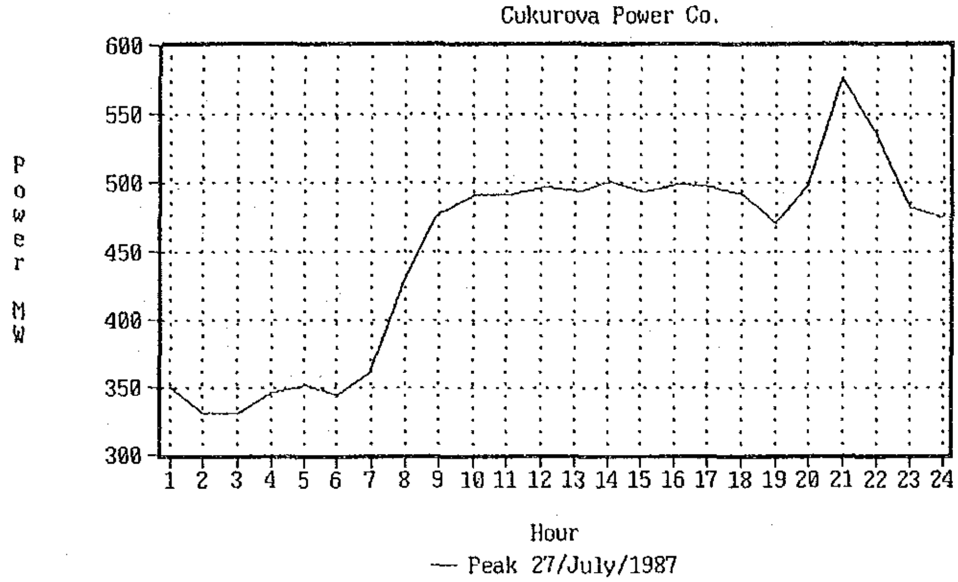


Fig. 5-11 **Daily Load Curve**



CHAPTER 6. METEOROLOGY AND HYDROLOGY

CHAPTER 6. METEOROLOGY AND HYDROLOGY

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CHAPTER 6. METEOROLOGY AND HYDROLOGY

6.1 *Outline of Meteorology and Hydrology*

6.1.1 General

The site of the Goktas Project is located at the downstreammost part of the Zamanti River, one of the two largest tributaries of the Seyhan River which flows through the southern part of Turkey. The Seyhan River is one of the greatest rivers of Turkey with a length of 506 km and catchment area of 20,730 km^2, and rises in Central Anatolian plateau, flows south, and empties into the Mediterranean Sea. The upstream part of the Seyhan River consists of two large tributaries: the Zamanti River and the Goksu River.

The basin of the Seyhan River, as shown in Fig. 6-1, is divided by the Tros Mountain Range cutting across the midstream part from southwest to northeast, and with this as the boundary, the upstream part at the north side belongs to an area of Central Anatolian climate and the downstream part at the south side to an area of Mediterranean climate. The area of Mediterranean climate has the characteristics of being warm and rainy in the wintertime and hot and dry in the summertime, with 70 to 80 percent of the annual precipitation occurring in the rainy season from November to May. On the other hand, as for the Central Anatolian climate area of continental nature, whereas the summertime is hot and dry, the wintertime is cold and snowfall is seen, and in general, there is little precipitation throughout the year. The basin of the Zamanti River in which the Goktas Project is to be located is almost all in the region of Central Anatolian climate, and the downstreammost part of the basin in which the dam site is located belongs to the Mediterranean climate area.

Regarding the topography of the Zamanti River Basin, the downstreammost part presents a rugged mountainous topography formed by mountains connecting to the Tros Mountain Range. The river gradient is steep from the vicinity of the Camlica project site upstream of No. 1802 Gauging Station to the confluence with the Goksu River, and the river rushes down rapidly through a gorge from EL. 1,200 m to 300 m.

On the other hand, the part upstream of the Camlica project site presents a flat basin-like topography belonging to the Central Anatolian Plateau so that the river gradient is comparatively gentle and rain falling in the catchment area will not be discharged abruptly into rivers and streams to cause floods. In this aspect there is a great difference from the downstreammost area. The elevation-area curve of the catchment area of the Goktas Dam Site is shown in Fig. 6-2.

6.1.2 Meteorological and Discharge Observation Data

(1) Meteorological Observation Data

The meteorological observation data shown in Table 6-1 exist regarding the Zamanti River Basin and its surroundings. These data are from observations by DMI and the DSI. The locations of the observation stations are shown in Fig. 6-1.

Measurements of precipitation were carried out at all observation stations, while in addition, observations were made at a number of observation stations on snowfall, air temperature, evaporation, humidity, vapor pressure, wind speed, etc. However, as shown in Table 6-1, it was after 1960 that a sufficient number of observation stations were provided for making analyses. Moreover, an observation station is not provided in the downstreammost basin of the Zamanti River where the Goktas Dam is to be located.

(2) Discharge Observation Data

(a) Long-term Discharge Observation Data

The long-term discharge observation data of the Zamanti River and its surroundings are shown in Table 6-2. These data were all observed by EIE and data up to the 1983 Turkish hydrological year (October of the preceding year to September of the current year) are presently available for use.

The locations of these discharge gauging stations are shown in Fig. 6-1.

(b) Recent Discharge Observation Data from Vicinity of the Goktas Dam Site

Besides the long-term observation data up to the 1983 hydrological year mentioned above, there are the observation data for the 1986 - 1987 hydrological years of the discharge gauging stations recently provided with the purpose of investigating the discharge at the Zamanti River downstream area where the Goktas Dam Site is located. These data are given in Table 6-3. Of these, the DSI is carrying out investigations on the area upstream of the dam site including the location of the former No. 1802 Gauging Station (EIE). As for EIE, it resumed investigations from March 1987 at a point approximately 5 km upstream of the former No. 1806 Gauging Station location downstream of the dam site.

The locations of these discharge gauging stations are also shown in Fig. 6-1.

6.1.3 Meteorology and Hydrology of Project River Basin

(1) Meteorology of Project River Basin

Monthly precipitation, snow cover depth, and mean temperature data observed at some meteorological stations within and surrounding the basin of the project site are shown in Tables 6-4, 5, 6.

The Zamanti River Basin where the Goktas Dam Site is located has its southernmost part dissected from southwest to northeast by the Tros Mountain Range, and with this as the boundary, is divided into areas of different meteorologies.

The upstream area which belongs to the Central Anatolian Region shows the characteristics of a continental climate, and the annual precipitation is sparse at approximately 400 mm, there being almost no rainfall especially in July and August so that it is very dry. In comparison, the monthly precipitations from September to June are from 20 to 60 mm, with more rainfall from March to May. According to the records of the Pinarbasi Meteorological Station (EL. 1,470 m), the mean air temperature from December to February is below freezing point, and since the average elevation of the basin is a high 1,700 m, there is a fair amount of snow cover.

On the other hand, the southernmost part of the basin where the Goktas Dam Site is located is on the south side of the Tros Mountain Range and indicates Mediterranean climatic characteristics. This region is situated where moist atmosphere from the Mediterranean Sea hits the Tros Mountain Range causing rain to fall, and it is a fairly rainy zone with annual precipitation of 800 to 1,200 mm. The rainy season is from November to May with 70 to 80 percent of the annual precipitation occurring during this period. According to the records of the Mansurlu Meteorological Station adjacent to the downstreammost area of the Zamanti River, snow cover exceeding 1 m is seen at times from January to February, from which it can be comprehended that there is a fair amount of snow cover in the mountainland at the south side of the Tros Mountain Range.

The dam, waterway, and powerhouse sites of the Goktas Project are located in an area of elevation from 630 m to 320 m at the downstreammost part of the Zamanti River. For the air temperature in this region, the observation records from the Feke Meteorological Station (EL. 620 m) in the downstream area of the Goksu River will serve as references as seen from a geographical standpoint. According to the records obtained at the Feke Station, the annual mean temperature is 15°C, the minimum monthly mean temperature is 0°C in January, while the maximum is 26°C in July and August, making for a mild climate. According to the snowfall and snow cover observation records at the Feke Station, there is some amount of snow cover on average from the middle of January to the beginning of February.

(2) Hydrological Condition of Project Basin

(a) Annual Discharge

Monthly average discharges of some essential gauging stations existing in the Zamanti River Basin and surrounding the project site are shown in Table 6-7. According to Table 6-7, the discharge of the Zamanti River Basin in the snowmelt season from March to May is maximum, while from September to October when the dry season is about to end it is minimum. In the upstream area, there is a tendency for the runoff peak to come slightly later than in the downstream area because of slower melting of snow due to the higher elevation.

At the No. 1806 Gauging Station site at the downstreammost part of the Zamanti River, the baseflow discharge is extremely large, while conversely, the high water discharge is small compared with the No. 1805 Gauging Station at the downstreammost part of the Goksu River. This is thought to be the influence of the runoff condition of the Zamanti River Basin, namely, rain falling on the ground first disappears underground and then gradually be discharged into downstream rivers and streams through underground streams because of distribution of limestone in the Zamanti River Basin. Kapzu Spring, in the vicinity of the upstream end of the projected Goktas Reservoir, and numerous other large and small springs in the project area are manifestations of this condition.

According to Table 6-7, the annual average discharge of 22 m^3/s at the No. 1802 Gauging Station (CA. 7,418 km^2) upstream of the Goktas Dam Site, that of 68 m^3/s at the No. 1806 Gauging Station (CA. 8,698 km^2) downstream of the dam site is approximately triple. This means that the discharge from the catchment area between the No. 1802 Gauging Station and the No. 1806 Gauging Station exceeded the precipitation in this area. The cause of this is thought to be the inflow of ground water from outside the basin through the beforementioned underground streams in the limestone, but since such a phenomenon does not normally occur, there is a possibility that this is an error in the observed discharge data. Therefore, as pointed out in the Master Plan

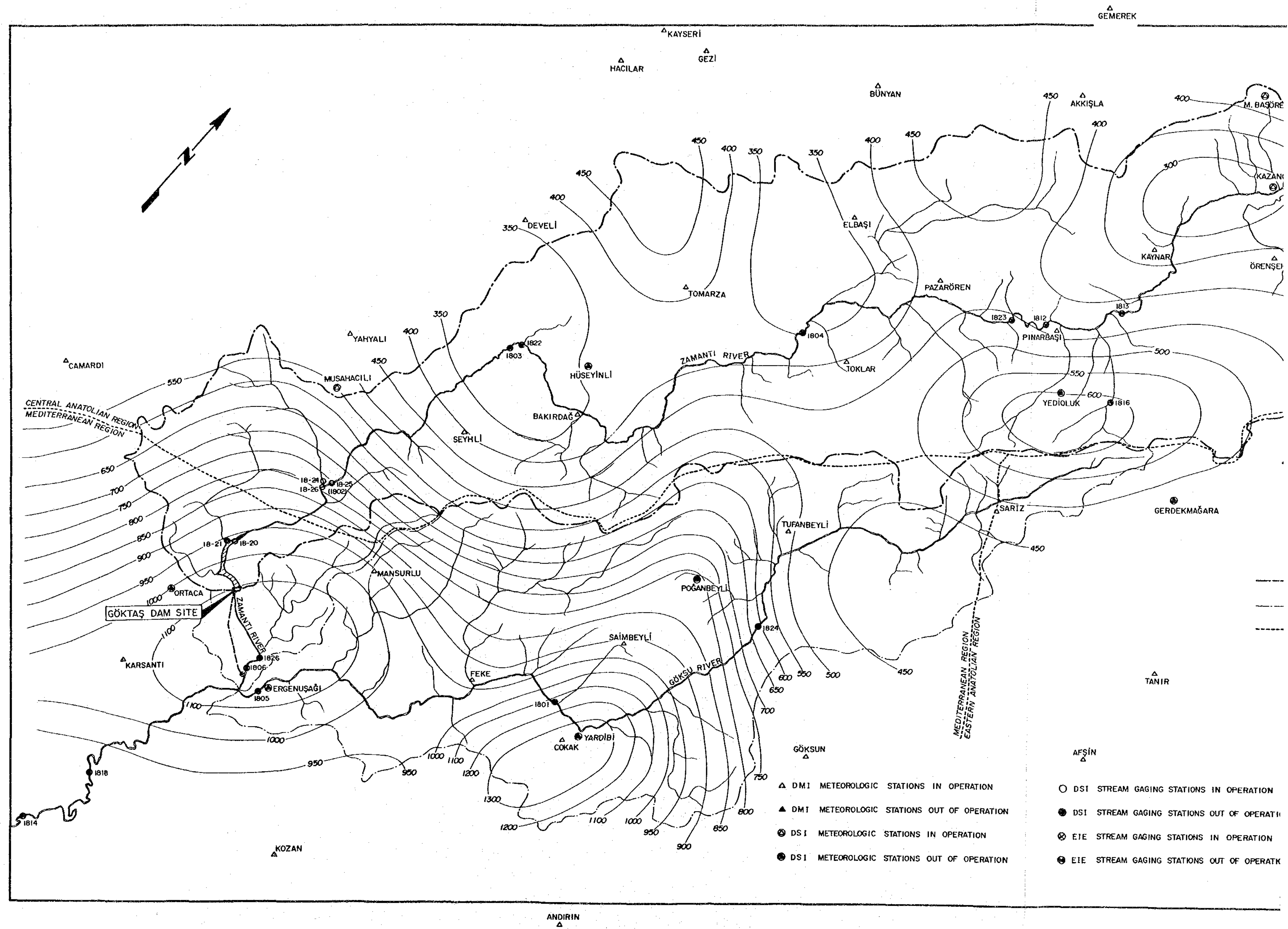
Report, confirmation of the existence of this phenomenon and verification of the discharge data are topics of great importance. The study regarding this point is described in detail in 6.2.

(b) Flood

Storms occur from October to June in the midstream and upstream parts of the Zamanti River Basin which belong to the Central Anatolian Region, but the amounts of rain falling in the storms are comparatively small so that floods occur most frequently from March to May when snowmelt water and storm rainfall water are discharged together.

At the No. 1802 Gauging Station site, almost all annual maximum peak discharges have occurred in April or May.

On the other hand, in the downstreammost part of the Zamanti River Basin where a Mediterranean climate is predominant, storms from atmospheric lows of Mediterranean nature occur in the rainy season from November to May. In this area, which corresponds to the south slope of the Tros Mountain Range, storms moving in from the Mediterranean Sea hit against the mountain range to cause heavy rains, and floods by storms occur throughout the rainy season. There is a fair amount of snowfall in this area, so that snowmelt floods also occur frequently from rapid rises in temperature during March and April. According to the records of the No. 1806 Gauging Station, approximately 70 percent of the annual maximum peak discharges have occurred in March and April.



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TOKLAR
ZAMANTI RIVER
YEDİOLUK
BAKIRDAĞ
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MEDITERRANEAN REGION
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GERDEKMAĞARA
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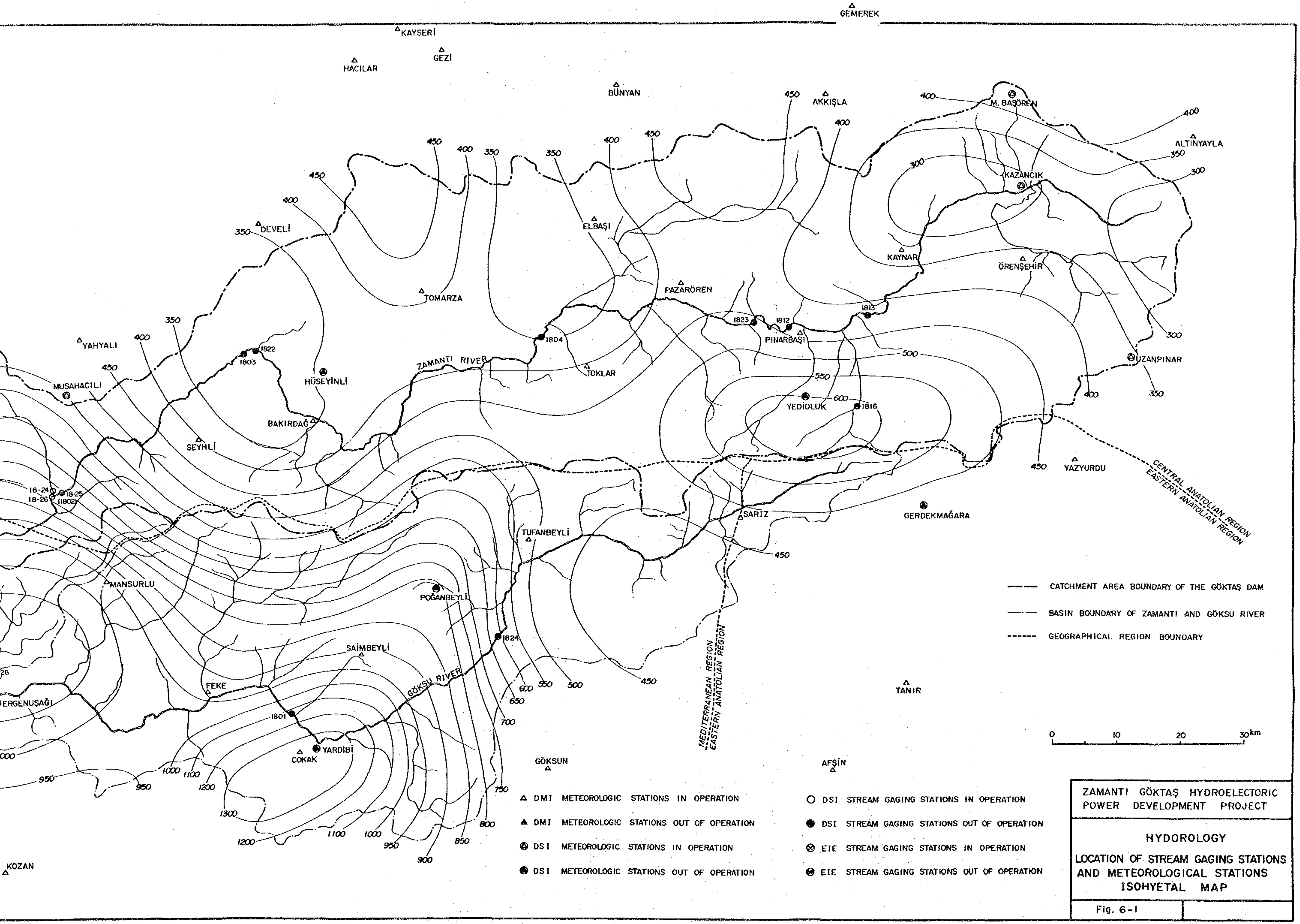


ZAMANTI GÖKTAŞ HYDROELECTORIC POWER DEVELOPMENT PROJECT

HYDOROLOGY

LOCATION OF STREAM GAGING STATIONS AND METEOROLOGICAL STATIONS ISOHYETAL MAP

Fig. 6-1

Fig.6-2 ELEVATION-AREA CURVE OF THE CATCHMENT AREA OF THE GÖKTAŞ DAMSITE

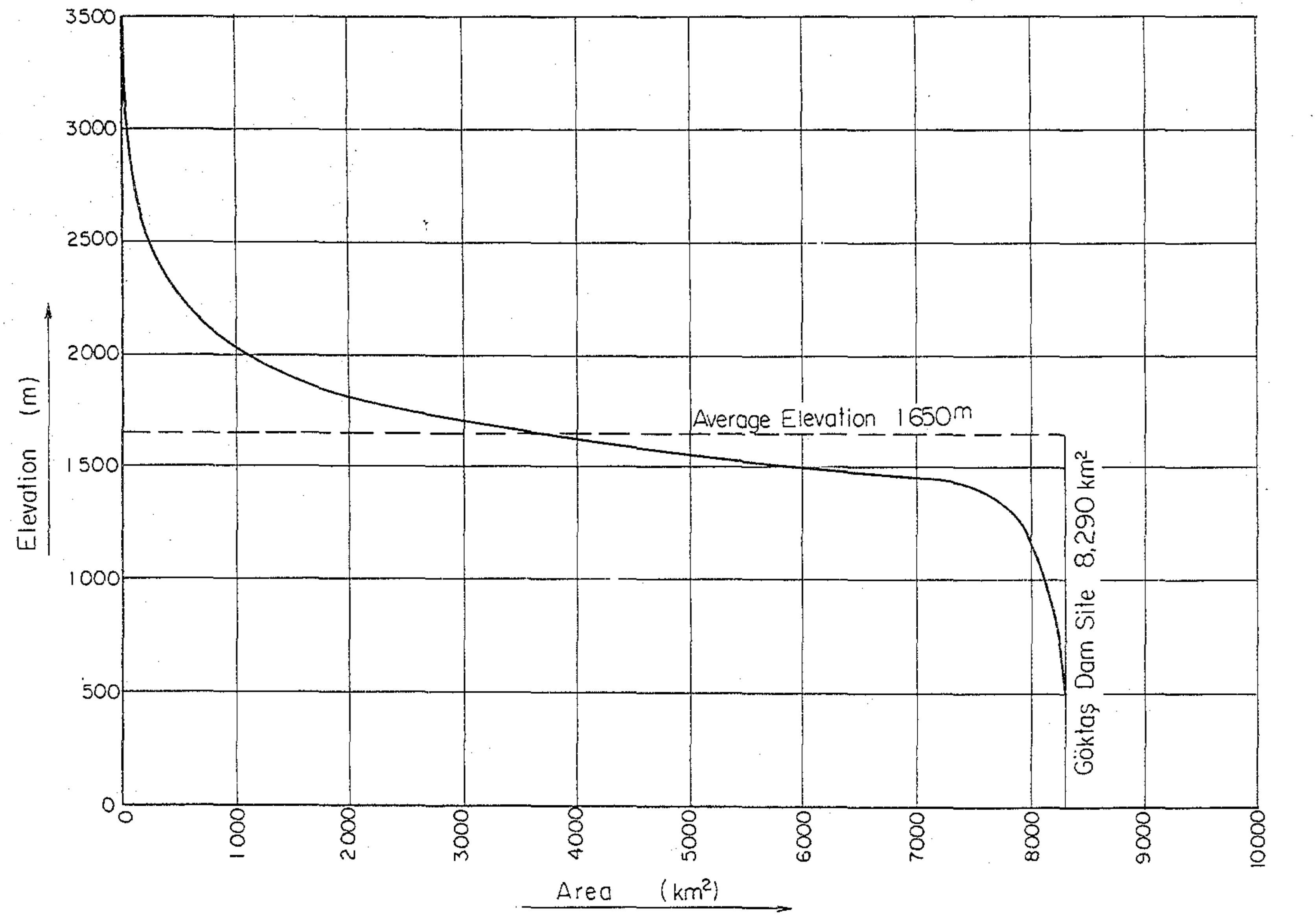


Table 6-1 Meteorological Data within and nearby the Zamanti River Basin

(1) Within the Zamanti River Basin

No.	Station	Elevation (m)	Data Period (Year)										Observed by
			Precipitation	Snow				Temperature	Evaporation	Relative Humidity	Vapour Pressure	Wind	
				Number of Snowy Days	Start & Last Date	Continuous Snowy Days	Snow Cover Depth						
1	SEYHLI	1400	69-85										DMI
2	BAKIRDAG	1300	60-82				60-82						"
3	HUSEYINLI	1330	66-73										DSI
4	TOMARZA	1400	63-86			63-86	63-86	65-86	73-86	65-86	65-86		DMI
5	TOKLAR	1400	65-83										"
6	ELBASI	1425	65-86										"
7	PAZAROREN	1500	64-86				64-86						"
8	PINARBASI	1470	50-86	70-86	51-86	50-86	50-86	64-86		64-86	64-86		"
9	YEDIOLUK	1790	67-73										DSI
10	KAYNAR	1550	65-82				65-82						DMI
11	M.BASOREN	1670	66-86										DSI
12	KAZANCIK	1585	65-86										"
13	ORENSEHIR	1600	64-86				64-86						DMI
14	UZUNPINAR	1740	59-86						65-86				DSI

(2) Nearby the Zamanti River Basin

No.	Station	Elevation (m)	Data Period (Year)										Observed by
			Precipitation	Snow				Temperature	Evaporation	Relative Humidity	Vapour Pressure	Wind	
				Number of Snowy Days	Start & Last Date	Continuous Snowy Days	Snow Cover Depth						
15	ORTACA	740	61-69										DSI
16	KARSANTI	860	60-82										DMI
17	ELGENUSAGI	800	63-72										DSI
18	MANSURLU	1050	64-85				63-86						DMI
19	FEKE	620	41-86	70-86	41-86	41-86	41-86	66-86		66-86	66-86		"
20	COKAK	1350	69-86										"
21	YARDIBI	1050	63-72	63-72									DSI
22	SAIMBEYLI	1100	57-86				57-86						DMI
23	DOGANBEYLI	1350	63-72	63-72									DSI
24	TUFANBEYLI	1350	57-86				57-86						DMI
25	SARIZ	1500	51-86			51-86	51-86	64-86		63-86	64-86		"
26	GERDEK-MAGARA	1725	63-77	63-77					66-77				DSI
27	YAZYURDU	1750	65-86										DMI
28	ALTINYAYLA	1375	65-86										"
29	GEMEREK	1173						64-86			64-86		"
30	AKKISLA	1500	65-84										"
31	BUNYAN	1300	50-86										"
32	GEZI	1250	66-86										"

- Continue -

No.	Station	Elevation (m)	Data Period (Year)										Observed by
			Precipitation	Snow				Temper-ature	Evapora-tion	Relative Humidity	Vapour Pressure	Wind	
				Number of Snowy Days	Start & Last Date	Continuous Snowy Days	Snow Cover Depth						
33	KAYSERI	1068	29-86	70-86	37-86	29-86	29-86	31-86	61-86		31-86	31-86	DMI
34	HACILAR	1500	64-86										"
35	DEVELI	1180	51-86					65-86			65-86	65-86	"
36	YAHYALI	1260	64-86										"
37	MUSAHACILI	950	74-86						74-86				DSI
38	CAMARDI	1500	61-85										DMI
39	KOZAN	150	51-86								63-86		DMI
40	ANDIRIN	1250	53-86										"
41	GOKSUN	1344	54-86					63-86	73-86		63-86	66-86	"
42	AFSIN	1180	58-86										"
43	TANIR	1200	69-86										"
44	NIGDE	1208	35-86	70-86	35-86	35-86	35-86				35-86		"
45	POZANTI	778	31-86							64-86	64-86	66-86	"
46	KAMISLI	950	63-86										DSI
47	ADANA	20	29-86					29-86	63-86	29-86	29-86	29-86	DMI
48	ULUKISLA	1451	29-86								38-86		"
49	TARSUS	33	33-86								50-86		"
50	KARAISALI	230	50-67									66-86	"

Table 6-2 Discharge Data of EIE's Gauging Stations within the Upper Seyhan Basin

Station No.	Station Name	River	Catchment Area (Km^2)	Evaluated Data Period (Water Year)	Note
1813	G.KARABOGAZ	Zamanti	2,144	1962 – 1974	out of operation
1812	PINARBASI	Zamanti	2,623	1955 – 1973	out of operation
1823	EMEGIL	Zamanti	2,756	1974 – 1983	
1804	SOGUTLU	Zamanti	4,389	1941 – 3.1955, 1962 – 1968	out of operation
1822	FRAKTIN	Zamanti	6,335	1969 – 1983	
1803	FRAKTIN	Zamanti	6,789	1939 – 1944	out of operation
1802	FARASA	Zamanti	7,418	1936 – 3.1954	out of operation
1806	ELGENUSAGI	Zamanti	8,698	1939 – 1956, 1961 – 1979	out of operation
1801	HIMMETLI	Goksu	2,597	1936 – 1983	
1805	GOKDERE	Goksu	4,243	1939 – 1983	
1818	EYNER	Seyhan	13,846	1966 – 1983	

Table 6-3 Discharge Data of New Gauging Stations nearby the Goktas Damsite

Observer	Station	River	Catchment Area (km^2)	Data Period	Remark
DSI	No. 18-20	Zamanti	7,825	Oct. 1985 - Mar. 1988, Jun. - Jul. 1988	
	No. 18-21	Topaktas	380	"	
	No. 18-24	Zindan	174	Oct. 1986 - Mar. 1988, Jun. - Jul. 1988	
	No. 18-25	Zamanti	7,418	"	No. 18-25 G.S. is located on the same site as EIE's No. 1802 G.S. (out of operation)
	No. 18-26	Zamanti	7,594	Oct. 1986 - Mar. 1988	
EIE	No. 1826	Zamanti	8,660	Mar. 1987 - Jul. 1988	No. 1826 G.S. is located just upstream of the site of EIE's No. 1806 G.S. (out of operation)
DSI	Goktas Dam Site	Zamanti	8,290	Jun. 1988 - Jul. 1988	

Discharge values of these gauging stations have not been evaluated enough.

Table 6-4 Monthly Precipitation Amounts at Some Meteorological Stations within and nearby the Zamanti River Basin

No	Station	Elevation (m)	Data Period	Monthly Mean Precipitation (mm)												Annual Total (mm)
				Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
1	SEYHLI	1400	1969 - 1984	44	29	50	76	43	25	8	7	9	25	31	42	389
2	BAKIRDAG	1300	1960 - 1981	39	26	41	44	48	33	4	5	14	24	30	37	345
3	HUSEYINLI	1330	1967 - 1972	30	23	29	44	57	38	9	5	21	29	37	34	356
4	TOMARZA	1400	1963 - 1986	39	33	45	57	57	41	8	5	17	30	33	44	409
5	TOKLAR	1400	1965 - 67, 70 - 77, 79 - 83	33	24	45	63	54	42	8	9	18	38	35	32	401
6	ELBASI	1425	1967 - 1986	33	27	33	53	54	35	10	2	18	28	27	36	356
7	PAZAROREN	1500	1964 - 1986	32	28	38	63	66	47	7	8	17	30	32	38	406
8	PINARBASI	1470	1951 - 1986	41	39	47	57	64	46	7	9	17	26	33	45	431
9	YEDIOLUK	1790	1967 - 1972	38	49	64	78	77	62	22	19	23	42	68	75	617
10	KAYNAR	1550	1965 - 1982	28	21	35	51	55	37	10	9	15	28	27	36	352
11	M.BASOREN	1670	1967 - 1986	38	35	44	64	77	46	11	5	18	30	36	31	435
12	KAZANCIK	1585	1966 - 1986	18	14	24	41	47	27	6	7	14	25	21	20	264
13	ORENSEHIR	1600	1964 - 1986	30	26	35	52	58	35	8	9	15	29	31	36	364
14	UZUNPINAR	1740	1960 - 70, 72 - 86	25	23	48	43	57	36	11	6	17	27	27	30	350
15	ORTACA	740	1961 - 65, 67 - 68	145	164	147	82	135	47	21	17	31	54	123	247	1,213
16	KARSANTI	860	1960 - 75, 79, 81	201	146	110	97	79	34	13	13	20	47	109	218	1,087
17	ELGENUSAGI	800	1963 - 1971	184	129	147	107	79	48	12	15	47	35	142	180	1,125
18	MANSURLU	1050	1964 - 65, 67 - 85	152	111	111	126	82	31	11	14	20	60	98	138	954
19	FEKE	620	1942 - 61, 64, 66, 68 - 86	151	128	114	108	75	36	11	13	24	51	87	134	932
20	COKAK	1350	1969 - 1986	225	186	172	193	104	36	8	11	25	94	122	242	1,418

* Station No. 1 to 14 are located in the Zamanti River Basin, and No. 15 to 20 are located nearby the downstreammost part of the Zamanti River Basin and belong to the Mediterranean climate area.

Table 6-5 Monthly Temperatures at Some Meteorological Stations

Station	Elevation (m)	Data Period		Temperatures (°C) Months Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Mean
Feke	620	1966, 1968 - 1986	Mean	4.4	5.9	9.6	13.8	18.3	22.9	26.4	26.4	22.9	16.7	10.4	5.9	15.3
			Mean Max.	16.4	18.9	24.5	29.1	32.7	36.6	39.0	39.7	37.0	32.5	25.4	19.5	-
			Mean Min.	-4.9	-4.7	-1.5	3.0	7.0	11.3	14.4	14.7	10.5	4.9	0.0	-3.4	-
Tomarza	1,400	1965 - 1986	Mean	-4.3	-2.8	2.4	8.0	12.4	16.3	19.7	19.6	15.5	9.5	3.6	-1.8	8.2
			Mean Max.	8.5	10.7	17.9	23.2	26.4	30.4	33.3	33.7	31.0	25.7	18.3	11.8	-
			Mean Min.	-21.9	-19.8	-13.6	-5.0	-1.1	2.1	5.3	4.4	0.4	-5.2	-10.1	-17.2	-
Pinarbasi	1,470	1964 - 1986	Mean	-4.5	-3.0	2.0	7.6	12.0	15.6	18.9	18.7	14.6	9.1	3.4	-1.8	7.7
			Mean Max.	7.5	9.7	16.5	22.1	25.4	29.7	32.7	33.5	30.0	24.9	17.8	11.0	-
			Mean Min.	-20.6	-19.3	-13.5	-4.6	-1.0	2.6	4.8	4.2	0.1	-4.4	-9.5	-16.6	-

Table 6-6 Snow Cover Observation Data of Some Snow Gauging Stations

Station	Elevation (m)	Data Period		Snow Cover Depth (cm)												
				Months												Annual Maximum
				Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
Feke	620	1941 - 1986	Mean	6	7	1	0	-	-	-	-	-	-	-	2	11
			Max.	54	62	35	2	-	-	-	-	-	-	-	17	62
Mansurlu	1,050	1965 - 1985	Mean	34	30	8	0	-	-	-	-	-	-	0	6	43
			Max.	135	130	93	7	-	-	-	-	-	-	3	35	135
Bakirdag	1,300	1961 - 1981	Mean	19	14	7	2	-	-	-	-	-	0	8	9	24
			Max.	55	50	26	15	-	-	-	-	-	2	35	30	55
Tomarza	1,400	1963 - 1986	Mean	22	20	9	3	-	-	-	-	-	0	4	13	29
			Max.	73	73	26	14	-	-	-	-	-	3	23	46	73
Pinarbasi	1,470	1951 - 1986	Mean	20	23	12	3	0	-	-	-	-	0	5	13	29
			Max.	70	67	42	13	3	-	-	-	-	6	44	46	70
Orensehir	1,600	1964 - 1986	Mean	26	23	15	4	0	-	-	-	0	2	7	16	29
			Max.	80	79	36	12	3	-	-	-	5	13	25	42	80

Table 6-7 Monthly Mean Discharge at Nos. 1812, 1804, 1822, 1802, 1806, 1801, 1805 and 1818 G.S.

Station No.	River	Catchment Area (km^2)	Observation Period (water year)	Mean Discharge (m^3/s) Months												
				Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Annual Mean
1812	Zamanti	2,623	1955, 1957 - 1973	7.1	7.1	7.1	7.0	7.4	12.9	19.1	14.8	11.0	7.6	7.0	6.9	9.6
1804	Zamanti	4,389	1941 - 1954, 1962, 1965 - 1968	8.7	8.8	9.1	9.4	9.5	16.0	26.6	20.3	13.1	10.1	9.4	9.3	12.5
1822	Zamanti	6,335	1969 - 1983	12.5	13.1	15.1	14.8	17.2	29.4	48.0	46.9	26.2	13.5	10.6	11.2	21.4
1802	Zamanti	7,418	1936 - 1953	12.2	14.6	14.5	13.2	16.4	27.1	54.6	46.2	25.8	15.0	12.3	11.9	22.0
1806	Zamanti	8,698	1940 - 1956, 1961 - 1979	40.6	45.0	53.9	54.7	65.1	95.2	132.8	110.6	73.5	53.7	45.6	42.3	67.7
1801	Goksu	2,597	1936 - 1983	15.4	16.5	22.4	25.8	31.6	59.9	74.2	48.1	28.2	19.6	16.1	15.1	31.0
1805	Goksu	4,243	1940 - 1983	21.6	26.0	48.2	67.7	83.2	129.6	153.9	91.3	45.4	28.8	23.0	21.5	61.5
1818	Seyhan	13,846	1966 - 1979, 1981 - 1983	76.0	83.6	142.7	181.3	174.1	259.8	307.4	228.4	138.1	97.6	81.1	75.8	153.7

6.2 The Discharge at the Project Sites

6.2.1 Available Data to Estimate the Goktas Dam Site Discharge

To estimate the discharge at the dam site, data over a substantial period are essential. Data from the No. 1806 G.S. located downstream of the dam site can be applied for the estimation of discharge at the dam site. Taking into account that the discharge at the No. 1806 G.S. is approximately treble that of the No. 1802 G.S., it seems necessary to reflect the discharge at the No. 1802 G.S. to calculate that at the dam site.

The discharge observation at the No. 1802 G.S. was terminated in March 1954 and the data at the No. 1806 G.S. are not available from October 1956 to September 1960, and after October 1979. It is necessary to supplement this missing data, using other gauging station data, to calculate the dam site discharge from the discharge of the No. 1802 and 1806 G.S. The supplementation method will be described in the next paragraph.

The recent discharge data observed after October 1985 shown in Table 6-3 are not used to calculate the dam site discharge but used as reference, because their observation period is short and their continuity with data of the No. 1802 and 1806 G.S. is not given.

6.2.2 Supplementation of Missing Discharge Data

(1) Supplementation Method

Some methods are available to supplement the missing data. These include the discharge analysis drawn from rainfall data, data generation, and correlation with the other available observed data. The discharge analysis by the correlation method are generally applied to supplement missing data on the condition that discharge data from surroundings of the project area is available.

The correlation among the discharge data relative to the Goktas Project, which are drawn from the discharge data presented in Table 6-2, is given in Table 6-8 and illustrated in Figs. 6-3, 4, 5, 6, 7, 8, and 9. Regarding the Table and Figures mentioned above, it beco-

Table 6-8 Results of the Correlation Analysis of the Monthly Mean Discharges at Stream Gauging Stations

Station Y	Station X	Evaluated Years	Regression Equation (unit: m^3/s)	Correlation Coefficient	Supplementary Period	Remark
1802	1804	1941 - 1952	$Y = -7.95 + 2.56 X$	0.921	-	Fig. 6-3
	1803 (1822)	1940 - 1944	$\log Y = 0.08 + 1.02 \log X$	0.968	1969 - 1983	Fig. 6-4
	1806	1940 - 1952	$Y = -3.29 + 0.38 X$	0.949	1954 - 1968	Fig. 6-5
1806	1805	1940 - 1979	$\log Y = 0.91 + 0.53 \log X$	0.911	1957-1960, 1980	Fig. 6-6
	1818	1966 - 1979	$Y = 14.74 + 0.36 X$	0.940	-	Fig. 6-7
1805	1818	1966 - 1979	$Y = -21.42 + 0.55 X$	0.982	-	Fig. 6-8
1806 + 1805	1818	1966 - 1979	$\log Y = 0.00 + 0.97 \log X$	0.944	1981 - 1983	Fig. 6-9

Fig. 6-3 Correlation between the Monthly Mean Discharges of Nos. 1802 and 1804 G.S.

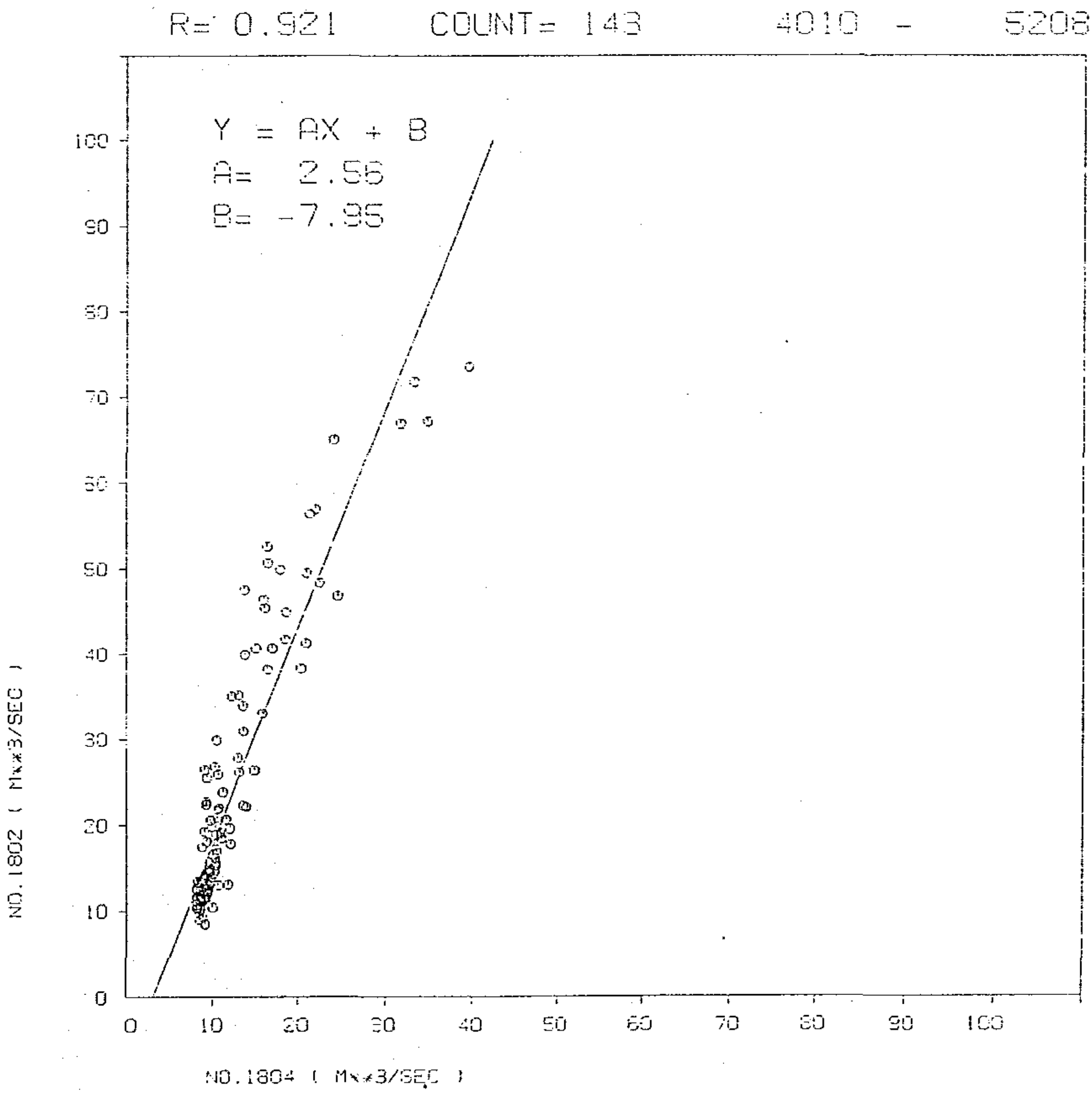


Fig. 6-4 Correlation between the Monthly Mean Discharges of Nos. 1802 and 1803 G. S.

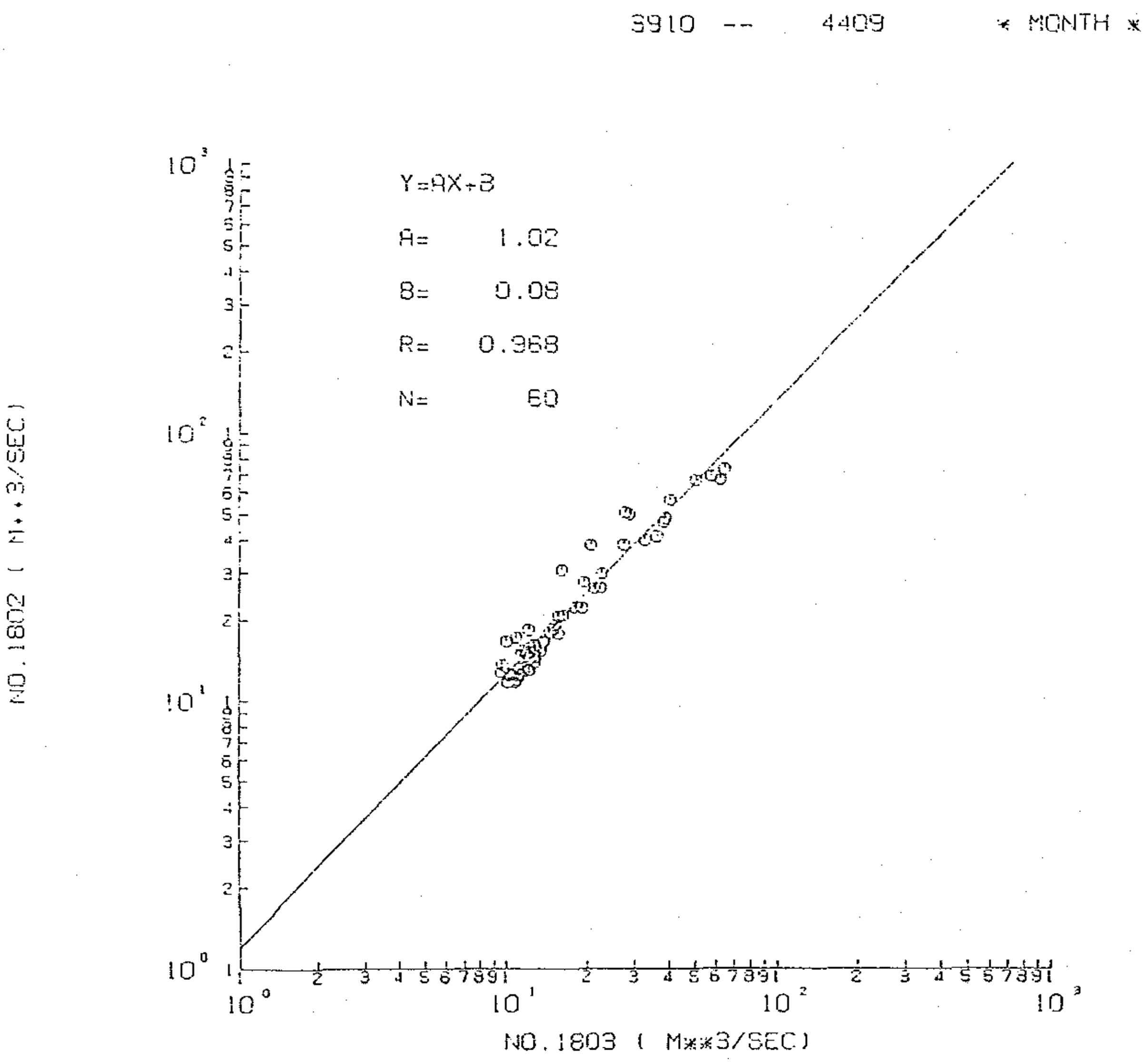


Fig. 6-5 Correlation between the Monthly Mean Discharges of Nos. 1802 and 1806 G. S.

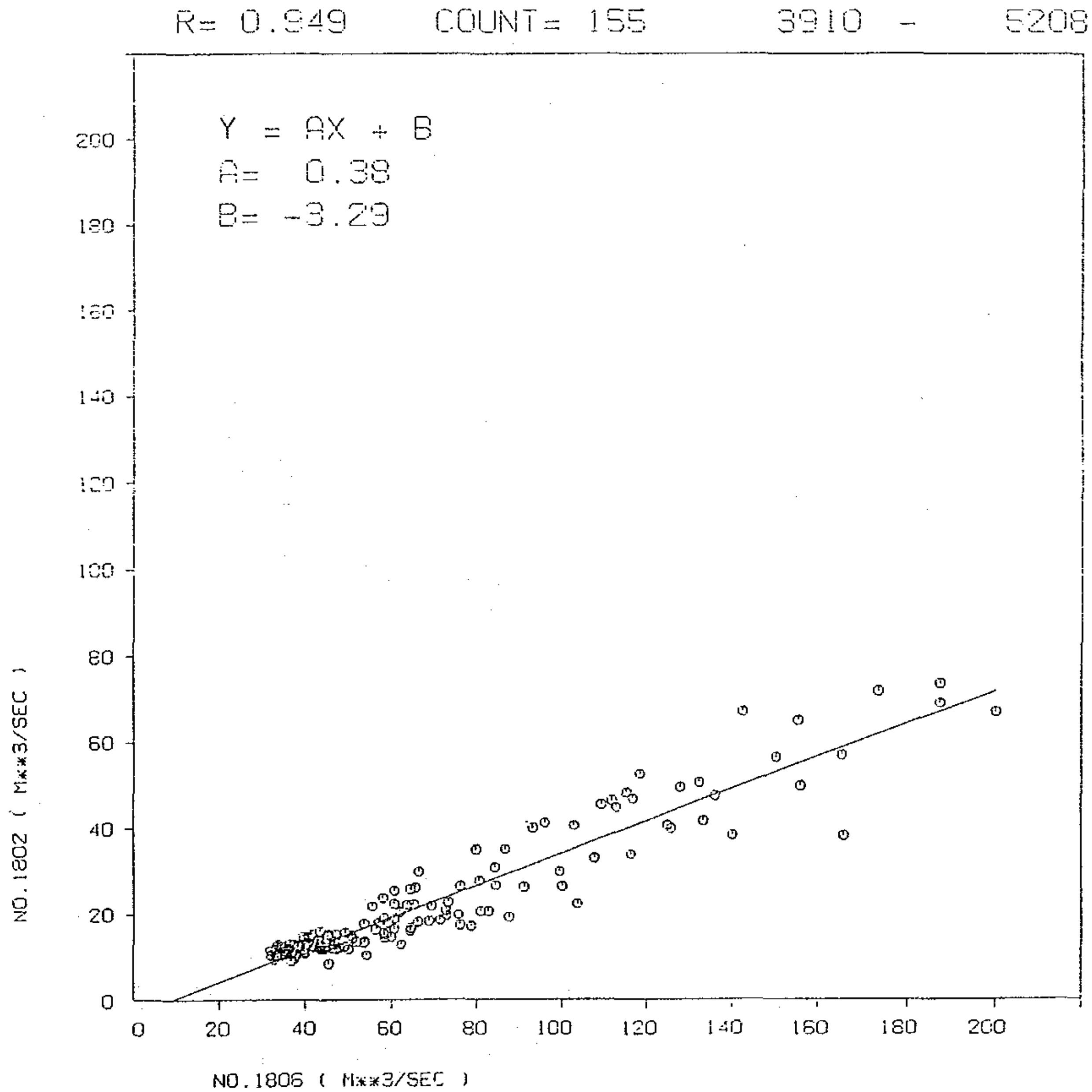


Fig. 6-6 Correlation between the Monthly Mean Discharges of Nos. 1806 and 1805 G. S.

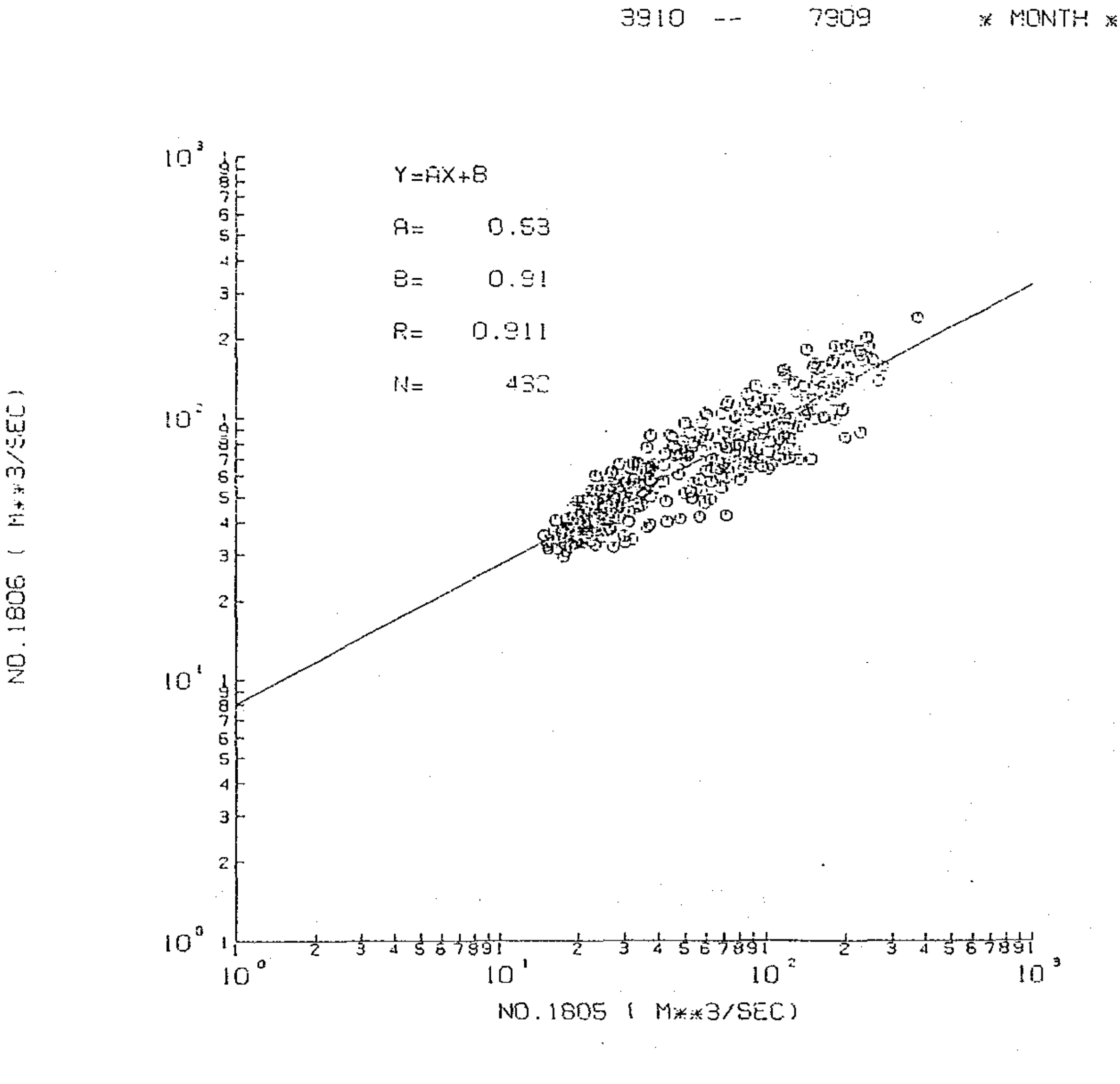


Fig. 6-7 Correlation between the Monthly Mean Discharges of Nos. 1806 and 1818 G. S.

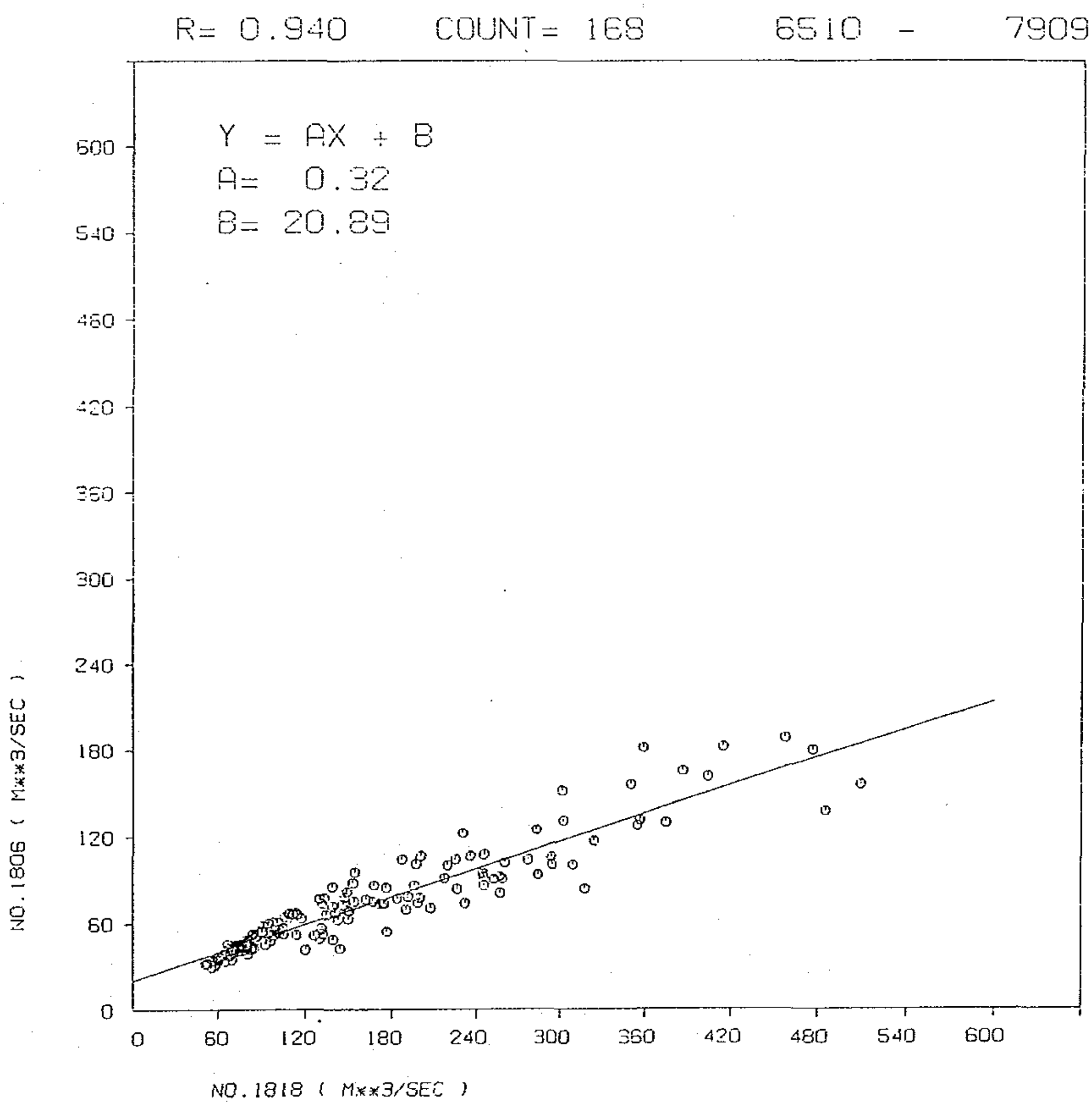


Fig. 6-8 Correlation between the Monthly Mean Discharges of Nos. 1805 and 1818 G.S.

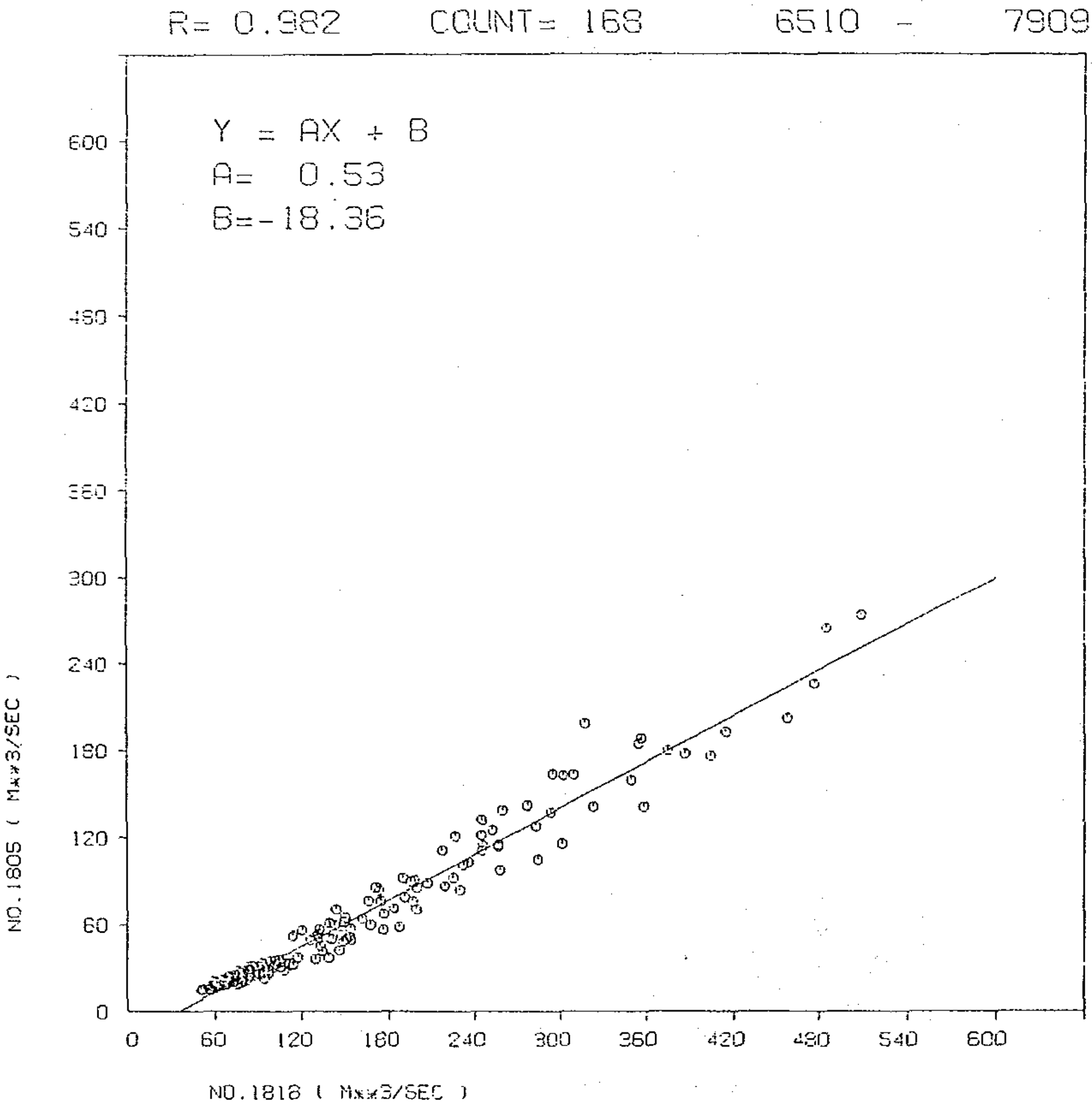
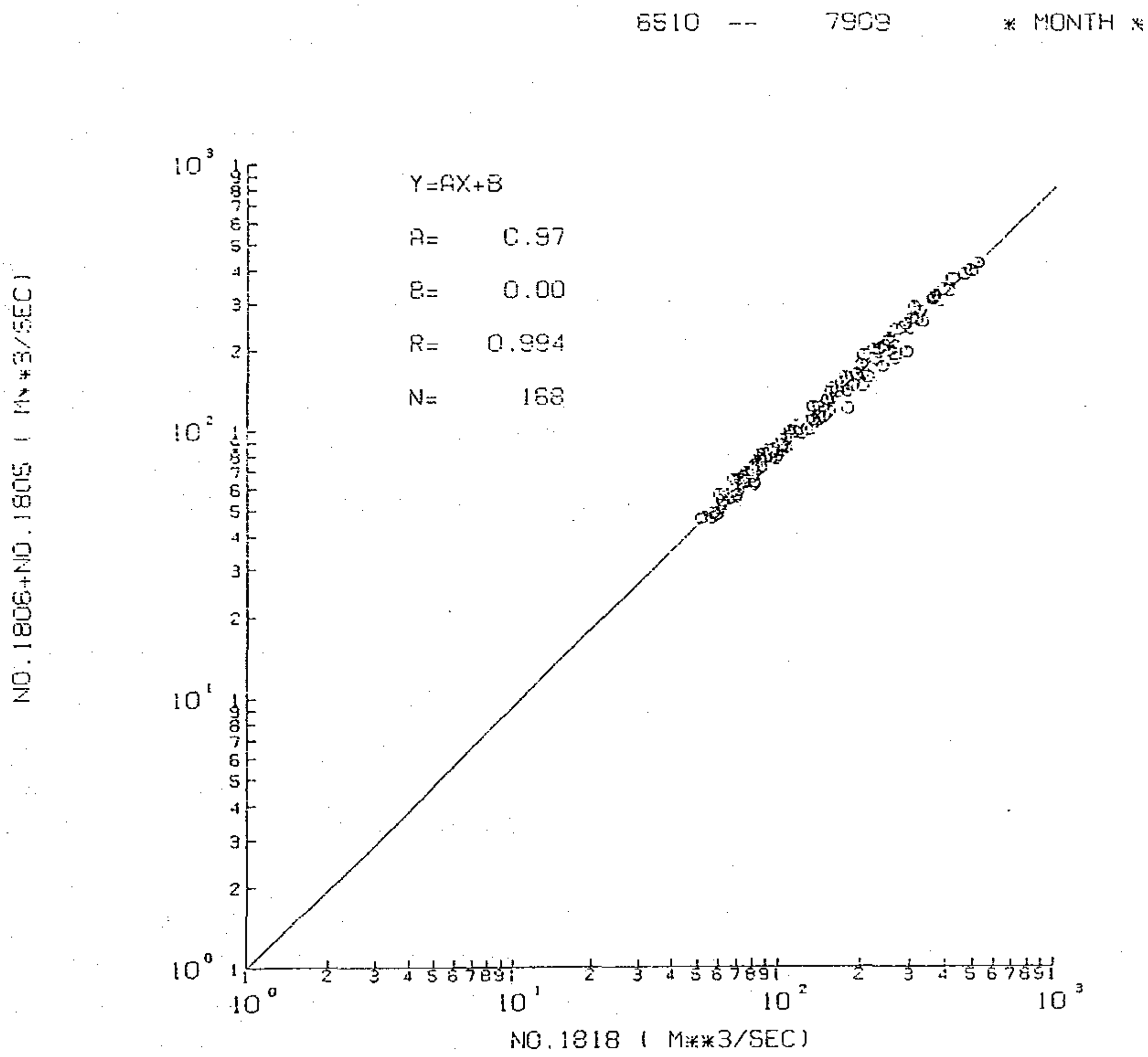


Fig. 6-9 Correlation between the Monthly Mean Discharges of (No. 1805 + No. 1806 G. S.) and No. 1818 G. S.



mes clear that there is a close correlation exists among the discharge data. Accordingly, it is considered that supplementation of missing discharge data is possible, following the correlation confirmed among these data.

(2) Supplementation of the No. 1806 G.S. Data

(a) October 1956 to September 1960 and October 1979 to September 1980

Over each of these periods, discharge data are available at three gauging stations. These are the No. 1812 G.S. upstream of the Zamanti River, the No. 1801 G.S. in the midstream region of the Goksu River, and the No. 1805 G.S. downstream of the Goksu River. Reviewing the discharge data, it is found that the data from the No. 1805 G.S. exhibit the closest relation with the data from the No. 1806 G.S., giving a correlation coefficient of R = 0.911. Although this figure is insubstantial, no other adequate data are available, and therefore, the data from the No. 1805 G.S. are applied for data supplementation. Thus, the discharge data of the No. 1806 G.S. are given for over each of the above periods according to the following equation:

Q1806 = 10 ** (0.53 * logQ1805 + 0.91) (unit: m^3/S)

(b) October 1980 to September 1983

Over this period, discharge data are available at five gauging stations. These include the No. 1823 G.S. upstream in the Zamanti River, the No. 1822 G.S. in the midstream area of the Zamanti River, the No. 1801 G.S., and the No. 1805 G.S. along the Goksu River, and the No. 1818 G.S. downstream of the confluence of the Zamanti and Goksu Rivers. Examining data from the above-mentioned gauging stations, it was clarified that the discharge data from the No. 1822 G.S. stand in closest correlation with the data of the No. 1806 G.S. (R = 0.95). Surveying the correlation between the sum of the discharge data of the No. 1806 and 1805 G.S., and the data of the No. 1818 G.S. demonstrates that there exists a close correlation using a correlation coefficient of R = 0.994. In view of the above, the data of the No. 1806 G.S. are given by the following equation.

$$Q1806 = 10 ** (0.97 * \log Q1818) - Q1805 \quad (\text{unit: } m^3/S)$$

(3) Supplementation of the No. 1802 G.S. Data

(a) April 1954 to November 1968

Over the above-specified period, discharge data are available at four gauging stations. These include the No. 1812 G.S. in the upstream region of the Zamanti River, No. 1806 G.S. downstream along the river, and the No. 1801 G.S. and 1805 G.S. along the Goksu River. Of these, the correlation between the No. 1812 and 1802 G.S. is unclear, because the No. 1812 G.S. has no lapped observation period over the No. 1802 G.S. Further, it was found that the No. 1801 and 1805 G.S. discharge data had smaller correlation coefficients of 0.859 and 0.766, respectively, with the No. 1802 G.S. discharge data. Therefore, applying these discharge data will involve problems. Meanwhile, the No. 1806 G.S. instrumentation data gave a correlation coefficient of 0.949 with the No. 1806 G.S. discharge data, proving serviceability only from the viewpoint of correlation coefficient. This observation data, however, lacks continuity over the four years from October 1956 to September 1960. Considering this fact, the No. 1806 G.S. flow data cannot be applied directly for estimation and river discharge at the No. 1802 G.S. But in view of the fact that no other adequate discharge observation data are available, the river discharge at the No. 1802 G.S. is estimated, using the data of calculated discharge at the No. 1806 G.S. referred to in paragraph 6.2.2 (2) above, to make up for the discontinuity.

The expression of correlation between the discharge data of the No. 1802 G.S. and No. 1806 G.S. was formulated excluding the defective data. And because these defective data were mostly from the period between September 1952 and March 1954, in this report an expression of the correlation between the discharge data of the No. 1802 and 1806 G.S. was formulated, employing the data of discharge measured before August 1952. The observed data, however, of the discharge over the period touched upon above were applied as the river runoff at the No. 1802 G.S.

Accordingly, the discharge data gained over the period from April 1954 to November 1968 at the No. 1802 G.S. were compensated for according to the following expression:

$$Q1802 = 0.38 * Q1806 - 3.29 \quad (\text{unit: } m^3/S)$$

(b) December 1968 to September 1983

For the above period, discharge observation data are now available for the No. 1806 G.S. downstream along the Zamanti River and No. 1822 G.S. midstream along the river. Although the No. 1822 G.S. (A = 6,335 km^2) had no coexistent period with the No. 1802 G.S., the No. 1822 G.S. is located just downstream of the No. 1803 G.S. (A = 6,789 km^2), which is now out of operation. Thus, the discharge data of the No. 1803 G.S. can be introduced into the river discharge at the position of the No. 1822 G.S. with the following expression.

$$Q1822 = ((6,335\ km^2/6,789\ km^2)**1.02)*Q1803 \quad (\text{unit: } m^3/S)$$
$$= 0.9315 * Q\ 1803$$

Examination of the No. 1822 G.S. discharge data thus obtained, and the observed discharge data of the No. 1802 G.S., demonstrates that there exists a favorable correlation with the correlation coefficient of R = 0.968 present between the two.

The No. 1802 G.S. discharge data is supplemented over the said period according to the following expression:

$$Q1802 = 10 ** (1.02 * \log Q1822 + 0.11) \quad (\text{unit: } m^3/S)$$

Referring to the Upper Seyhan Masterplan Report, it is disclosed that discharge at the No. 1802 G.S. over the above-mentioned period was estimated, following correlation with the No. 1806 G.S. discharge data. Further, it is found that, after the estimation referred to above, when the discharge at the No. 1822 G.S. was greater as compared with the discharge at the No. 1802 G.S., the value of the No. 1802 G.S. discharge was converted to the value calculated from the No. 1822 G.S. discharge data with a basin areal ratio. Regrettably, however, if the above step is taken actually correcting only the unfavorable data, the discharge data will be deprived of its statistical nature. Considering this, it can be fairly said that the method for supplementing the discharge data at the No. 1802 G.S. (mentioned above) would be reasonable.

6.2.3 Verification of Discharge Data

(1) Verification of the No. 1802 G.S. Discharge Data

(a) Correlation with other discharge data (No. 1804 G.S., No. 1803 G.S., and the No. 1806 G.S.)

Studying the discharge data of some gauging stations which had been coexisting with the No. 1802 G.S. over a certain period brought forth a fact that, as shown in Figs. 6-3, 4, and 5, the discharge data of the No. 1802 G.S. (A = 7,418 km^2) had good correlation with the respective data of No. 1804 G.S. (A = 4,389 km^2), No. 1803 G.S. (A = 6,789 km^2), and No. 1806 G.S. (A = 8,698 km^2). These showed the respective correlation coefficients of 0.921, 0.968, and 0.949.

(b) Correlation with rainfall data

The rainfall data available only from the Pinarbasi meteorological station midstream along the Zamanti River had a time span no longer than four years coinciding with the period of discharge observation at No. 1802 G.S. Therefore, it failed to verify the correlation of annual discharge and annual rainfall.

(c) Comparison with the discharge data from the upstream gauging stations

The mean monthly discharge (mm) and runoff ratio at some gauging stations along the Zamanti and Goksu Rivers are shown in Table 6-9. In the above Table, it is found that the flow regime at the gauging stations upstream of the No. 1802 G.S. along the Zamanti River are approximately the same. This is because the topological, geological, and meteorological conditions in the upstream and midstream basins of the Zamanti River are identical.

Table 6-9 Monthly Runoff Depth Values at the Gauging Stations within the Zamanti and Goksu River Basin

Basin River Catchment Area (km^2)		No. 1804 G.S. Zamanti 4,389	No. 1803 G.S. Zamanti 6,789	No. 1802 G.S. Zamanti 7,418	No. 1806 G.S. Zamanti 8,698	No. 1801 G.S. Goksu 2,597	No. 1805 G.S. Goksu 4,243
Data Term (Water Year)		'41-'54/'62/ '65-'68	'40-'44	'40-'53	'40-'56/ '61-'79	'40-'83	'40-'83
Monthly Runoff Depth (mm)	Oct.	5.3	4.6	4.6	12.5	15.6	13.6
	Nov.	5.2	4.9	5.0	13.4	15.7	15.9
	Dec.	5.6	5.1	5.0	16.6	21.3	30.5
	Jan.	5.7	5.0	4.7	16.8	26.3	42.8
	Feb.	5.6	5.1	5.2	18.3	28.5	47.8
	Mar.	9.8	9.5	9.7	29.3	61.4	81.8
	Apr.	15.7	19.9	19.0	39.6	73.4	94.0
	May	12.4	13.9	17.1	34.1	49.0	57.6
	Jun.	7.7	7.2	9.0	21.9	27.7	27.7
	Jul.	6.2	4.9	5.2	16.5	19.8	18.2
	Aug.	5.8	4.4	4.2	14.0	16.4	14.5
	Sep.	5.5	4.1	4.0	12.6	14.9	13.1
Annual Runoff Depth (mm)		91	88	93	246	370	457
Annual Precipitation (mm)		400	395	392	437	723	837
Runoff Percentage (%)		23	22	24	56	51	55
Annual Precipitation Loss (mm)		309	307	299	191	353	380

(d) Conclusion

Through the verification study in (a), (b), and (c) above, it is concluded that the No. 1802 G.S. discharge data have some validity, although it is not sufficiently appraised because of its age.

(2) Verification of the No. 1806 G.S. Discharge Data

(a) Correlation with other discharge data (No. 1805 G.S., No. 1818 G.S.)

Through a correlation study of the discharge data from some gauging stations that had for some time coexisted with the No. 1806 G.S., it was revealed that, as shown in Figs. 6-6 and 7, the correlation coefficient between the No. 1806 G.S. discharge and the No. 1805 G.S. discharge (the farthest downstream of the Goksu River) is 0.911. The coefficient between the No. 1806 G.S. discharge and the No. 1818 G.S. discharge (downstream of the confluence of the Zamanti and Goksu Rivers) is 0.940. Meanwhile, the No. 1805 G.S. data has the correlation coefficient of 0.982 as shown in Fig. 6-8. Examination of the correlation between the sum of the Nos. 1806 and No. 1805 G.S. discharge, and the No. 1818 G.S. discharge, gives good correlation between the two with a correlation coefficient of R = 0.994 as shown in Fig. 6-9. This result signifies that there exists a reasonable correlation among the No. 1805, No. 1806, and No. 1818 G.S. data. The above could be explained by the reasons below:

* The duration curve and hydrograph of both discharges are very simular as shown in Figs. 6-10 and 11.

* The double-mass curve of both discharges gives a straight line as shown in Fig. 6-12.

Fig. 6-10 DURATION CURVES OF THE DISCHARGES AT THE Nos. 1805, 1806 AND 1818 G.S.

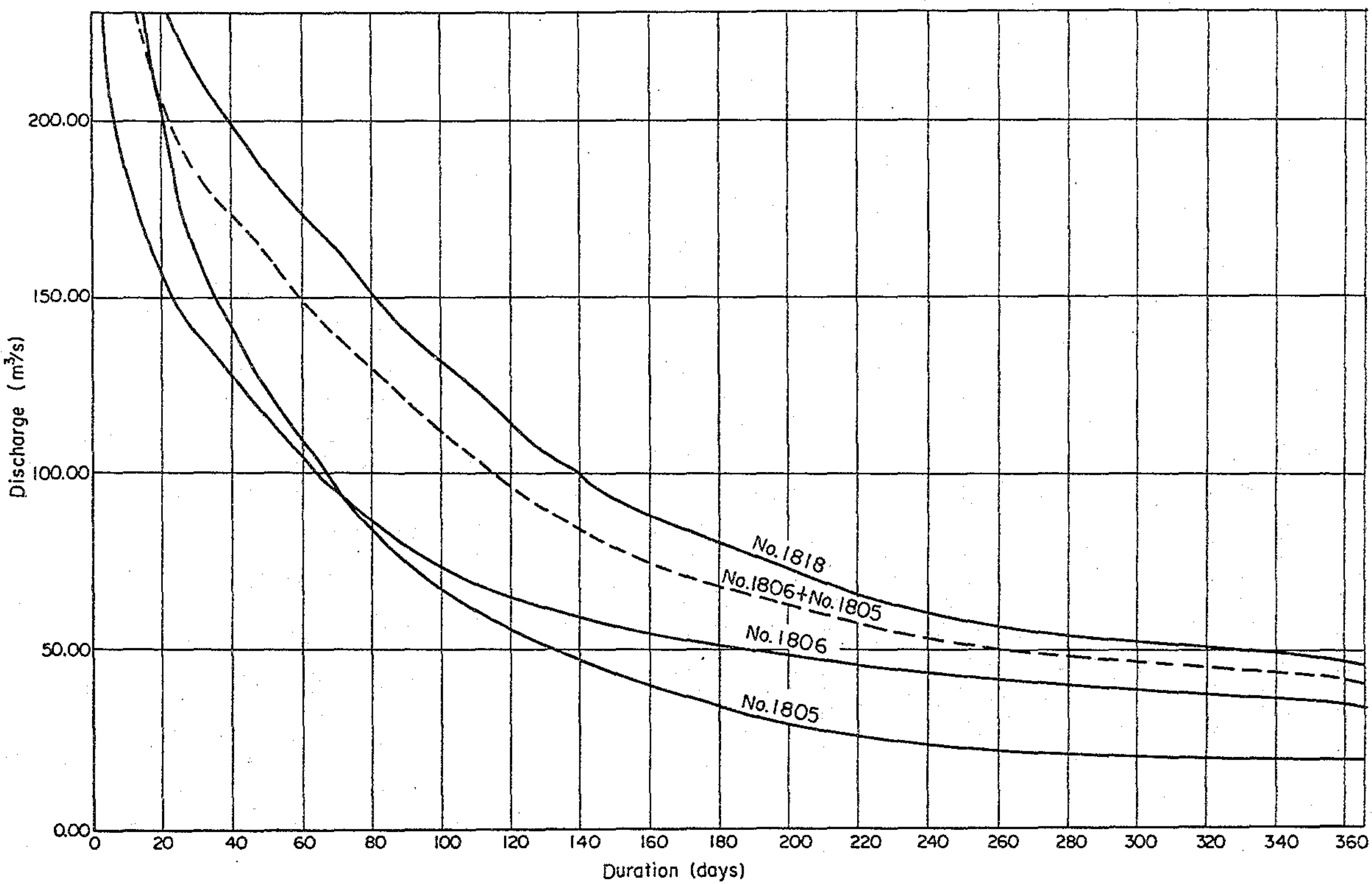


Fig. 6-11 MONTHLY MEAN DISCHARGE HYDROGRAPHS OF Nos. 1805, 1806, (1806 + 1805), AND 1818 G.S

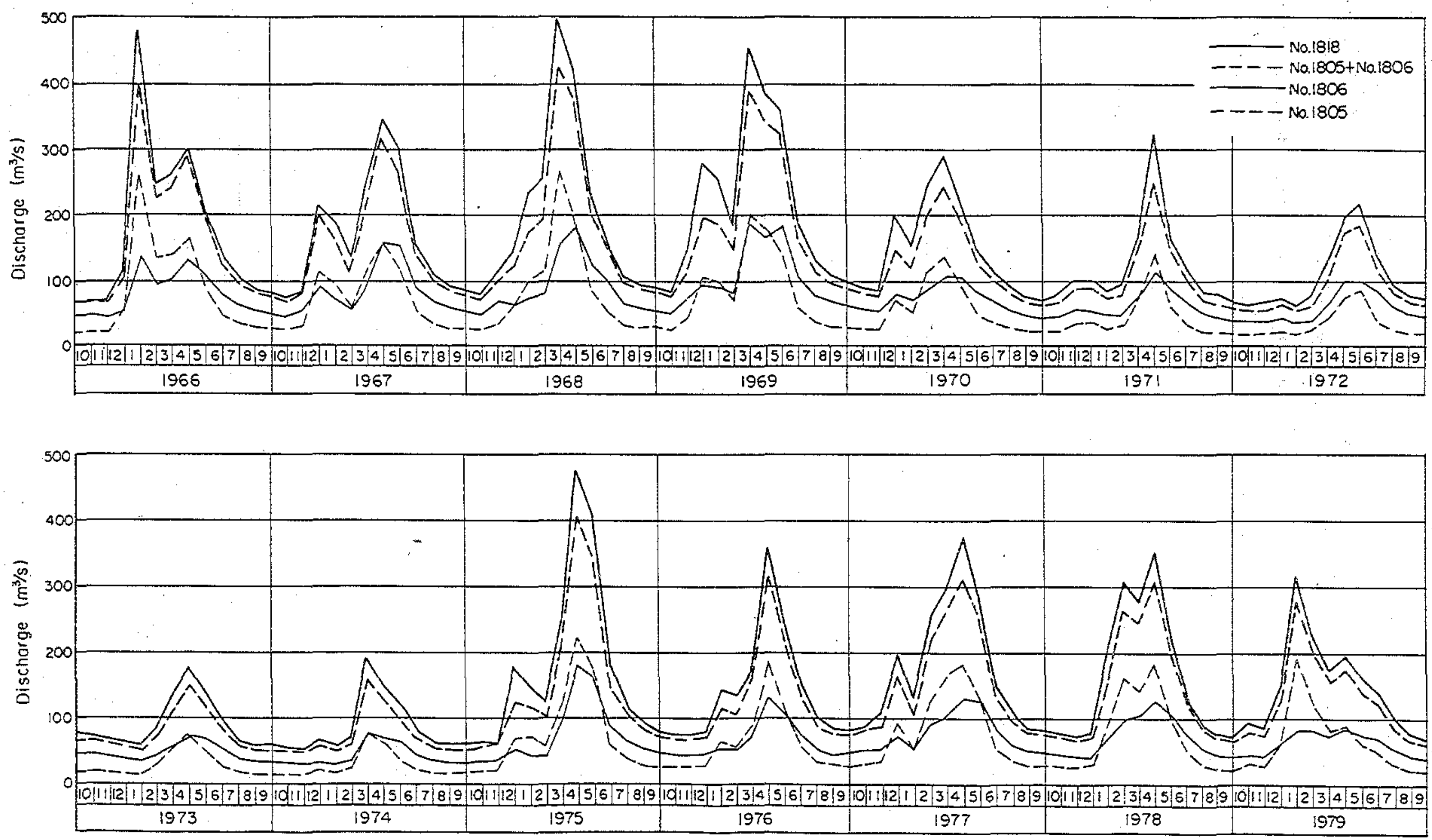
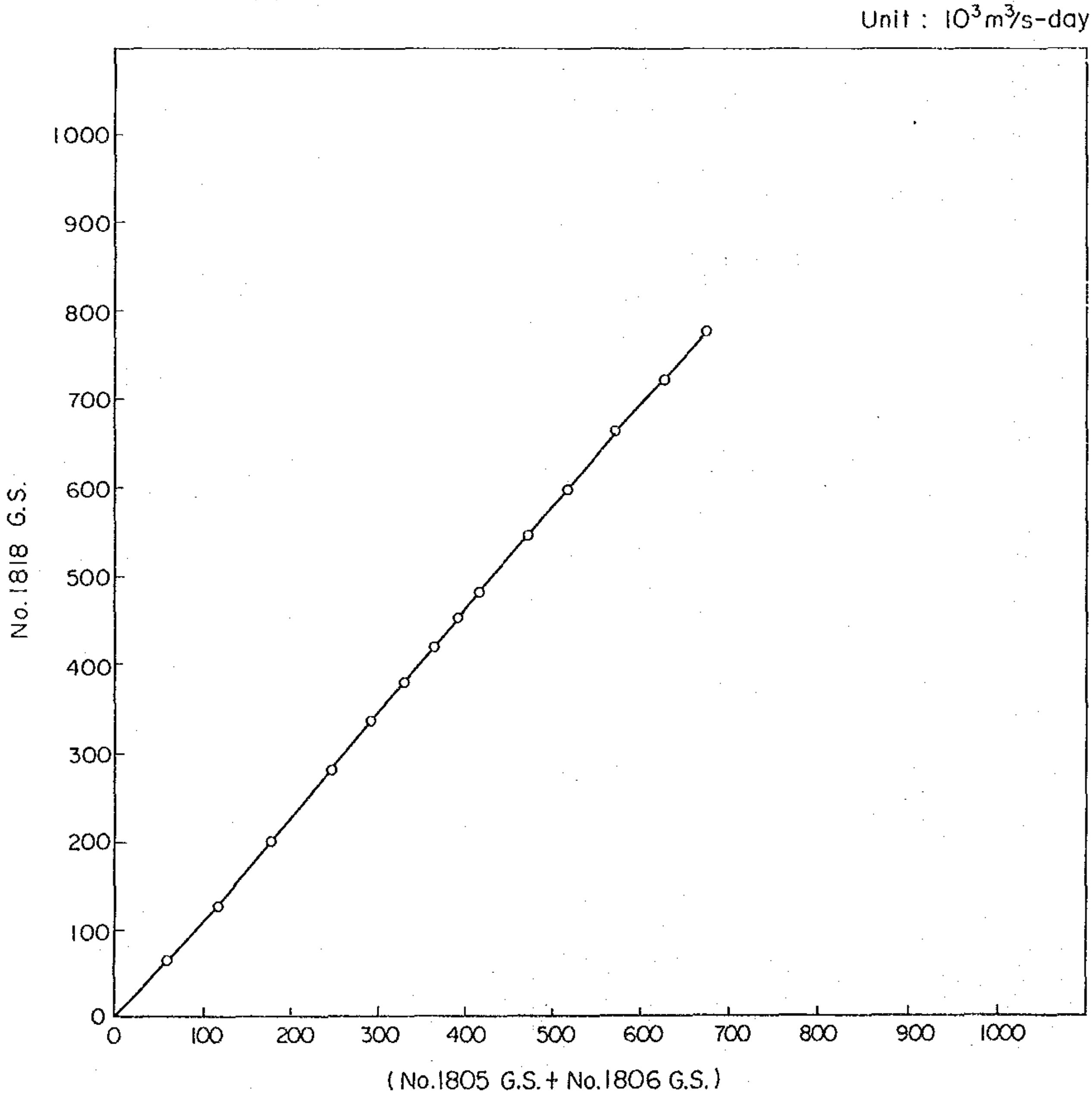


Fig.6-12 DOUBLE MASS CURVE OF THE ANNUAL FLOWS OF No.1818 G.S. AND (No.1805 G.S. + No.1806 G.S.)



(b) Correlation with rainfall data

It was not observed that the annual discharge data from the No. 1806 G.S. has a correlation with the rainfall data throughout the year in the upstream basin of the Zamanti River. No rainfall data are available from the downstream basin of the Zamanti River, but the rainfall data at the Ortaca, Karsanti, Ergenusagi, Mansurlu, Feke, and Cokak meteorological stations in the neighborhood of the No. 1806 G.S. are ready for optional access. The annual rainfall of these stations is around 1,000 mm, and it is supposed that the area around the No. 1806 G.S. is located in a relatively heavy rainfall area. Investigating the rainfall data of these meteorological stations and the No. 1806 G.S. discharge data demonstrates that there is such a correlation between the annual rainfall and annual discharge, as shown in Figs. 6-13 and 14. The fact that the No. 1806 G.S. discharge is found rather more related to the rainfall within the downstream basin of the Zamanti River than to the rainfall within the midstream and upstream basin agrees with the fact that the discharge from the downstream basin of the No. 1802 G.S. retains a large share within the No. 1806 G.S. discharge.

(c) Comparison with the discharge data from the adjacent basins

Table 6-9, shows that the flow regime at the No. 1806 G.S. is different from that upstream of the No. 1802 G.S. along the Zamanti River. This means that the annual discharge (mm) at the No. 1806 G.S. is more than two times the annual discharge at the No. 1802 G.S. This signifies that the discharge from the basin upstream of the No. 1802 G.S. and that from the downstream basin would be much different from each other. On the other hand, the duration at the No. 1806 G.S. is also different from that at the No. 1801 G.S. and the No. 1805 G.S. along the Goksu River. That is, the discharge in the wet season is considerably greater than that in the dry season at the No. 1801 G.S. and the No. 1805 G.S. in comparison with the No. 1806 G.S. These studies show that the flow regime at the No. 1806 G.S. is midway between those in an upstream basin of the Zamanti River and the Goksu River basin. This study result is reasonable, considering the topological and meteorological characteristics of the entire river basin.

Fig. 6-13 Correlation between the Annual Runoff Depth at No. 1806 G. S. and the Mean Annual Precipitation of the Karsanti, Ergenusagi, Mansurlu, Feke, and Cokak Meteorological Stations

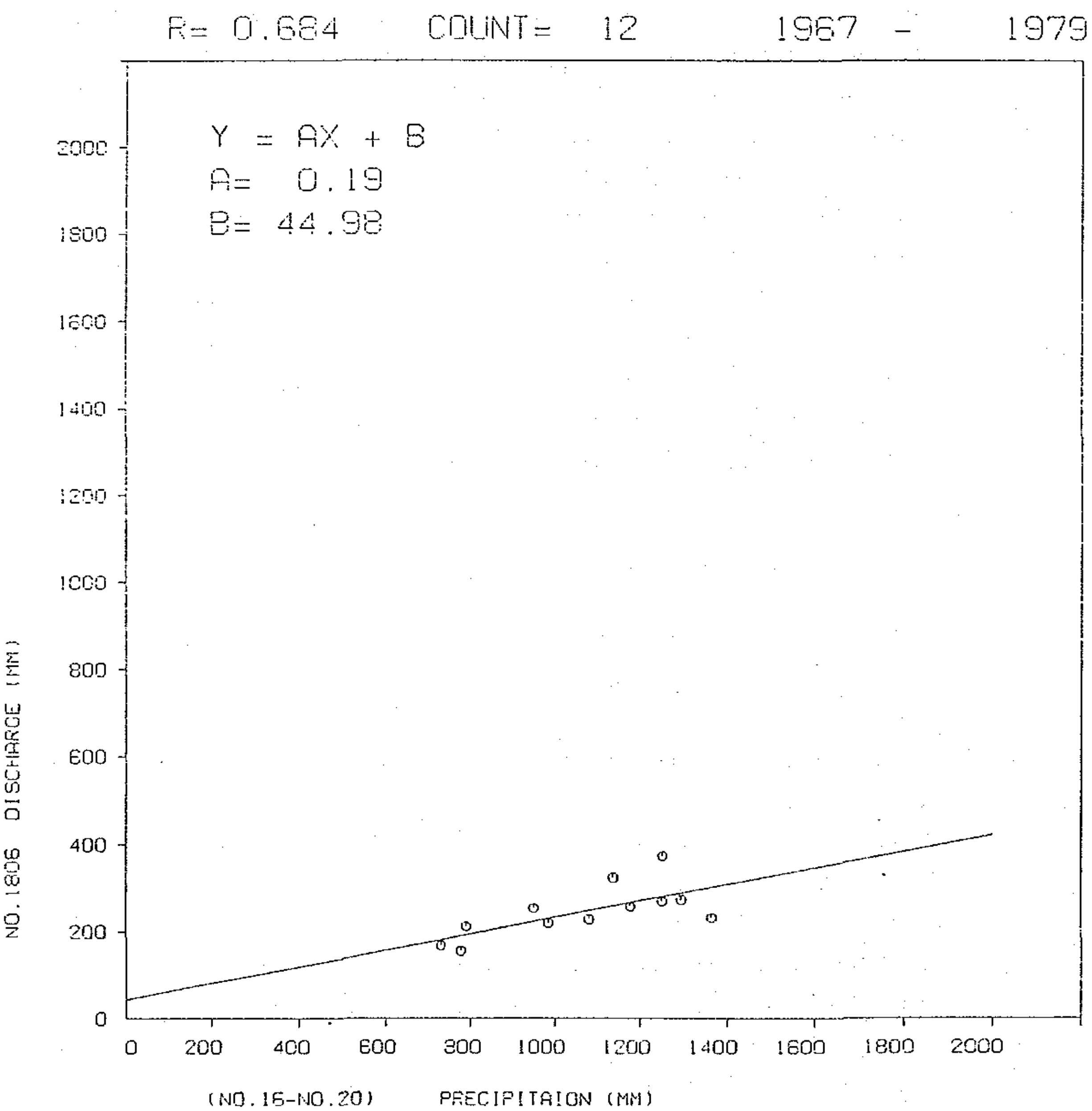
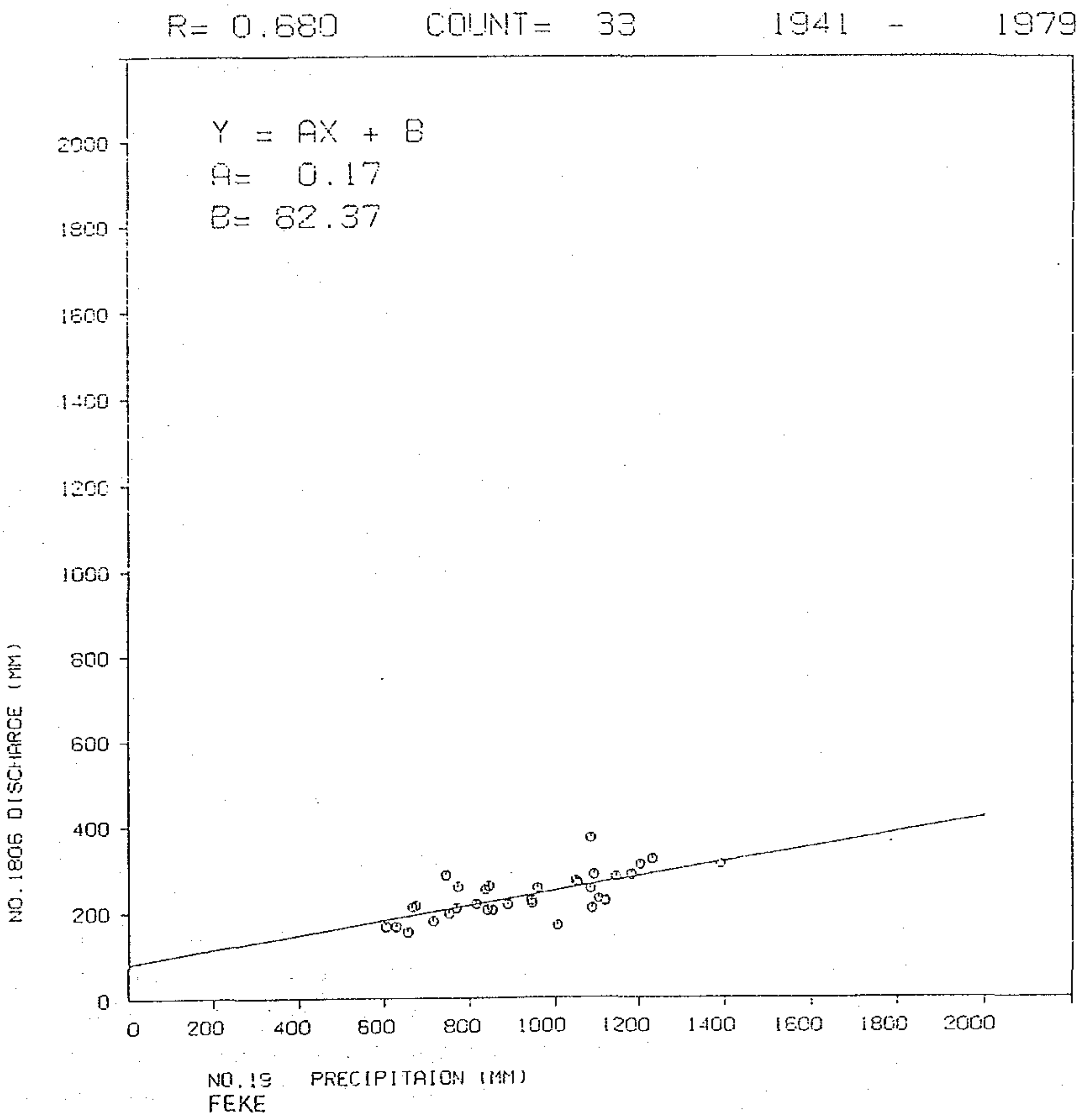


Fig. 6-14 Correlation between the Annual Runoff Depth at No. 1806 G. S. and the Annual Precipitation of the Feke Meteorological Station



(d) Conclusion

As a result of the study in (a), (b), and (c), it is concluded that the discharge data from the No. 1806 G.S. have a measure of validity, particularly considering the relationship with the No. 1805 G.S. data and the No. 1818 G.S. data. As shown in the below Table, however, the discharge from the basin between the No. 1802 G.S. and the No. 1806 G.S. -- 990 mm/year -- is are abnormally large compared with the rainfall of approximately 850 mm/year estimated from the Isohyet Map. Further study of this phenomenon is required.

(3) A Review of the Runoff Within the Basin Between the No. 1802 G.S. and the No. 1806 G.S.

(a) A comparison of hydrological conditions in the neighboring basins

(Oct. 1967-Sep. 1979)

Basin	Catchment Area (Km2)	Discharge		Annual Precipitation (mm)	Runoff Percentage (%)
		Average (m3/S)	Annual (mm)		
A: 1802-1806	1280	40.1	990	850	116
B: 1801-1805	1646	30.3	580	900	64
C: 1806, 1805-1818	905	20.9	730	950	77
AC: 1802, 1805-1818	2185	61.0	880	900	98

The above Table gives the results of a comparison made regarding the runoff percentages among the following basins: A: between the No. 1802 G.S. and the No. 1806 G.S., B: between the No. 1801 G.S. and the No. 1805 G.S., and C: between (No. 1806 G.S. + No. 1805 G.S.) and the No. 1818 G.S., AC: between (No. 1802 G.S. + No. 1805 G.S.) and the No. 1818 G.S.

In this Table, the calculated discharge data of the No. 1802 G.S., which was calculated with a correlation expression with the No.

1822 G.S. or the No. 1806 G.S., is applied to compare the hydrological condition of each basin in the same period.

The above Table shows that the runoff percentage of the basin A: between the No. 1802 G.S. and No. 1806 G.S. is 116%. Even the basin AC: between (No. 1802 G.S. + No. 1805 G.S.) and the No. 1818 G.S. shows a runoff percentage of as high as 98%. A review on the background of these high runoff percentages is made below.

(b) A review on the relationship with rainfall

As shown in Fig. 6-13, it is recognized that there exists some correlation between the discharge at the No. 1806 G.S. and the rainfall in the vicinity downstream of the Zamanti River. With this in mind, the discharge supplied from each of the respective basins -- A:, B:, C: -- is examined in the relation to the rainfall at the Mansurlu meteorological station. This examination proves that there exists such a correlation between the annual runoff depth (mm) within each basin and the annual rainfall (mm) as shown in Figs. 6-15, 16, and 17. As can be understood from these Figures, between each of these three basins there exists a characteristic difference between runoff depth and rainfall. That is, regardless of the fact that with all the basins, the same approximate inclination holds true in the relationship between the runoff depth (mm) and rainfall (mm), the following are observed.

A: Concerning the basin between the No. 1802 G.S. and the No. 1806 G.S. the correlation expression in Fig. 6-15 shows that approximately 90 mm of outflow remains -- even when the rainfall at the Mansurlu station is zero.

B: Concerning the basin between the No. 1801 G.S. and the No. 1805 G.S., the correlation expression in Fig. 6-16 shows that zero flow takes place with an annual rainfall of approximately 390 mm at the Mansurlu station.

C: Concerning the basin between (No. 1806 G.S. + No. 1805 G.S.) and the No. 1818 G.S., the correlation expression in Fig. 6-17 shows that zero flow occurs with an annual rainfall of approximately 280 mm at the Mansurlu station.

Fig. 6-15 Correlation between the Annual Runoff Depth from the Basin between Nos. 1802 and 1806 G.S. and the Annual Precipitation at the Mansurlu Station

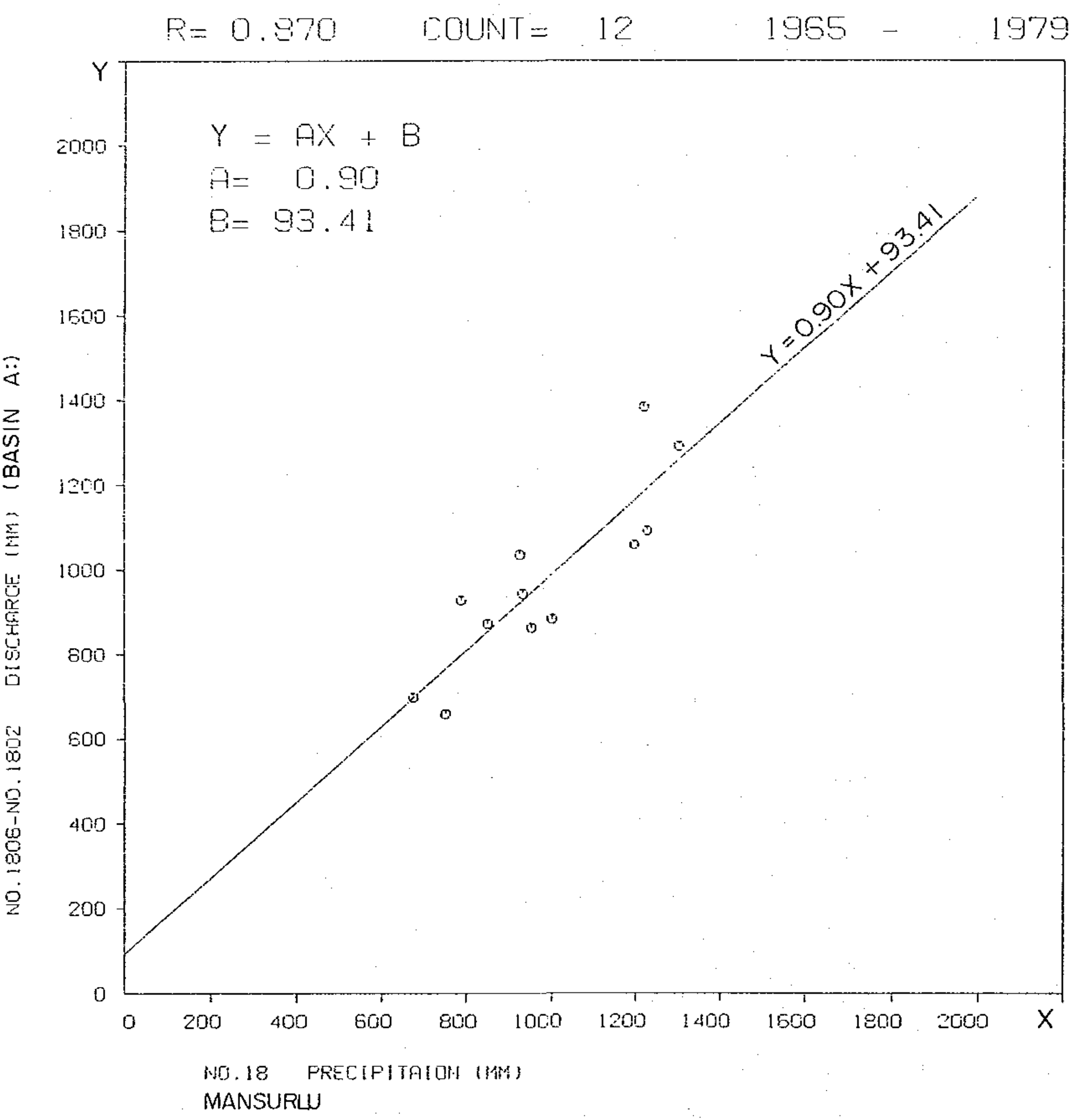


Fig. 6-16 Correlation between the Annual Runoff Depth from the Basin between Nos. 1801 and 1805 G.S. and the Annual Precipitation at the Mansurlu Station

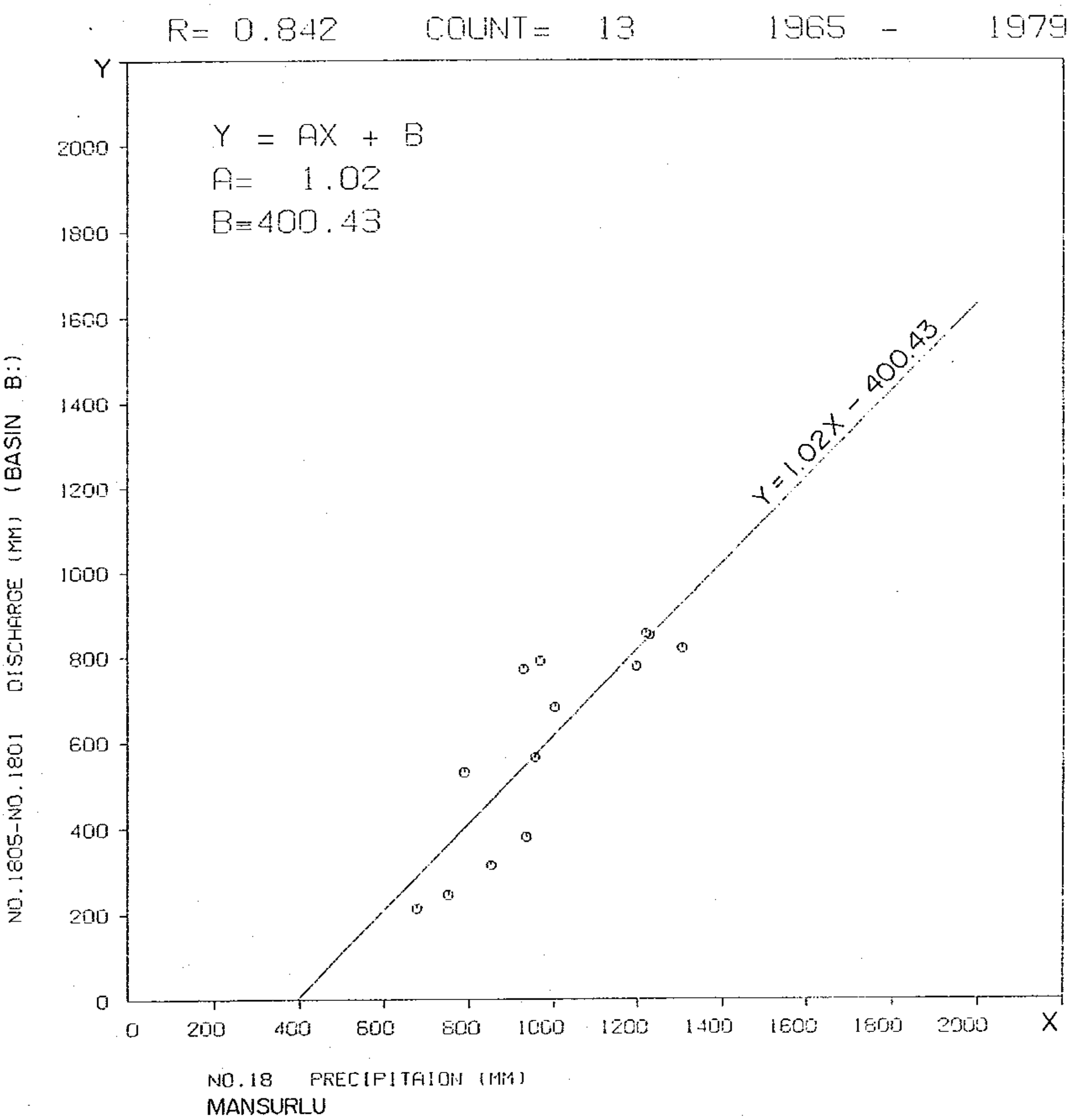


Fig. 6-17 Correlation between the Annual Runoff Depth from the Basin between Nos. 1801, 1805 and 1818 G.S. and the Annual Precipitation at the Mansurlu Station

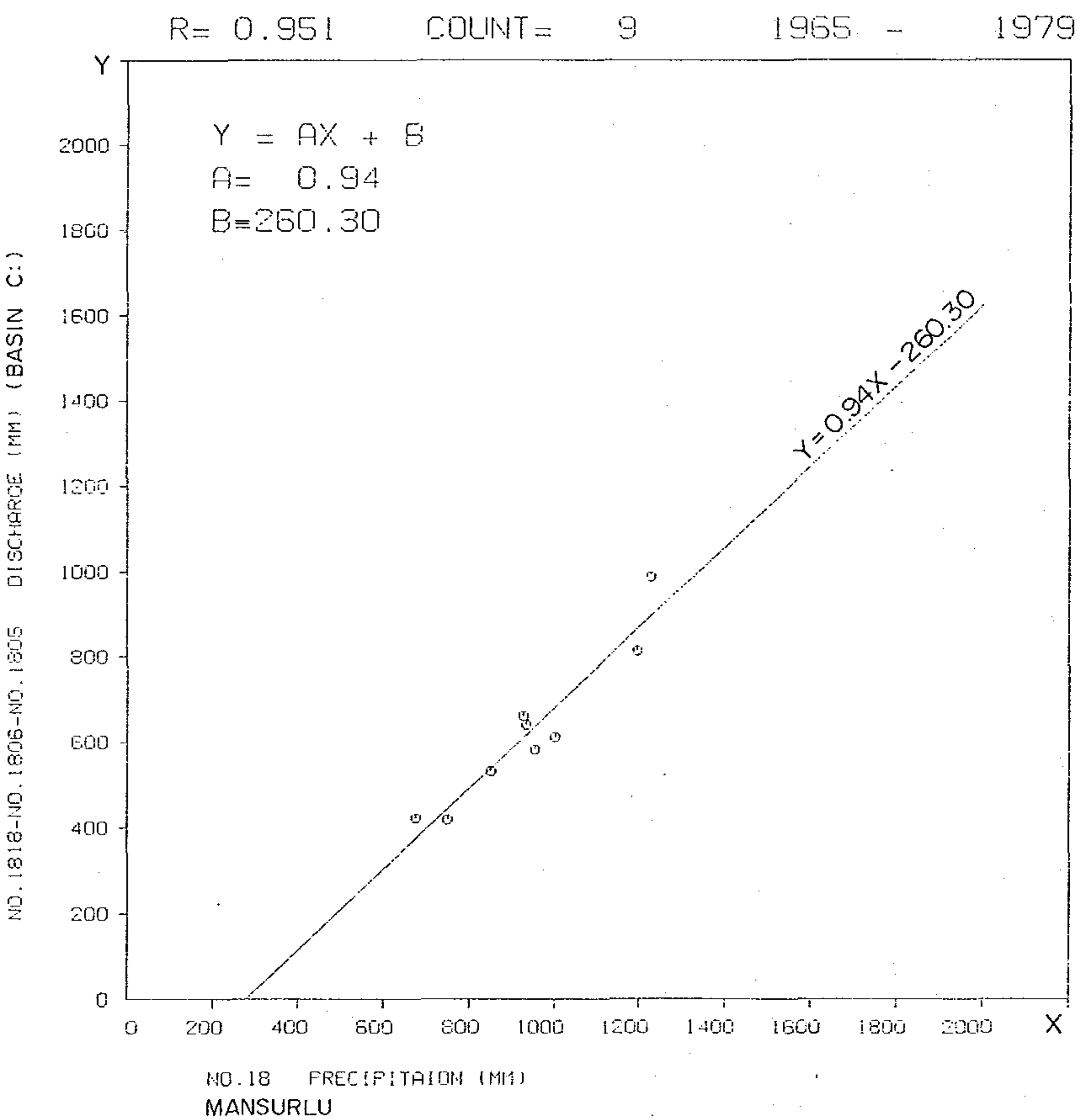


Table 6-10 Study on Relation between Runoff Depth and Precipitation Depth of the Basins around the Goktas Damsite

(Evaluated Years: Oct. 1967 - Sep. 1979)

Basin	Area	(1) Average Discharge	(2) Annual Runoff Depth	(3) Annual Precipitation Depth	(4) Actual Runoff Percentage	(5) Natural Runoff Percentage	(6) Natural Runoff Depth (3)x(5)	(7) Exceptional Runoff (2)-(6)		(8) Annual Precipitation Loss	(9) Exceptional Runoff by Figs. 6-15, 16,17	
	(km^2)	(m^3/s)	(mm)	(mm)	(%)	(%)	(mm)	(mm)	(m^3/s)	(mm)	(mm)	(m^3/s)
A: 1802 - 1806	1,280	40.1	990	850	116	64	540	450	18.3	390	440	17.8
B: 1801 - 1805	1,646	30.3	580	900	64	64	580	0	0	390	0	0
C: 1806,1805-1818	905	20.9	730	950	77	64	610	120	3.4	390	110	3.2

Remarks:

(5) : Natural runoff percentage value of 64% is assumed with the actual runoff percentage of the basin of B:

(6) : Natural runoff depth values calculated from annual mean precipitation values under assuming natural runoff percentage of 64%.

(7) : Exceptional runoff values estimated with correlation between annual runoff depth and annual precipitation depth of Mansurlu meteorological station under assuming annual precipitation loss of 390 mm which can be found from Fig. 6-16 concerned with the basin of B:

Meanwhile, as can be seen from Table 6-9, there are approximately 300 - 310 mm of annual rainfall loss in the upstream and midstream basin of the Zamanti River, and the basin of the Goksu River suffers an annual rainfall loss of approximately 350 - 380 mm. The rainfall loss of approximately 400 mm in the former case is small compared with the latter. This is ascribable to the minimal precipitation, resulting in the topsoil remaining parched in a dry season, thereby suppressing the amount of substantial evapotranspiration.

Each basins of A:, B:, and C: shown in the above Table has steady annual precipitation of approximately 900 mm. Taking this into account, it appears that each basin will undergo 380 mm of annual rainfall loss. It must be noted that the assumed loss of rainfall stated above coincides with the consequence (zero outflow with a yearly rainfall of 390 mm) obtainable from the relationship between the rainfall and the outflow of the basin between the No. 1801 G.S. and the No. 1805 G.S. in B:.

Adapting this considerable rainfall loss of 390 mm in each of the basins between the No. 1802 G.S. and the No. 1806 in A:, and the basin between (No. 1806 G.S. + No. 1805 G.S.) and the No. 1818 G.S. in C:, demonstrates that the runoff depth -- that is due to be zero with an annual rainfall of 390 mm -- likewise in the basin of B: increases up to approximately 440 mm (18 m^3/S) in the basin of A:, and also up to 110 mm (3 m^3/S) in the basin of C:. This signifies that the basins between the No. 1802 G.S. and the No. 1806 G.S. in A:, and between (No. 1806 G.S. + No. 1805 G.S.) and the No. 1818 G.S. in C:, have extra sources from somewhere for discharge as much as 18 m^3/S and 3 m^3/S respectively. As given in Table 6-10, the quantity of such an extra source for discharge concurs with approximately the balance between the outflow within a given basin -- which is calculated by multiplying the annual rainfall amount with the runoff percentage of 64% of the basin of B: -- and the river discharge actually measured at the gauging stations. The fact proves the validity to the results gained from the correlation between rainfall data and discharge data.

(c) A review of each basin from the geological standpoint

Regrettably, it remains unclear as to where such an above-mentioned extra source for discharge originates. It does not stem directly from the rainfall within a basin. But reflecting the distribution of limestone spring water witnessed within the basin between the No. 1802 G.S. and the No. 1806 G.S., it is considered that the extra discharge possibly originates from seepage water from the snow in the Aladag mountain range; and from the rainfall within the midstream basin of the Zamanti River.

In addition, it is also observed within the basin between (No. 1806 G.S., and No. 1805 G.S.) and the No. 1818 G.S., that limestone occurs extending up to the Aladag mountain range. In view of this, it is thought that this basin will also be supplied with underground water from the limestone area.

(d) Conclusion of the Review

Summarizing the consequences of the above reviews the following findings are noted.

* The relationship between the No. 1802 G.S. discharge data and those of the gauging stations located in upstream and midstream of the Zamanti River; and the relationship between the discharge data of the No. 1806, 1805, and 1818 G.S., are considered to be adequate from the points of correlation of each data and hydrological regime.

* It is found that there is a correlation of similar inclination between the annual outflow and annual rainfall in each of the basins between the No. 1802 G.S. and the No. 1806 G.S., between the No. 1801 G.S. and the No. 1805 G.S., and between (No. 1806 G.S. + No. 1805 G.S.) and the No. 1818 G.S. Further, the amount of extra supply of discharge calculated from the correlation between outflow and rainfall is approximately the same with the quantity calculated from the balance between the outflow presumed from the rainfall within the given range and the discharge actually measured.

This fact proves that the discharge not stemming from the rainfall within the own basin is being supplied to the basin between the No. 1802 and No. 1806 G.S.

* The basin with an extra source for discharge not stemming directly from rainfall carries a distribution of limestone.

From the above fact, the discharge data of the No. 1802 G.S. and the No. 1806 G.S. are regarded to be adequate.

(4) Discharge Measurement Around the Goktas Dam Site Since October 1985

(a) Outline of the Discharge Measurement

The abnormal discharge difference between the No. 1802 G.S. (EIE) upstream of the Goktas dam site and the No. 1806 G.S. mentioned in 6.2.3, was also pointed out in the Upper Seyhan Masterplan Report (1984). To clarify the background of such an abnormal phenomenon between two points, as mentioned in 6.1.2 (2), DSI began discharge measurements, at the upstream area of the Goktas dam site. Further, EIE also began discharge measurement at the No. 1826 G.S. installed immediately upstream of the No. 1806 G.S. (EIE), from March 1987. In addition to the above, DSI began discharge measurement at the Goktas dam site, in June 1988.

These gauging stations are listed in Table 6-3 and the locations of these gauging stations are indicated in Fig. 6-1.

Table 6-11 shows the remeasured drainage area of each gauging station and dam site.

(b) Review of the Rating Curves

The rating curves of the Nos. 18-20, 18-21, 18-24, 18-25 and 18-26 gauging stations were reviewed by referring to the data from DSI. Table 6-12 presents the reviewed rating curves of the individual gauging stations. The discharge at each gauging station, calculated by the reviewed rating curves, is shown in Table 6-13.

Table 6-11 Review of the Catchment Area Values of the Goktas Damsite and Gauging Stations

Basin	Value of Catchment Area (km^2)		
	On the Master Plan Report	Obtained from DSI	Reviewed Values
Goktas Dam Site	8,400	-	8,290
No. 1802 G.S. (EIE)	7,418 or 7,558		7,418
No. 1806 G.S. (EIE)	8,698		8,698
No. 1826 G.S. (EIE)	-		8,660
No. 18-20 G.S. (DSI)	-	7,938.5	7,825
No. 18-21 G.S. (DSI)	-	394.5	380
No. 18-24 G.S. (DSI)	-	173.7	174
No. 18-25 G.S. (DSI)		7,418	7,418
No. 18-26 G.S. (DSI)		7,591.4	7,594

Table 6-12 Review of the Rating Curves of DSI's Gauging Stations

Gauging Stations	Expressions of the Rating Curves
No. 18-20 G.S.	Q18-20 = 10**(0.3558*(log H)^2 - 0.1875*log H + 0.7908)
No. 18-21 G.S.	Q18-21 = 10**(1.7816*log H - 1.9651)
No. 18-24 G.S.	Q18-24 = 10**(-5.4473*(log H)^2 + 23.4351*log H - 24.3509)
No. 18-25 G.S.	Q18-25 = 10**(2.4191*log H - 3.4204)
No. 18-26 G.S.	Q18-26 = 10**(-0.8565*(log H)^2 + 6.9633*log H - 9.4964)
Remarks)	Q ; Discharge in m^3/s H ; Water Level in cm These rating curves were determined with insufficient data.

Table 6-13 Estimated Discharges of DSI's Gauging Stations

Gauging Station	Catchment Area (km^2)	Monthly Mean Discharge (m^3/s)												Annual Mean Discharge (m^3/s)
		1986			1987									
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	
No. 18-20	7,825	15.3	17.5	18.6	24.6	34.5	36.8	76.5	70.8	49.3	27.2	18.5	16.1	33.7
No. 18-21	380	5.0	4.2	3.6	5.5	6.4	7.2	13.8	14.5	18.9	15.2	11.7	8.8	9.6
No. 18-24	174	0.0	0.0	0.0	0.0	0.1	0.1	2.2	3.2	1.3	0.0	0.0	0.0	0.6
No. 18-25	7,418	9.6	11.4	10.8	14.7	23.5	22.6	63.7	57.8	35.7	15.2	10.0	9.6	23.7
No. 18-26	7,594	9.5	11.2	10.8	16.6	23.3	22.8	79.4	70.0	39.1	15.7	8.9	9.1	26.3

These discharge values were calculated with the rating curves listed in Table 6-12.

(c) Study on Discharge at Each Gauging Station

i) No. 18-25 G.S.

Because the frequency of discharge measurement using a current meter is relatively high, and the observed data fluctuation is very small, the reliability of data would be high.

ii) No. 18-24 G.S.

Reliability of the data is low because the frequency of discharge measurement using a current meter is low. But the annual mean discharge of 0.6 m^3/s (100 mm/year of annual runoff depth) is reasonable considering the annual mean rainfall in the drainage area estimated from the Isohyet map and flow ratio. Moreover this, slight errors in the data would be permitted because the river discharge of this station is relatively small -- with its catchment area of 174 km^2 -- compared with other gauging stations.

iii) No. 18-26 G.S.

Regarding the No. 18-26 G.S. located immediately downstream of the No. 18-25, the dry season hydrographs for these two stations are very similar. In the wet season, however, the discharge at the No. 18-26 G.S. is much larger than that at the No. 18-25 G.S. The reason for this phenomena would be the unreliable rating curve for high discharge because of the low frequency of the discharge measurement using a current meter. Meanwhile, the discharge at the No. 18-20 G.S. downstream of both gauging stations is sometimes greater than that at the No. 18-26 G.S. Further the discharge at the No. 18-26 G.S. is too large in the wet season when compared with the data at the No. 1802 G.S. (EIE). In view of the above, the reliability of the high discharge of the No. 18-26 G.S. is lower than that of the No. 18-25 G.S.

(d) No. 18-20 G.S.

Because the frequency of discharge measurement using a current meter is low -- especially for high discharge -- and the data fluctuation for low discharge is very large, the reliability of the rating curve of the No. 18-20 G.S. is doubtful. Compared with the discharge at the No. 18-25 G.S. upstream of the No. 18-20 G.S., the discharge balance between the two gauging stations over the April to May period -- when the discharge is the greatest -- is smaller than the discharge balance over the February to March and June to July periods. It is possible that the high discharge is underestimated for above reason.

(e) No. 18-21 G.S.

The No. 18-21 G.S. is located immediately downstream of the Kapuz Spring, and the discharge data at this station is important in studying the underground water discharge from the limestone stratum. The reliability, however, of the rating curve of this station is low. This is because the station is located at an unsuitable position, the frequency of discharge measurements using a current meter is low, and the data fluctuation is very large at this location.

(f) No. 1826 G.S. (EIE)

In March 1987, EIE began water level observations at the No. 1826 G.S. as a successor station to the former No. 1806 G.S. Discharge measurements using a current meter were begun in November 1987. Because this station is located approximately at the same location as the No. 1806 G.S., the discharge data of this station are as important as the data at the No. 18-25 G.S. (same location as the No. 1802 G.S.) -- and at the dam site to estimate the dam-site discharge. Accordingly, the data from March 1987 to July 21, 1988 are in hand through DRI.

(g) Goktas dam site

At the Goktas dam site, DSI conducted discharge measurements using a current meter on June 15 and July 7, 1988. In addition, DSI undertook water level observations prior to the above-mentioned discharge measurement. The discharge data at the dam site calculated from the water level data from June 1 to July 20, 1988 are also in hand.

Although the reliability of the discharge data calculated from the water level is not very high because of the lack of discharge measurements using a current meter to make a rating curve, these are very important reference data to decide the calculation method of discharge at the dam site.

The discharge data measured at the No. 18-25 G.S. (DSI), No. 1826 G.S. (EIE), and Goktas dam site from June 1 to July 20, 1988; and study on the relationship between each discharge are mentioned in next paragraph.

6.2.4 Estimation of the Discharge at the Goktas Dam Site

(1) Relationship between Dam-Site Discharge and Discharge at the New and Old Gauging Stations

(a) Relationship between discharge data at the No. 18-25 G.S. and No. 1826 G.S., and those at the No. 1802 G.S. and No. 1806 G.S.

The relationship between the converted discharge data of No. 1826 G.S. to the No. 1806 G.S. site and the data of No. 18-25 G.S. is in the range of relationship between the discharge at No. 1806 and No. 1802 G.S. shown in Fig. 6-5. This shows that the discharge data of these old and new gauging stations are considered as approximately the equal data.

The discharge of the No. 1806 G.S. -- which was calculated from the discharge of the No. 18-25 G.S. using the correlation equation between the No. 1802 G.S. and No. 1806 G.S. listed Table 6-8 -- and the discharge of the No. 1806 G.S. calculated from the No. 1826 G.S. by drainage area ratio, are shown in Table 6-14.

Table 6-14 Observed Discharges of Nos. 18–25 and 1826 G.S. and Estimated Discharges at No. 1806 G.S.

Gauging Station	Catchment Area (km^2)		Monthly Mean Discharge (m^3/s)												Annual Mean Discharge (m^3/s)
			1987									1988			
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	
No. 18–25	7,418		63.7	57.8	35.7	15.2	10.0	9.6	12.3	16.6	19.0	15.2	17.7	32.9	25.5
No. 1826	8,660		170.9	127.1	92.7	62.4	49.5	44.0	43.8	50.8	65.6	52.7	69.9	118.8	86.0
No. 1806	8,698	(1)	174.2	129.2	94.4	63.8	50.7	45.1	44.7	51.8	67.0	53.8	71.5	121.4	87.9
		(2)	176.3	160.8	102.6	48.7	35.0	33.9	41.0	52.4	58.7	48.7	55.2	95.3	75.6

Remark

* The discharges of No. 1806 G.S. (1) were calculated from the discharges of No. 1826 G.S. with catchment area ratio of the two basins.:

Q1806 = Q1826 + (Q1826 - Q18-25) * (A1806 - A1826) / (A1826 - A18-25)

* The discharges of No. 1806 G.S. (2) were calculated from the discharges of No. 18-25 G.S. with the correlation between the discharges of No. 1802 G.S. and No. 1806 G.S.

According to Table 6-14, the annual mean discharge (75.6 m^3/S) at the 1806 G.S. (April 1987-March 1988) calculated from the data the of No. 18-25 G.S., is slightly smaller than that calculated from the No. 1826 G.S. (87.9 m^3/s).

This indicates that the discharge of the No. 1806 G.S. is not abnormally large, and also that the discharge actually greatly increased between the No. 1802 G.S. and No. 1806 G.S. Therefore, the discharge data of the No. 1802 G.S. and No. 1806 G.S. are considered to be reliable to be used for the estimation of the discharge at the Goktas Damsite.

(b) Relationship between the discharge data at the No. 18-25 G.S. and No. 1826 G.S., and the dam-site discharge

The observed discharge data at the No. 18-25 G.S., No. 1826 G.S., and dam site in June and July 1988 are indicated below.

Observation Site	Catchment Area (km)	Observed Discharge (M3/s)				Remarks
		June 15	July 7	from June 1 to 30	from July 1 to 20	
No. 18-25	7418	55.1	35.2	50.9	30.7	
No. 1826	8660	109.5	76.1	102.7	73.7	
DAM SITE	8290	96.0	63.5	93.3	59.1	
		(93.3)	(63.9)	(88.8)	(62.2)	Estimated

The figures in parentheses are estimated discharges by dividing the discharge between No. 18-25 and 1826 G.S. to the basin between No. 18-25 G.S. and the damsite and the basin between the damsite and the No. 1826 G.S. using the catchment area ratio of the basins.

The formula of this calculation is shown below.

$$Q(DAM) = Q(18\text{-}25)+((Q(1826)-Q(18\text{-}25)) \\ *(A(DAM)-A(18\text{-}25))/A(1826)-A(18\text{-}25) \\ = Q(18\text{-}25)+((Q(1826)-Q(18\text{-}25))*(8290-7413)/(8660-7418)$$

Comparison of the value of the damsite discharge calculated according to the above formula with the value actually measured by DSI, shows that the two are approximately the same. This fact indicates the adequacy of dividing the outflow between the two gauging stations according to the basin area ratio. Reflecting that both the No. 1826 G.S. and the former No. 1806 G.S. are situated at the same approximate locations, it is assumed that the same relationship can be adapted to the discharge data between each of the No. 1802 G.S. and the No. 1806 G.S. and the dam site.

(2) Estimation of the Discharge at the Goktas Dam Site

The discharge of the Goktas Dam Site will be calculated by dividing the discharge between the No. 1802 G.S. and the No. 1806 G.S. to the basin between the No. 1802 G.S., the Goktas damsite, and the No. 1806 G.S. by the drainage area ratio under the study mentioned above.

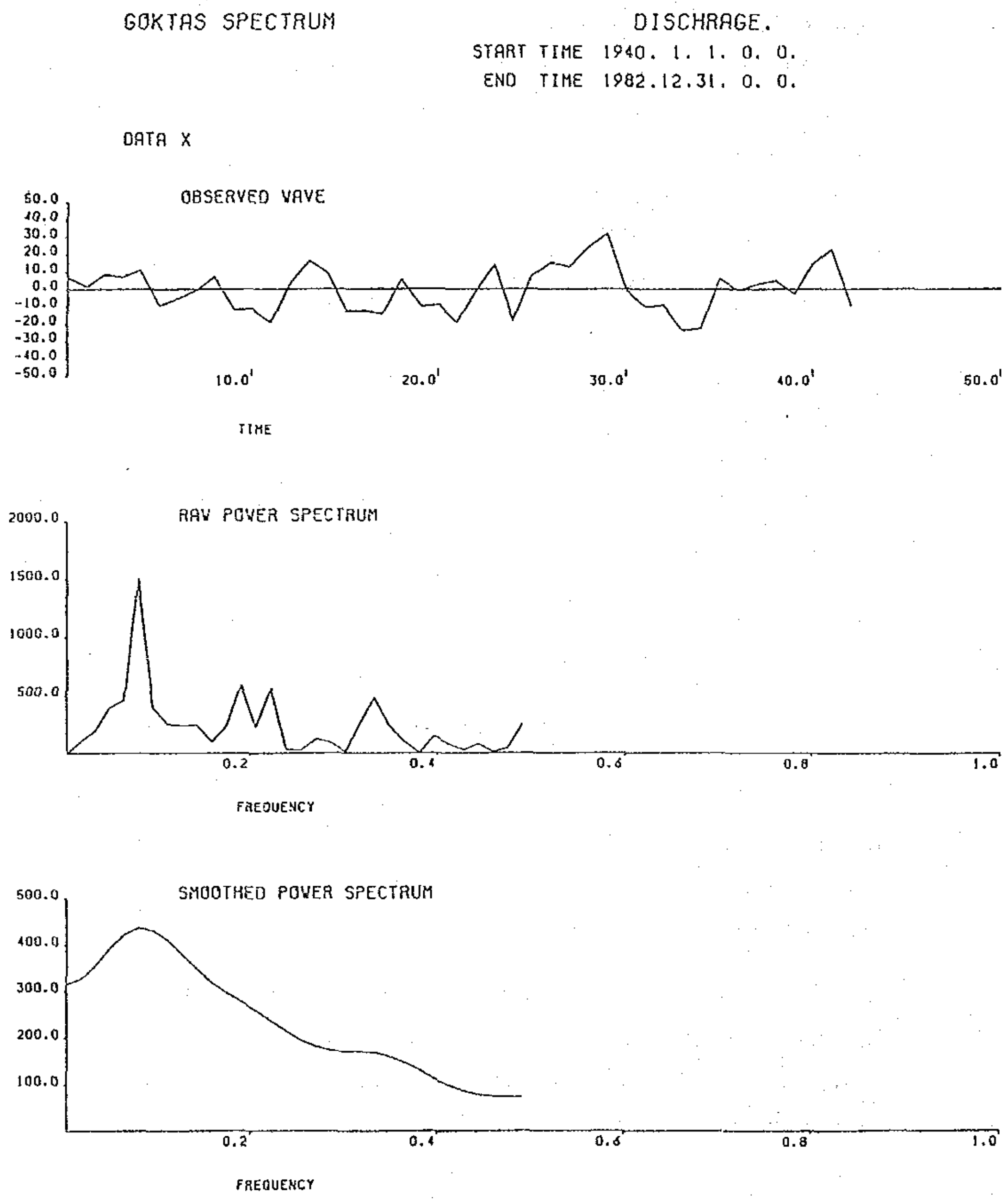
The equation for calculating the dam-site discharge is shown below.

$$Q(DAM) = Q(1802)+(Q(1806)-Q(1802))*(A(DAM)-A(1802))/(A(1806)-A(1802)) \\ = Q(1802)+(Q(1806)-Q(1802))*(8290-7418)/(8698-7418)$$

The discharge at No. 1802 G.S. and No. 1806 G.S., and the discharge at the Goktas dam site calculated by the above equation over the 43 years from January 1940 to December 1982, are shown in Tables 6-15, 16, and 17.

Power spectral analysis with Fourier transformation is carried out on the estimated discharge at the Goktas Damsite. The result is shown in Fig. 6-18. This analysis shows that the annual flow at the Goktas Damsite has approximately 13 years cycle.

Fig. 6-18 Spectral Analysis of the Annual Mean Discharges at the Goktas Damsite



6.2.5 The Discharge at the Project Sites Related to the Goktas Project

(1) Bahcelik Dam Site

The discharge of the No. 1823 G.S. (2,732 km^2) located at approximately same site of the Bahcelik dam site (2,756 km^2) is directly applied as the discharge at the Bahcelik dam site. However, the discharge observation at the No. 1823 G.S. was started in October 1974. The discharge data of the No. 1823 G.S. before September 1974 is supplemented with data of other gauging station using the method mentioned below.

(a) December 1938 to September 1940

The discharge at the No. 1822 G.S. (6,335 km^2) is calculated from the discharge of the No. 1803 G.S. (6,789 km^2) with the catchment area ratio of each station.

Q1822 = Q1803 * (6,335/6,789) ** 1.02

Then, the discharge at the No. 1812 G.S. (2,623 km^2) is calculated with the correlation between the discharges of the No. 1822 G.S. and the No. 1812 G.S. (correlation coefficient is 0.698)

Q1812 = 0.39 * Q1822 + 2.34 (unit: m^3/s)

And then, the discharge at the No. 1823 G.S. is calculated from the discharge at the No. 1812 G.S. with the catchment area ratio of each station.

Q1823 = Q1812 * (2,756/2,623) ** 0.65

(b) October 1940 to September 1954

The discharge at the No. 1812 G.S. is calculated with the correlation between the discharges of the No. 1804 G.S. and the No. 1812 G.S. (correlation coefficient is 0.986)

Q1812 = 10 ** (0.90 * log Q1804) (unit: m^3/s)

Then, the discharge at the No. 1823 G.S. is calculated from the discharge at the No. 1812 G.S. with the catchment area ratio of the each station.

$$Q1823 = Q1812 * (2,756/2,623) ** 0.65$$

(c) October 1954 to March 1956

The discharge at the No. 1823 G.S. is calculated from the discharge of the No. 1812 G.S. with the catchment area ratio of each station.

$$Q1823 = Q1812 * (2,756/2,623) ** 0.65$$

(d) April 1956 to September 1956

The discharge at the No. 1823 G.S. is calculated with the correlation between the discharges of the No. 1806 G.S. and the No. 1823 G.S. (correlation coefficient is 0.923)

$$Q1823 = 0.22 * Q1806 - 3.17 \qquad \text{(unit: } m^3/s\text{)}$$

(e) October 1956 to September 1973

Same as (c).

The discharge data of the No. 1823 G.S. supplemented with above equations is used as the discharge at the Bahcelik dam site. The discharge at the Bahcelik dam site from 1940 to 1982 is shown in Table 6-18.

(2) Gumusoren Dam Site

The discharge of the No. 1822 G.S. (6,335 km^2) located at approximately the same site of the Gumusoren dam site (6,325 km^2) is directly applied as the discharge at the Gumusoren dam site. However, the discharge observation at the No. 1822 G.S. was started in December 1968. The discharge data of the No. 1822 G.S. before November 1968 is supplemented with data of other gauging station using the method mentioned below.

(a) December 1938 to September 1944

The discharge at the No. 1822 G.S. is calculated from the discharge of the No. 1803 G.S. (6,789 km^2) with the catchment area ratio of each station.

$$Q1822 = Q1803 * (6{,}335/6{,}789) ** 1.02$$

(b) October 1944 to March 1955

The discharge at the No. 1803 G.S. is calculated with the correlation between the discharges of the No. 1804 G.S. (4,389 km^2) and No. 1803 G.S. (correlation coefficient is 0.987)

$$Q1803 = 1.89 * Q1804 - 6.86 \qquad \text{(unit: } m^3/s\text{)}$$

Then, the discharge at the No. 1822 G.S. is calculated from the No. 1803 G.S. with the catchment area ratio of each station.

$$Q1822 = Q1803 * (6{,}335/6{,}789) ** 1.02$$

(c) April 1955 to March 1956

The discharge at the No. 1822 G.S. is calculated with the correlation between the discharges of the No. 1812 G.S. (2,623 km^2) and No. 1822 G.S. (correlation coefficient is 0.968)

$$Q1822 = 2.42 * Q1812 - 4.38 \qquad \text{(unit: } m^3/s\text{)}$$

(d) April 1956 to September 1956

The discharge at the No. 1822 G.S. is calculated with the correlation between the discharges of the No. 1806 G.S. (8,698 km^2) and No. 1822 G.S. (correlation coefficient is 0.945)

$$Q1822 = 0.42 * Q1806 - 7.57 \qquad \text{(unit: } m^3/s\text{)}$$

(e) October 1956 to September 1961

Same as (c).

(f) October 1961 to May 1963

Same as (b).

(g) June 1963 to March 1964

Same as (c).

(h) April 1964 to September 1968

Same as (b).

(i) October 1968 to November 1968

Same as (d).

The discharge data of the No. 1822 G.S. supplemented with above equations is used as the discharge at the Gumusoren dam site. The discharge at the Gumusoren dam site from 1940 to 1982 is shown in Table 6-19.

(3) Indere Dam Site

The Indere dam site (catchment area is 146 km^2) is located in the midstream of the Indere river that joins the Zamanti river at the downstream of the Goktas dam site. Taking into account that the discharge data observed on the Indere river is not available, the discharge at the Indere dam site is calculated from the outflow of the basin between the No. 1802 G.S. and the No. 1806 G.S. (catchment area is 1,280 km^2) with the catchment area ratio.

$$Qindere = (146/1,280) * (Q1806 - Q1802)$$

The discharge data of the Indere dam site from 1940 to 1982 calculated with the above equation is shown in Table 6-20.

Table 6-15 Supplemented Monthly Flow Data of the No. 1802 G.S. (unit: 10^6 m^3)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1940	48.06	51.70	80.17	178.98	107.30	68.45	44.16	34.62	32.43	35.70	40.75	49.71	772.07
1941	44.94	63.72	125.36	173.91	110.63	57.41	47.62	41.04	36.12	39.01	38.19	34.78	812.73
1942	34.98	37.80	102.72	190.50	129.44	57.68	38.45	33.36	34.21	40.10	53.99	51.25	804.50
1943	43.18	35.55	49.19	173.43	151.10	72.08	41.09	33.52	30.26	33.26	32.74	31.31	726.72
1944	32.09	43.02	102.36	129.20	135.63	80.14	44.41	36.42	33.01	33.45	35.94	33.72	739.40
1945	32.76	28.54	38.76	108.20	124.11	66.98	36.75	29.86	29.02	31.81	31.02	32.51	590.32
1946	29.61	28.68	53.03	103.48	127.27	58.98	36.51	31.23	29.76	33.36	30.85	31.67	594.42
1947	34.57	42.15	90.91	91.19	68.24	56.56	32.58	24.07	27.48	27.34	68.44	59.82	623.35
1948	48.24	48.22	48.54	147.61	174.17	105.45	50.55	40.09	37.37	37.71	33.87	34.39	806.20
1949	30.82	27.32	55.24	105.49	140.87	58.12	32.82	25.94	28.01	31.46	32.20	30.33	598.61
1950	25.08	27.35	71.56	117.67	132.58	53.18	36.12	28.89	27.81	31.45	28.82	27.76	608.28
1951	27.44	24.84	70.00	77.43	93.91	61.71	35.93	28.41	26.72	33.17	32.61	35.64	547.81
1952	35.67	54.92	88.47	185.98	120.24	50.82	27.83	22.65	18.27	20.94	22.80	23.80	672.39
1953	23.53	31.55	36.18	189.32	163.33	91.72	36.33	24.81	23.69	22.67	23.26	21.14	687.53
1954	22.89	27.86	85.40	173.77	139.16	67.59	48.22	39.13	34.19	31.70	40.46	75.43	785.80
1955	70.64	50.70	59.80	69.09	80.75	48.67	38.17	31.62	27.19	25.63	27.73	29.15	559.14
1956	31.97	57.52	55.99	107.02	78.27	47.76	34.36	28.67	25.39	30.29	29.95	31.78	558.96
1957	30.77	36.04	97.69	50.71	54.93	39.59	31.42	28.48	27.88	28.49	28.41	82.66	537.09
1958	126.59	82.71	141.92	111.26	70.61	50.83	37.97	33.16	30.54	30.34	28.92	31.72	776.59
1959	72.96	50.25	77.83	96.72	62.59	45.46	34.86	31.00	28.97	30.21	28.76	32.95	592.55
1960	54.21	48.01	89.14	102.67	80.89	48.84	37.39	32.43	29.93	26.75	25.02	26.85	602.14
1961	29.18	44.55	49.22	72.26	52.40	36.90	32.56	27.13	25.22	24.13	22.60	59.42	475.55
1962	38.85	58.24	129.07	96.02	92.11	54.65	40.69	32.06	29.04	27.50	25.15	76.87	701.08
1963	61.93	89.64	91.86	125.03	133.61	106.08	64.41	50.09	44.27	40.71	35.77	33.81	877.22
1964	26.78	30.50	77.12	60.42	58.74	46.74	34.80	29.90	27.96	26.78	29.35	42.91	492.01
1965	43.75	51.19	124.95	141.51	104.99	76.04	54.75	44.97	39.03	37.38	34.29	44.31	797.17
1966	131.16	76.83	95.04	120.52	99.70	68.12	53.11	45.00	39.82	36.06	43.43	84.12	892.90
1967	62.03	40.50	85.16	145.22	145.83	78.09	59.66	50.40	43.39	40.69	58.21	54.91	864.07
1968	66.42	68.70	150.23	170.90	115.82	85.39	56.75	50.18	45.09	42.11	63.32	79.12	994.02
1969	73.14	62.95	220.29	239.62	305.98	142.13	93.75	75.66	67.03	64.02	56.03	73.26	1473.86
1970	73.46	86.55	140.21	176.11	124.13	81.46	52.78	43.23	41.69	51.32	53.79	53.71	978.44
1971	50.92	41.74	69.26	117.50	102.53	61.89	30.83	35.40	33.51	36.06	37.61	41.54	658.80
1972	37.40	36.13	67.61	112.38	109.09	126.31	53.30	33.89	37.67	44.64	42.17	45.54	746.13
1973	52.04	37.26	59.53	93.67	92.74	42.37	19.31	17.86	19.97	25.97	27.36	33.89	521.96
1974	41.52	37.98	80.86	91.73	78.66	25.18	18.33	20.93	25.30	27.75	29.79	32.38	510.43
1975	32.45	29.91	95.42	216.40	242.02	98.17	56.21	40.46	36.46	40.05	39.82	39.69	967.06
1976	36.61	32.28	80.39	208.23	198.48	93.50	38.34	29.41	35.06	50.46	47.51	58.27	908.54
1977	44.45	75.32	127.26	192.73	210.19	86.28	46.45	36.51	37.00	43.01	43.76	47.22	990.19
1978	47.86	70.71	106.63	169.15	171.63	84.55	42.58	34.98	40.72	45.14	48.96	59.94	922.86
1979	74.69	87.29	103.66	131.04	110.54	99.42	50.13	35.60	31.84	35.47	60.06	56.74	876.48
1980	61.01	59.01	133.77	256.26	288.11	135.36	74.49	54.63	56.35	69.02	57.12	68.54	1313.67
1981	59.87	58.65	180.76	173.68	201.68	157.15	73.63	49.86	45.41	53.16	55.93	101.32	1211.10
1982	71.58	75.00	68.64	211.27	158.86	94.38	54.36	42.60	49.13	48.36	47.10	34.09	955.38
TOTAL	2118.08	2149.39	3957.20	6005.30	5543.88	3168.20	1904.77	1540.97	1469.21	1564.65	1673.87	2029.98	33125.51
MEAN	49.26	49.99	92.03	139.66	128.93	73.68	44.30	35.84	34.17	36.39	38.93	47.21	770.36
MAX	131.16	89.64	220.29	256.26	305.98	157.15	93.75	75.66	67.03	69.02	68.44	101.32	1473.86
MIN	22.89	24.84	36.18	50.71	52.40	25.18	18.33	17.86	18.27	20.94	22.60	21.14	475.55

Table 6-16 Supplemented Monthly Flow Data of the No. 1806 G.S. (unit: 10^6 m^3)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1940	152.28	207.13	266.21	485.40	249.12	196.87	150.49	124.58	107.22	108.34	127.43	190.70	2365.76
1941	172.64	220.16	312.45	368.95	256.91	164.81	143.19	125.88	110.79	108.88	102.25	100.05	2186.97
1942	104.23	140.31	375.03	485.56	307.90	168.77	136.06	119.95	110.49	120.67	188.07	155.70	2412.75
1943	172.12	144.56	184.08	518.56	402.33	208.58	155.74	131.76	113.88	116.22	113.45	106.66	2367.93
1944	124.43	196.76	444.02	403.76	353.97	218.31	162.05	138.58	118.18	114.38	110.91	108.89	2494.25
1945	128.21	121.07	155.86	345.63	299.14	166.74	125.13	106.94	95.96	93.56	89.40	116.54	1844.19
1946	99.41	114.01	202.39	325.96	364.48	189.58	143.43	120.41	102.12	102.66	93.41	116.14	1974.00
1947	166.71	183.68	311.21	224.63	162.35	143.51	112.74	98.44	91.42	88.56	259.13	277.37	2119.75
1948	158.36	219.45	176.87	428.39	416.02	266.26	162.17	135.17	113.63	105.88	94.09	89.67	2365.97
1949	85.39	82.81	216.41	323.50	316.56	156.89	119.88	100.56	91.70	80.39	86.03	94.87	1762.98
1950	87.32	84.99	226.05	283.15	342.06	160.44	127.81	106.67	97.77	96.36	86.11	85.53	1784.27
1951	101.50	80.94	175.42	171.75	213.43	149.96	118.01	98.12	89.63	92.48	98.89	143.28	1533.41
1952	107.38	173.56	288.33	449.73	301.90	188.54	145.21	121.83	104.44	99.94	107.30	143.70	2231.86
1953	171.92	237.09	188.19	620.31	430.00	269.62	173.35	141.90	121.84	110.76	99.75	89.80	2654.52
1954	110.06	119.57	286.98	479.72	389.40	200.31	150.09	126.18	112.42	106.61	128.92	221.69	2431.94
1955	209.09	154.36	180.56	204.26	235.69	150.52	123.64	106.39	93.99	90.64	95.40	99.91	1744.46
1956	107.32	173.05	170.52	304.07	229.17	148.12	113.60	98.64	89.27	102.90	101.25	106.82	1744.73
1957	104.15	115.78	280.28	155.90	167.75	126.63	105.88	98.15	95.82	98.16	97.21	240.72	1686.42
1958	356.31	238.59	396.66	315.24	209.01	156.22	123.12	110.46	102.82	103.03	98.55	106.65	2316.68
1959	215.18	153.19	228.00	276.97	187.89	142.07	114.93	104.77	98.67	102.70	98.13	109.89	1832.38
1960	165.84	148.03	257.77	292.62	236.07	150.97	121.59	108.53	101.21	93.59	88.28	93.86	1858.35
1961	99.97	138.18	152.70	212.59	161.08	119.54	108.88	94.57	88.82	86.69	81.92	179.56	1524.49
1962	125.44	174.27	362.85	275.12	265.59	166.27	130.27	109.65	98.85	95.57	88.62	225.48	2117.98
1963	186.17	256.85	264.94	351.48	374.80	301.59	192.70	154.99	138.94	130.32	116.56	112.17	2581.50
1964	93.66	101.97	226.14	181.45	177.76	145.45	114.77	101.87	96.01	93.67	99.69	136.11	1568.56
1965	138.31	155.67	352.00	394.85	299.49	222.55	167.27	141.54	125.15	121.56	112.68	139.79	2370.85
1966	368.34	223.12	273.30	339.60	285.56	201.69	162.96	141.62	127.23	118.08	136.72	244.56	2622.78
1967	186.42	127.53	247.30	404.61	406.94	227.93	180.18	155.81	136.62	130.26	175.63	167.68	2546.92
1968	197.97	202.49	418.52	472.18	327.97	247.16	172.53	155.24	141.10	134.01	189.06	250.67	2908.91
1969	242.82	186.80	504.14	428.54	485.74	270.79	205.82	178.33	158.86	146.59	134.71	207.39	3150.51
1970	183.13	208.16	284.08	270.17	218.42	171.66	144.89	121.98	109.05	120.03	144.89	141.64	2118.11
1971	128.04	115.58	201.34	303.77	230.94	172.05	133.40	116.22	101.29	101.85	97.45	114.99	1816.91
1972	97.17	97.28	176.24	262.39	268.14	220.96	160.47	129.42	118.28	121.06	107.02	99.44	1857.86
1973	91.25	101.74	151.19	190.96	181.03	134.84	103.98	91.43	86.26	86.66	81.80	90.37	1391.53
1974	78.99	84.26	210.11	179.41	169.93	112.85	92.38	84.40	80.12	92.42	94.78	145.27	1424.92
1975	113.68	101.34	252.69	465.52	432.52	219.03	165.87	136.35	115.43	109.95	103.34	109.30	2325.02
1976	130.70	123.80	197.13	341.37	288.07	194.82	138.47	116.75	121.72	135.80	135.74	198.28	2122.67
1977	137.98	218.83	268.94	336.61	334.28	201.83	153.01	127.33	117.89	117.80	106.82	110.30	2231.63
1978	189.08	242.76	278.29	331.78	285.36	190.77	144.38	119.72	110.50	121.69	111.90	168.43	2294.65
1979	224.76	202.31	197.34	222.89	204.95	185.92	144.05	117.31	106.51	109.00	141.55	200.13	2056.72
1980	234.12	204.81	388.11	407.17	356.24	213.49	158.92	133.14	122.89	122.87	117.02	145.81	2604.59
1981	328.56	296.46	417.86	287.36	278.53	228.33	200.52	149.15	124.45	136.33	130.95	286.51	2865.02
1982	177.69	115.43	162.05	302.48	218.07	149.05	140.48	125.64	117.02	116.33	105.35	105.54	1835.12
TOTAL	6854.09	6988.73	11310.55	14426.35	12322.59	8022.29	6144.31	5226.38	4706.25	4693.23	4978.19	6377.87	92050.83
MEAN	159.40	162.53	263.04	335.50	286.57	186.56	142.89	121.54	109.45	109.14	115.77	148.32	2140.72
MAX	368.34	296.46	504.14	620.31	485.74	301.59	205.82	178.33	158.86	146.59	259.13	286.51	3150.51
MIN	78.99	80.94	151.19	155.90	161.08	112.85	92.38	84.40	80.12	86.66	81.80	85.53	1391.53

Table 6-17 Natural Monthly Flow Volumes at the Goktas Damsite (unit: 10^6 m^3)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1940	119.06	157.58	206.91	387.73	203.92	155.94	116.60	95.91	83.38	85.18	99.80	145.76	1857.77
1941	131.94	170.30	252.82	306.78	210.28	130.58	112.72	98.84	86.99	86.61	81.83	79.25	1748.93
1942	82.16	107.64	288.23	391.51	251.02	133.36	104.95	92.35	86.18	94.99	145.33	122.41	1900.12
1943	131.02	109.81	141.08	408.55	322.25	165.07	119.19	100.45	87.22	89.77	87.73	82.64	1844.80
1944	95.00	147.76	335.11	316.25	284.37	174.27	124.55	106.02	91.04	88.59	87.02	84.93	1934.89
1945	97.79	91.58	118.54	269.95	243.35	134.94	96.96	82.37	74.62	73.88	70.80	89.75	1444.52
1946	77.16	86.81	154.78	255.05	288.87	147.95	109.35	91.98	79.05	80.57	73.47	89.21	1534.26
1947	124.59	138.57	240.99	182.09	132.35	115.79	87.19	74.73	71.04	69.05	198.35	208.03	1642.77
1948	123.26	164.87	135.96	338.89	338.93	215.00	126.59	104.86	89.32	84.15	74.89	72.05	1868.79
1949	67.99	65.12	165.04	254.01	260.56	125.40	92.13	76.77	71.40	70.24	68.87	74.30	1391.84
1950	67.48	66.62	176.81	230.41	275.29	126.25	98.58	81.88	75.47	75.67	67.85	67.12	1409.42
1951	77.89	63.06	141.82	141.69	175.33	121.83	91.84	75.90	69.58	73.58	77.77	108.97	1219.25
1952	84.52	135.74	224.62	365.66	243.99	144.64	107.79	90.22	76.97	74.76	80.37	105.48	1734.78
1953	124.62	171.58	139.74	482.93	345.00	212.92	129.68	104.57	90.55	82.68	75.37	67.91	2027.54
1954	82.27	90.34	222.73	382.20	309.64	158.01	117.62	98.43	87.49	82.73	100.72	175.07	1907.23
1955	164.96	121.32	142.07	161.18	186.31	118.06	96.39	82.56	72.69	69.92	73.83	77.36	1366.64
1956	83.30	136.22	134.01	241.26	181.07	116.13	88.34	76.34	68.91	79.75	78.52	82.90	1366.77
1957	80.76	90.36	222.08	122.37	131.79	98.89	82.14	75.94	74.17	75.95	75.28	190.34	1320.07
1958	283.08	188.91	315.46	250.22	164.90	122.63	95.98	85.82	79.78	79.86	76.36	82.77	1825.78
1959	169.85	120.38	180.13	219.52	147.95	111.27	89.40	81.25	76.45	79.59	76.02	85.37	1437.19
1960	130.26	116.15	204.02	232.08	186.60	118.41	94.76	84.27	78.49	72.28	68.12	72.50	1457.93
1961	77.41	108.33	119.72	167.86	126.43	93.20	84.55	73.07	68.55	66.75	63.01	141.26	1190.14
1962	97.84	137.29	288.34	218.03	210.30	130.69	101.72	85.17	76.60	73.87	68.39	178.11	1666.35
1963	146.57	203.55	209.77	279.30	297.92	239.27	151.81	121.55	108.76	101.75	90.81	87.20	2038.26
1964	72.34	79.19	178.64	142.87	139.82	113.98	89.28	78.93	74.32	72.35	77.27	106.41	1225.41
1965	108.17	122.37	279.63	314.10	237.49	175.85	131.40	110.76	97.70	94.72	87.70	109.35	1869.24
1966	292.74	176.49	216.48	269.76	226.32	159.11	127.95	110.82	99.37	91.94	106.98	193.42	2071.38
1967	146.77	99.79	195.62	321.93	323.71	180.17	141.76	122.21	106.91	101.71	138.21	131.73	2010.51
1968	156.04	159.84	333.00	376.14	260.35	195.60	135.63	121.75	110.50	104.71	148.98	195.99	2298.54
1969	188.73	147.32	413.67	368.32	428.44	229.78	170.10	145.60	129.58	120.27	109.63	164.63	2616.08
1970	148.18	169.40	238.22	240.19	188.37	142.91	115.53	96.88	87.58	98.13	115.85	113.62	1754.84
1971	103.46	92.04	159.24	244.39	190.01	136.94	100.71	90.46	79.68	80.88	78.38	91.58	1447.76
1972	78.12	77.79	141.61	214.57	217.44	190.79	126.31	98.97	92.59	96.70	86.35	82.26	1503.50
1973	78.75	81.19	121.97	159.95	152.89	105.37	76.99	67.98	65.13	67.31	64.45	72.37	1114.36
1974	67.05	69.51	168.91	151.46	140.84	84.90	68.78	64.17	62.64	71.81	74.06	109.29	1133.42
1975	87.79	78.57	202.56	386.11	371.80	180.51	130.92	105.78	90.26	87.67	83.10	87.11	1892.17
1976	100.71	94.63	159.92	298.93	259.52	162.53	106.55	88.91	94.10	108.60	107.62	153.65	1735.66
1977	108.17	173.09	223.78	290.75	294.73	165.00	119.05	98.38	92.11	93.96	86.72	90.19	1835.92
1978	144.07	187.92	223.58	279.94	249.11	156.91	111.93	92.71	88.25	97.29	91.84	133.85	1857.39
1979	176.93	165.65	167.48	193.61	174.86	158.35	114.11	91.26	82.71	85.56	115.58	154.43	1680.52
1980	178.94	158.34	307.04	359.07	334.53	188.59	132.00	108.11	101.68	105.70	97.93	121.18	2193.11
1981	242.92	220.66	342.29	251.12	254.03	205.64	160.08	117.50	99.26	109.82	107.04	227.48	2337.83
1982	143.87	102.54	132.27	273.41	199.20	131.63	113.03	99.17	95.38	94.67	86.78	82.76	1554.70
TOTAL	5344.49	5446.19	8966.67	11742.14	10161.88	6475.05	4792.96	4051.66	3674.44	3695.99	3924.94	4991.98	73268.38
MEAN	124.29	126.66	208.53	273.07	236.32	150.58	111.46	94.22	85.45	85.95	91.28	116.09	1703.92
MAX	292.74	220.66	413.67	482.93	428.44	239.27	170.10	145.60	129.58	120.27	198.35	227.48	2616.08
MIN	67.05	63.06	118.54	122.37	126.43	84.90	68.78	64.17	62.64	66.75	63.01	67.12	1114.36

Table 6-18 Natural Monthly Flow Volumes at the Bahcelik Damsite (unit: 10^6 m^3)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1940	20.91	20.62	29.02	61.54	38.93	27.91	20.14	17.92	17.15	21.30	20.36	24.00	319.79
1941	22.94	28.45	49.05	64.91	42.42	28.75	26.10	22.48	20.74	21.36	20.63	23.13	370.96
1942	25.48	20.40	41.40	72.96	45.24	28.17	22.07	20.64	19.90	21.16	22.20	23.68	363.30
1943	22.44	20.18	23.88	59.78	43.17	26.89	22.39	20.96	19.53	20.30	19.49	20.42	319.45
1944	20.62	21.20	34.26	35.78	34.29	28.12	21.89	20.74	19.45	20.02	19.45	20.02	295.85
1945	20.42	18.45	20.90	36.84	33.41	22.43	19.84	19.16	18.37	19.00	18.45	19.32	266.59
1946	18.92	17.47	21.67	28.43	29.22	19.61	19.24	18.76	18.19	19.60	18.37	18.96	248.46
1947	18.94	17.51	28.96	26.94	20.52	22.20	19.94	18.70	18.39	18.90	19.32	20.24	250.56
1948	20.42	18.60	20.54	42.97	48.06	30.75	22.70	20.86	19.55	19.84	19.01	19.76	303.07
1949	19.90	18.21	25.05	34.15	34.12	19.78	18.88	18.72	18.19	18.84	18.33	19.18	263.37
1950	19.50	17.83	22.43	32.57	42.53	20.67	18.52	18.01	17.33	18.01	17.39	18.01	262.81
1951	18.07	16.34	28.07	22.03	26.33	23.45	18.90	17.99	17.39	18.07	17.39	18.11	242.17
1952	19.16	21.86	33.18	62.35	38.30	25.09	21.87	20.12	19.32	19.36	18.52	19.26	318.41
1953	19.52	17.94	20.16	55.62	42.33	30.17	23.08	20.98	19.90	20.28	19.63	20.06	309.67
1954	20.02	20.40	40.87	81.30	62.92	38.93	31.78	28.36	27.41	25.50	23.37	23.46	424.31
1955	23.59	19.74	25.64	31.91	37.73	18.84	16.68	16.90	15.77	15.77	15.20	17.15	254.91
1956	15.43	18.14	23.59	58.68	41.93	24.37	16.50	13.21	11.42	19.25	18.63	16.90	278.06
1957	15.71	14.86	34.49	26.79	26.50	22.97	15.16	13.28	13.68	14.08	13.30	13.58	224.40
1958	13.50	13.99	21.52	51.63	35.52	29.95	18.89	18.84	17.48	17.90	16.78	17.15	273.15
1959	16.79	13.09	31.39	39.27	29.65	24.22	17.29	15.90	15.28	16.35	15.87	15.38	250.49
1960	15.46	21.99	22.60	64.05	39.75	23.64	20.22	19.36	18.04	16.76	16.14	15.52	293.53
1961	15.54	14.79	19.17	23.40	17.84	18.07	14.41	12.03	11.64	11.81	11.64	13.11	184.34
1962	11.40	11.42	37.56	34.37	20.63	18.20	15.74	15.43	14.48	14.94	14.27	18.01	234.60
1963	22.63	19.89	30.23	54.18	49.48	42.53	30.20	24.95	22.99	23.07	21.57	21.16	362.89
1964	18.42	17.10	45.56	38.44	31.23	23.98	17.37	16.02	16.57	16.26	15.12	16.43	272.50
1965	15.35	13.44	49.10	55.41	43.56	27.57	22.21	20.08	18.36	19.83	19.41	21.60	325.93
1966	26.30	26.33	37.20	56.16	42.18	25.70	22.46	20.30	21.12	21.16	20.08	22.85	341.84
1967	21.27	17.09	28.30	80.28	68.79	33.67	29.29	26.08	23.10	23.84	23.45	25.56	401.52
1968	22.60	25.07	63.53	122.52	68.32	45.10	30.98	29.46	26.13	26.86	26.23	28.32	515.12
1969	26.72	23.53	79.22	82.93	83.03	47.73	34.71	29.65	27.44	28.90	27.60	30.23	521.69
1970	31.39	31.70	46.69	53.91	35.07	25.43	21.91	20.14	19.65	20.44	21.41	22.02	349.76
1971	19.80	19.29	25.92	38.71	27.24	23.80	16.40	19.28	17.32	18.20	17.88	17.09	260.93
1972	17.23	16.12	25.34	40.23	40.52	57.44	25.09	20.91	19.09	19.86	18.60	16.49	316.92
1973	15.74	15.49	21.16	26.23	29.37	19.86	11.64	11.67	11.91	15.53	14.88	15.67	209.17
1974	13.20	12.29	33.00	45.75	29.94	15.09	12.16	13.77	13.89	12.80	14.05	15.99	231.93
1975	13.15	12.60	29.86	96.99	122.30	35.69	29.68	22.20	15.94	21.53	19.65	19.12	438.73
1976	16.23	15.23	21.08	74.57	61.74	35.72	23.28	18.88	19.70	25.61	17.88	20.33	350.25
1977	16.07	32.85	42.08	60.03	70.31	30.51	21.75	18.27	19.10	25.34	19.70	19.50	375.50
1978	17.14	31.98	46.79	61.85	45.21	26.85	20.38	17.95	18.43	22.66	21.18	22.71	353.13
1979	23.52	36.63	40.39	42.33	33.24	31.62	25.50	23.25	17.39	21.11	20.58	20.73	336.28
1980	17.06	18.59	50.27	87.84	105.64	37.92	29.30	27.78	25.69	25.47	25.01	28.77	479.34
1981	27.91	25.69	54.34	43.99	57.37	43.47	31.52	25.71	26.49	27.05	24.91	30.77	419.23
1982	28.47	23.13	34.82	91.47	46.98	33.41	28.04	25.36	21.15	23.41	19.88	21.24	397.37
TOTAL	845.02	858.34	1460.30	2302.15	1930.86	1237.15	946.11	861.08	810.08	867.36	822.84	871.02	13812.30
MEAN	19.65	19.96	33.96	53.54	44.90	28.77	22.00	20.03	18.84	20.17	19.14	20.26	321.22
MAX	31.39	36.63	79.22	122.52	122.30	57.44	34.71	29.65	27.44	28.90	27.60	30.77	521.69
MIN	11.40	11.42	19.17	22.03	17.84	15.09	11.64	11.67	11.42	11.81	11.64	13.11	184.34

Table 6-19 Natural Monthly Flow Volumes at the Gumusoren Damsite (unit: 10^6 m^3)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1940	35.84	36.16	55.99	137.25	80.58	53.75	33.92	28.43	27.02	29.27	31.72	37.01	586.95
1941	34.07	47.40	94.81	149.01	89.23	45.83	38.53	33.30	30.34	31.52	30.40	30.06	654.49
1942	29.84	27.25	67.47	154.23	95.99	43.08	29.99	27.41	26.61	29.54	38.78	37.55	607.74
1943	31.44	25.26	30.04	120.36	99.86	46.45	28.27	25.54	24.25	25.14	24.34	26.56	507.50
1944	27.05	25.26	50.91	68.76	68.89	38.30	24.78	23.78	22.75	25.42	24.78	25.42	426.08
1945	26.36	23.81	27.49	67.49	58.00	31.85	24.99	23.39	22.23	23.01	22.41	23.77	374.81
1946	22.82	21.51	29.33	46.46	47.63	25.15	23.58	22.45	21.81	24.43	22.23	22.92	330.31
1947	22.87	21.60	46.97	42.81	26.60	31.31	25.23	22.31	22.27	22.78	24.46	25.94	335.12
1948	26.36	23.47	26.64	83.15	95.39	52.21	31.78	27.40	25.01	24.99	23.73	24.80	464.94
1949	25.13	23.26	37.44	60.69	59.79	25.56	22.73	22.35	21.81	22.64	22.13	23.44	366.98
1950	24.19	22.36	31.12	56.72	81.11	27.66	21.88	20.70	19.81	20.70	19.94	20.70	366.90
1951	20.84	18.87	44.80	30.90	40.55	34.32	22.78	20.66	19.94	20.84	19.94	20.94	315.38
1952	23.39	31.23	57.44	134.25	70.31	38.29	29.80	25.65	24.46	23.86	22.59	23.63	504.90
1953	24.24	22.62	25.75	116.27	80.59	50.75	32.68	27.68	25.83	26.03	25.19	25.51	483.14
1954	25.42	28.45	76.86	185.96	134.67	72.79	53.95	45.51	43.95	43.38	40.98	41.07	792.98
1955	42.82	36.93	44.85	63.42	76.68	32.81	27.35	27.87	25.59	25.21	24.28	28.46	456.26
1956	24.44	31.53	43.56	108.09	75.98	42.59	27.44	21.15	17.87	33.38	32.30	27.87	486.20
1957	25.08	24.24	69.10	51.44	50.36	42.47	23.79	19.38	20.70	21.26	19.82	20.09	387.73
1958	19.90	22.19	38.70	109.65	71.49	58.84	32.54	32.41	29.61	30.21	27.98	28.46	501.96
1959	27.61	20.08	61.84	80.67	57.75	45.41	28.78	25.54	24.46	26.58	25.84	24.31	448.87
1960	24.50	40.57	41.22	138.75	81.41	44.03	35.65	33.64	30.92	27.55	26.47	24.63	549.35
1961	24.70	24.06	33.19	43.66	30.08	32.87	22.04	16.46	15.93	15.95	15.93	18.99	293.85
1962	15.17	16.16	76.29	69.19	55.35	31.49	25.15	24.44	22.58	23.27	22.08	30.46	411.63
1963	41.29	36.01	59.11	115.61	104.23	88.32	59.05	46.73	42.53	42.33	39.20	37.85	712.26
1964	31.44	29.11	95.02	78.72	61.45	44.85	28.97	25.80	27.47	26.38	24.09	26.77	500.07
1965	24.24	20.90	103.32	118.49	90.36	53.26	40.32	35.33	31.68	34.74	34.12	38.89	625.64
1966	49.91	51.11	75.45	120.25	87.11	48.86	40.90	35.84	38.14	37.85	35.69	41.81	662.93
1967	38.11	31.32	54.58	176.76	149.47	67.56	56.91	49.39	42.78	44.14	43.60	48.16	802.78
1968	41.22	47.78	137.15	275.75	148.37	94.34	60.86	57.30	49.87	51.21	50.12	57.76	1071.73
1969	53.47	46.07	157.62	171.05	217.52	102.50	68.21	55.28	49.06	46.93	41.15	53.56	1062.43
1970	53.71	62.94	101.21	126.48	89.82	59.39	38.84	31.93	30.80	37.78	39.54	39.51	711.95
1971	37.50	30.79	50.69	85.06	74.47	45.37	22.93	26.25	24.86	26.73	27.84	30.71	483.21
1972	27.71	26.75	49.51	81.42	79.13	91.31	39.21	25.16	27.89	32.95	31.15	33.61	545.79
1973	38.30	27.55	43.70	68.11	67.49	31.29	14.49	13.43	14.96	19.38	20.38	25.15	384.23
1974	30.70	28.07	59.00	66.73	57.43	18.79	13.77	15.68	18.87	20.68	22.15	24.06	375.94
1975	24.11	22.21	69.41	154.79	172.84	71.31	41.31	29.93	27.01	29.63	29.45	29.37	701.35
1976	27.14	23.95	58.66	149.06	142.30	67.99	28.39	21.89	25.99	37.16	35.01	42.79	660.33
1977	32.81	54.92	92.04	138.17	150.53	62.84	34.27	27.06	27.40	31.78	32.30	34.82	718.94
1978	35.29	51.63	77.39	121.57	123.41	61.60	31.47	25.95	30.09	33.32	36.05	43.99	671.76
1979	54.59	63.47	75.27	94.66	80.17	72.20	36.92	26.40	23.64	26.31	44.06	41.69	639.38
1980	44.76	43.27	96.66	182.69	245.26	97.72	54.44	40.17	41.39	50.52	41.94	50.17	988.99
1981	43.94	42.98	129.83	124.77	144.55	113.11	53.83	36.73	33.49	39.11	41.08	73.60	877.04
1982	52.36	63.85	58.43	179.85	135.23	68.62	39.98	31.48	36.18	35.65	34.72	25.30	761.63
TOTAL	1386.68	1418.94	2755.85	4749.14	4049.44	2309.04	1472.69	1255.16	1209.87	1301.53	1291.96	1412.17	24612.45
MEAN	32.25	33.00	64.09	110.45	94.17	53.70	34.25	29.19	28.14	30.27	30.05	32.84	572.38
MAX	54.59	63.85	157.62	275.75	245.26	113.11	68.21	57.30	49.87	51.21	50.12	73.60	1071.73
MIN	15.17	16.16	25.75	30.90	26.60	18.79	13.77	13.43	14.96	15.95	15.93	18.99	293.85

Table 6-20 Natural Monthly Flow Volumes at the Indere Damsite (unit: 10^6 m^3)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1940	11.88	17.72	21.21	34.93	16.17	14.64	12.12	10.26	8.53	8.28	9.88	16.07	181.68
1941	14.56	17.84	21.33	22.23	16.68	12.24	10.90	9.67	8.51	7.97	7.30	7.44	156.66
1942	7.89	11.69	31.04	33.64	20.34	12.66	11.13	9.87	8.70	9.19	15.29	11.91	183.34
1943	14.70	12.43	15.38	39.34	28.64	15.56	13.07	11.20	9.53	9.46	9.20	8.59	187.10
1944	10.53	17.53	38.95	31.30	24.89	15.75	13.41	11.65	9.71	9.23	8.55	8.57	200.05
1945	10.88	10.55	13.35	27.07	19.95	11.37	10.08	8.79	7.63	7.04	6.66	9.58	142.94
1946	7.96	9.73	17.03	25.36	27.04	14.89	12.19	10.17	8.25	7.90	7.13	9.63	157.27
1947	15.06	16.13	25.11	15.21	10.73	9.91	9.14	8.48	7.29	6.98	21.74	24.80	170.59
1948	12.55	19.52	14.63	32.01	27.57	18.33	12.72	10.84	8.69	7.77	6.87	6.30	177.81
1949	6.22	6.32	18.37	24.85	20.03	11.26	9.92	8.51	7.26	6.49	6.14	7.36	132.74
1950	7.10	6.57	17.61	18.87	23.88	12.23	10.45	8.87	7.98	7.40	6.53	6.58	134.06
1951	8.44	6.40	12.02	10.75	13.62	10.06	9.36	7.95	7.17	6.76	7.56	12.27	112.36
1952	8.17	13.52	22.78	30.07	20.71	15.70	13.38	11.31	9.82	9.01	9.63	13.67	177.78
1953	16.92	23.43	17.33	49.13	30.40	20.28	15.62	13.35	11.19	10.04	8.72	7.83	224.24
1954	9.94	10.45	22.98	34.88	28.53	15.13	11.61	9.92	8.92	8.54	10.08	16.67	187.66
1955	15.78	11.82	13.77	15.41	17.66	11.61	9.74	8.52	7.62	7.41	7.72	8.07	135.13
1956	8.59	13.17	13.06	22.46	17.20	11.44	9.03	7.98	7.28	8.28	8.13	8.55	135.18
1957	8.37	9.09	20.81	11.99	12.86	9.92	8.49	7.94	7.74	7.94	7.84	18.02	131.02
1958	26.19	17.77	29.04	23.25	15.78	12.01	9.71	8.81	8.24	8.29	7.94	8.54	175.57
1959	16.21	11.73	17.12	20.55	14.28	11.01	9.13	8.41	7.95	8.26	7.91	8.77	141.34
1960	12.73	11.40	19.22	21.65	17.69	11.64	9.60	8.68	8.13	7.62	7.21	7.64	143.21
1961	8.07	10.67	11.80	16.00	12.39	9.42	8.70	7.69	7.25	7.13	6.76	13.70	119.58
1962	9.87	13.22	26.65	20.42	19.78	12.72	10.21	8.75	7.96	7.76	7.24	16.94	161.53
1963	14.16	19.06	19.73	25.81	27.50	22.29	14.62	11.96	10.79	10.22	9.21	8.93	194.29
1964	7.62	8.15	16.99	13.80	13.57	11.25	9.12	8.21	7.76	7.63	8.02	10.63	122.73
1965	10.78	11.91	25.88	28.88	22.17	16.70	12.83	11.01	9.82	9.60	8.94	10.88	179.40
1966	27.04	16.68	20.32	24.97	21.19	15.23	12.52	11.01	9.96	9.35	10.64	18.29	197.21
1967	14.18	9.92	18.48	29.57	29.77	17.08	13.74	12.02	10.63	10.21	13.39	12.86	191.84
1968	15.00	15.25	30.59	34.35	24.19	18.44	13.20	11.98	10.95	10.48	14.33	19.56	218.30
1969	19.34	14.12	32.36	21.54	20.49	14.67	12.78	11.70	10.47	9.41	8.97	15.29	191.14
1970	12.50	13.86	16.40	10.72	10.75	10.28	10.50	8.98	7.68	7.83	10.39	10.02	129.92
1971	8.79	8.42	15.06	21.23	14.64	12.56	11.69	9.21	7.73	7.50	6.82	8.37	132.02
1972	6.81	6.97	12.38	17.10	18.13	10.79	12.22	10.89	9.19	8.71	7.39	6.14	126.74
1973	4.47	7.35	10.45	11.09	10.07	10.54	9.65	8.39	7.56	6.92	6.21	6.44	99.13
1974	4.27	5.28	14.73	10.00	10.40	9.99	8.44	7.24	6.25	7.37	7.41	12.87	104.25
1975	9.26	8.14	17.93	28.40	21.72	13.78	12.50	10.93	9.00	7.97	7.24	7.94	154.81
1976	10.73	10.43	13.31	15.18	10.21	11.55	11.42	9.96	9.88	9.73	10.06	15.96	138.41
1977	10.66	16.36	16.15	16.40	14.15	13.17	12.15	10.35	9.22	8.53	7.19	7.19	141.52
1978	16.10	19.61	19.57	18.54	12.97	12.11	11.61	9.66	7.96	8.73	7.17	12.37	156.39
1979	17.11	13.11	10.68	10.47	10.76	9.86	10.71	9.31	8.51	8.38	9.29	16.35	134.55
1980	19.74	16.62	28.99	17.20	7.77	8.91	9.62	8.95	7.58	6.14	6.83	8.81	147.17
1981	30.63	27.11	27.03	12.96	8.76	8.11	14.47	11.32	9.01	9.48	8.55	21.11	188.55
1982	12.10	4.61	10.65	10.40	6.75	6.23	9.82	9.47	7.74	7.75	6.64	8.15	100.29
TOTAL	539.90	551.68	838.28	960.00	772.77	553.37	483.31	420.14	369.02	356.66	376.69	495.66	6717.49
MEAN	12.56	12.83	19.49	22.33	17.97	12.87	11.24	9.77	8.58	8.29	8.76	11.53	156.22
MAX	30.63	27.11	38.95	49.13	30.40	22.29	15.62	13.35	11.19	10.48	21.74	24.80	224.24
MIN	4.27	4.61	10.45	10.00	6.75	6.23	8.44	7.24	6.25	6.14	6.14	6.14	99.13

6.3 Evaporation from Reservoir Surface

6.3.1 Data Concerning Calculation of Evaporation

The amounts of evaporation from reservoir surfaces will be calculated here for the Goktas project site and the related Gumusoren and Bahcelik project sites.

The evaporation observation data listed in Table 6-1 exist concerning the Zamanti River Basin and its surroundings. From among them, the data of the Tomarza Meteorological Station can be utilized for the Gumusoren project site without modification since this station is close to the Gumusoren site. However, observation data on evaporation which can be directly used for the Goktas and Bahcelik project sites are not available.

Evaporation generally has a close correlation with air temperature, and in case evaporation observation data are not available for a site under consideration, calculations are usually made employing air temperatures.

Temperature measurement data from the vicinities of the individual project sites are those of the Feke Meteorological Station for the Goktas project site, The Tomarza Meteorological Station for the Gumusoren project site, and the Pinarbasi Meteorological Station for the Bahcelik project site. However, all of these stations has short observation periods as indicated in Table 6-1. Air temperature observation data for long periods are available from the meteorological stations at Kayseri and Adana. Therefore, the observation data of these two stations are used for supplementation of the air temperature data of the Feke, Pinarbasi, and Tomarza Stations.

In order to find the relationship between air temperature and evaporation, it is necessary to have data of the two items measured simultaneously at same station. Where air temperature and evaporation were measured simultaneously in the Zamanti River Basin and its surroundings there are the four sites of Tomarza, Kayseri, Goksun, and Adana Meteorological Station. The correlations between air temperature and evaporation were obtained using the data of these stations.