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FEASIBILITY STUDY
ON
FLOOD CONTROL, FORECASTING AND WARNING SYSTEM
FOR
SEYHAN RIVER BASIN

FINAL REPORT

VOLUME III
SUPPORTING REPORT

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List of Final Report

SUPPORTING REPORT A

HYDROMETEOROLOGICAL ANALYSES

THE FEASIBILITY STUDY
ON
FLOOD CONTROL, FORECASTING AND WARNING SYSTEM
FOR
SEYHAN RIVER BASIN

Supporting Report A Hydrometeorological Analyses

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1. INTRODUCTION

The hydrometeorological investigation and analysis present the basic and necessary information to determine the optimum size and components of the system for the formulation of flood forecasting and warning plan in the Seyhan River basin.

The study items are composed of the following;

(1) Collection and analysis of the existing data
(2) Flood runoff analyses
(3) Flood forecasting model

The contents of the following chapters are briefly explained below.

(1) Chapter 2 : Description of the project area
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2. DESCRIPTION OF PROJECT AREA

2.1 Geography and Topography

2.1.1 Geography

The study area for the Project is the Seyhan River basin which is located within the bounds of 36°30' to 39°15' North latitude and 34°45' to 37°00' East longitude, and situated at the south part of Turkey. The Seyhan River basin climatologically expands across two regions, namely, the Central Anatolia Region and the Mediterranean Region. The Seyhan River basin straddles administratively the provinces of Sivas, Kayseri, K.Maras, Niğde and Adana province. The catchment area of the Seyhan River basin within Kayseri province consists of the middle and upstream reaches of the Zamantı River. The Seyhan River basin in Adana Province consists of the downstream reach of the Zamantı River, the Göksu River basin and the mainstream basin of the Seyhan River and its tributaries. The location map of the Seyhan River basin and its subbasins with the provincial boundaries are shown in Figure 2.1.1.

2.1.2 Topography

The Seyhan River basin is topographically composed of the following three areas;

- Steep mountainous area which formulates upstream and middlestream reaches of the Seyhan River basin, with elevations ranging 1,000 - 3,000 m ASL (above sea level).
- Hilly plateau area which formulates the lower part of the middle reach of the Seyhan River, with the elevations ranging 250 - 500 m ASL, and
- Delta plain area which expands at the lowest part of the Seyhan River after the City of Adana, with elevation of about 10 m ASL.

The Zamantı River rises from Mt. Karaca (El.2,079m) of the Kulmaç Mountain Range and the Göksu River from Mt. Sandikdere (El.2,601m) of the Tahtalı Mountain Range. Two rivers flow approximately in parallel in the south-southwest direction and merge at a point approximately 70 km north-northeast of the City of Adana to form the Seyhan River. The Seyhan River goes down, passing the urban area of Adana, and feeds into the Mediterranean Sea 50 km south of the Seyhan Dam.

2.2 Description of Basin

2.2.1 Tributaries of the Seyhan River

The Seyhan River basin is mainly composed of the following tributaries;

- Zamantı River,
- Göksu River,
- Seyhan River after the confluence of the Zamantı and Göksu Rivers, and
- Other tributaries after the confluence of the Zamantı and Göksu Rivers.

Other tributaries after the confluence of the Zamantı and Göksu Rivers are furthermore divided into the following rivers;

- Eğlence River which merges into the Seyhan River at the Çatalan Dam,
- Körkün River which drains into the existing Seyhan Reservoir,
- Üçürge River which drains into the existing Seyhan Reservoir,
- Çakıt River which drains into the existing Seyhan Reservoir, and
- Other small tributaries which drains into the Seyhan River after the confluence.

2.2.2 Catchment area of the subbasins

Based on the division of the tributaries in the Seyhan River basin, the catchment area calculation is performed for each tributary defined above. The catchment area calculation is made for two conceivable cases below;

- Without the Çatalan Reservoir and
- With the Çatalan Reservoir.

The Eğlence River and some small tributaries upstream of the Çatalan Dam are to be affected and inundated after the impounding water in the Çatalan Reservoir.
The results of the catchment area calculation are summarized below.

Catchment Area of Subbasins

	Sub-basin	Catchment Area (km^2) Without Çatalan Dam	With Çatalan Dam
(1)	Zamantı R.	8,822	8,822
(2)	Göksu R.	4,397	4,397
(3)	Zamantı - Göksu Join to Çatalan Dam (Seyhan R.)	1,430	858 (up to Çatalan Reservoir HWL) 572 (After Çatalan Reservoir HWL)
(4)	Eğlence R.	672	590 (up to Çatalan Reservoir HWL) 82 (After Çatalan Reservoir HWL)
(5)	Körkün R.	1,547	1,547
(6)	Üçürge R.	263	263
(7)	Çakıt R.	1,771	1,771
(8)	Çatalan B. - Seyhan B. Sub-Basin	435	435
	Total	19,377 km^2	

Total catchment area of the Seyhan River basin at the base point of the Seyhan Dam is estimated to be 19,337 km^2. The catchment area of the Seyhan River basin is furthermore divided into two areas depending on the flood control facilities such as Çatalan and Seyhan Dams, and the results are shown below.

Catchment Area of Çatalan & Seyhan Dams

Name of Dam	Sub-basin	Catchment Area of Sub-basin (km^2)	% of Total Catchment Area
Çatalan B.	• Zamantı R.	8,822	46
	• Göksu R.	4,397	23
	• Zamantı-Göksu Joint to Çatalan B.	1,430	7
	• Eğlence R.	672	4
	Sub-total	15,321	80
Seyhan B.	• Körkün R.	1,547	8
	• Üçürge R.	263	1
	• Çakıt R.	1,771	9
	• Çatalan B. - Seyhan B. Sub-basin	435	2
	Sub-total	4,016	20
	Total	19,337	100

2.3 Description of river

2.3.1 River length

The maximum travel distance along the main stream of each major tributaries in the Seyhan River basin is calculated from the base point to the upstream limits of drainage area. The results of the calculation are summarized below.

River Length of Tributaries

Sub-basin	River Length (km)	Base Point
Zamantı R.	331.0	Zamantı - Göksu Confluence to Seyhan River
Göksu R.	182.0	Zamantı - Göksu Confluence to Seyhan River
Seyhan R.	89.5	Seyhan Reservoir's HWL (El. 67.5 m)
Sub-basin (from Çatalan D. site to the confluence of Zamantı - Göksu R.)	35.0	Çatalan Reservoir's HWL (El. 125.0 m)
Eğlence R.	69.7	Seyhan Reservoir's HWL
	57.0	Çatalan Reservoir's HWL (El. 125.0 m)
Körkün R.	126.0	Seyhan Reservoir's HWL
Üçürge R.	53.2	Seyhan Reservoir's HWL
Çakıt R.	114.0	Seyhan Reservoir's HWL

Resultantly, the maximum river lengths from the base points such as Çatalan and Seyhan Reservoir's HWL are estimated below.

- from Çatalan Reservoir's HWL (El. 125.0 m)
  - Max. river length = 331 + 35.0
  - = 366 km
- from Seyhan Reservoir's HWL (El. 67.5 m)
  - Before Çatalan Dam imponding
    - Max. river length = 331 + 89.5
    - = 420.5 km
  - After Çatalan Dam imponding
    - Max. river length = 126 km

2.3.2 River gradient

To study the general basin geomorphology in the Seyhan River, sub-basin's features of hydrological importance are quantified in terms of stream length and elevation. The slope of the river channels is very much instrumental in creating the velocity of flow, and hence has a very profound effect on the surface runoff process. The river length and its elevation are plotted for each sub-basin and shown in Figure 2.3.1. The mean slope of river is also calculated below.

Mean Slope of River Channel

Sub-basin	Ave. Slope	Note
Zamantı R.	1/74	from the confluence to the Toros Mountain
	1/489	after the Toros Mountain
Göksu R.	1/126	
Seyhan R.	1/384	from Seyhan Reservoir's HWL to the confluence
	1/200	from Çatalan Reservoir's HWL to the confluence
Eğlence R.	1/31	from Seyhan Reservoir's HWL
	1/26	from Çatalan Reservoir's HWL
Körkün R.	1/64	from Seyhan Reservoir's HWL
Üçürge R.	1/33	from Seyhan Reservoir's HWL
Çakıt R.	1/60	from Seyhan Reservoir's HWL

2.4 Climatic Conditions

2.4.1 General

Anatolian geographical regions as explained in Section 2.1. Mediterranean climate is dominant in the Mediterranean Region and continental climate is dominant in the Central Anatolian Region. In the Mediterranean climate winters are warm and rainy, summers are hot and dry, and in the continental climate winters are cold and generally snowy, summers are hot and dry. The subareas of the Seyhan River basin close to the geographical region are transitional zones from the Mediterranean climate and the continental climate, and the continental climate is more dominant than the Mediterranean climate in these zones. Furthermore, the isohyets shown in Figure 2.4.1 are in good agreement with the climatic features of the catchment area explained above. Forty percent of the catchment area of the Seyhan River basin is forest covered area and the remaining part is barren. The forest cover is composed of the pin leaf trees such as pines and it takes place in the southern part of the basin. The Toros Mountains lying in the direction of South-Northeast divide the catchment area into two approximately equal subareas.

2.4.2 Precipitation

The mean annual isohyetal map in and around the Seyhan River basin is shown in Figure 2.4.1. It is in agreement with the topographical features and the vegetation cover of the Seyhan River basin and with the general inflow direction of the moist air masses to the basin. The relationship between annual rainfall and river channel profile for each tributary is shown in Figures 2.4.2 to 2.4.7. The frontal systems entering the basin from south and southeast direction bring the moist air masses over the catchment area and these air masses leave the most amount of their moistures in the form of the precipitation over the Toros Mountains while the air masses are moving over the Toros Mountains that take place in the middle section of the catchment area. Therefore the precipitation over the southern part of the catchment area is much higher than the other parts. The moist air flow continues in the northern direction after it has passed the Toros Mountains, and it carries less moisture. Because of the decrease in the moisture it precipitates in a less scale on the northern parts of the basin. As a result of this physical fact, the mean annual precipitation over the northern part of the catchment area is more less than that of the southern part.

In the coastal area of the Seyhan River basin precipitation is about 800 mm annually. At higher elevations it increases to 1,000 mm, and in the northern parts of the basin the value diminishes to 400 mm. Most of the precipitation which is 50 % of the annual total, fall between December and March. The mean annual precipitation of the basin is 590 mm. According to the climatic features of Turkey, the precipitation falling over the areas above 1,000 m elevation in winter is generally in the form of snow and it produces the snow cover on the ground. Snow melt starts around the end of winter or at the beginning of spring due to the temperature rises of the air.

2.4.3 Temperature, humidity and wind

Temperature decreases from south to north depending on higher elevations. The mean annual temperature in the lower basin is 18°C, while it decreases down to 8°C in the upper regions. The moisture is high in winters in the whole basin and high in summers at the coastal plains. In the northern regions where Central Anatolian climate dominates, moisture content is significantly reduced. The dominant wind direction is from southwest and the strongest winds exist in summertime. The maximum wind velocity recorded is 33.6 m/sec.

3. HYDROMETEOROLOGICAL OBSERVATION

3.1 General

The locations of the existing meteorological and hydrometric stations in and around the Seyhan River basin are shown in Figures 3.1.1 to 3.1.3.

Main observational items by meteorological and hydrometric stations are as follows;

(1) Precipitation
(2) Temperature
(3) Evaporation
(4) Wind
(5) Relative Humidity
(6) Snow Course
(7) Water Level
(8) Discharge

The meteorological stations are operated by DMİ and DSİ. The snow course stations are operated by EİE and DSİ. The hydrometric stations are operated by EİE and DSİ.
The lists of meteorological and hydrometric stations its station description and period of available records are shown in Tables 3.1.1 to 3.1.6.

The present methods of hydrometeorological observation and data collection and transmission are explained in the next sections.

3.2 Meteorological Observations

The precipitation values are measured by two types of rain gauges such as Pluviometer and Pluviograph. The numbers of rain gauge stations are summarized below.

No. of Rain Gauge Stations

Sub-basin	No. of Rain Gauge Stations	No. of Stations with pluviograph
Zamantı R.	12	1
Göksu R.	5	2
Sayhan R. (including other tributaries)	9	5(1)
Outside of Seyhan R. Basin	20	5

Note ( ) No. of Station with pluviograph which is closed in 1988

The rain gauge reading is made by the assigned local resident near the gauging station. Once a month observer is to post the monthly results to Adana regional office.

Then log sheets are sent to Ankara headquarter to be filed. No emergent action for the measurement is made in the case of heavy storm.

3.3 Hydrometric Observation

The water level reading is carried out by either staff gauge or automatic recorder (float type). The numbers of hydrometric station are summarized below.

No. of Hydrometric Stations

Sub-basin	No. of Hydrometric Station	No. of Station with Automatic Recorder
Zamantı R.	14	3
Göksu R.	6	1
Seyhan R.	1	1
Eğlence R.	3	1
Körkün R.	7	3
Çakıt R.	1	1
Other small tributaries	1	

The staff gauge reading is made by the assigned local resident, and its monthly records are to be sent to Adana regional office. Then records are sent to Ankara headquarter to be evaluated and filed for annual water book.

The staff gauge reading is carried out as follows;

(1) DSİ
- Twice a day at 8 a.m. and 4 p.m.

(2) EİE
- Twice a day at 8 a.m. and 4 p.m.

The discharge measurements at the stream gauge station are carried out twice a month by DSİ and once a month by EİE, including maintenance of equipment and checks on river bed condition.

The base high water level is set at each stream gauge station in case of flood. Observers start continuous measurement of water level in case that water level is above the base high water level records to Adana regional office by telephone when water level changes ±20 cm.

4. HYDROMETEOROLOGICAL ANALYSES

4.1 Data Collection

4.1.1 Rainfall data

(1) Daily rainfall

There are totally 46 rainfall gauging stations of DSİ and DMİ in and around the Seyhan River basin as shown in Figure 3.1.1. The available daily rainfall records observed when several major floods occurred in the Seyhan River are collected as listed in Table 4.1.1. The number of rainfall gauging station of which daily data are available is thirty two (32) in total and summarized below.

No. of Rainfall Gauging Stations

Sub-basin	No. of Rainfall Gauging Stations
Zamantı River	12
Göksu River	5
Seyhan River (including other tributaries)	8
Outside of Seyhan River basin	7
Total	32

The available periods of daily rainfall records are mainly from 1969 to 1987 as shown in Table 4.1.1.

(2) Hourly rainfall

The number of rainfall gauging stations with a pluviograph is reported to be fourteen (14) in total in and around the Seyhan River basin. The available hourly rainfall records observed at the occurrence of major floods are collected only from ten (10) stations as shown in Table 4.1.1. The available periods of hourly rainfall records are very limited to be only from 1975 to 1987.

4.1.2 Runoff data

(1) Daily water level and runoff data

The stream gauging stations operated by DSİ and EİE are listed in Tables 3.1.2 to 3.1.5 and the location of the stream gauging stations are shown in Figure 3.1.2.

The daily water level and runoff records observed at the occurrence of major floods in the Seyhan River basin were collected during the Site Investigation (Stage I). Since the staff gauge reading is carried out twice a day (at 8 a.m. and 4 p.m.), the flood water level records observed by staff gauge reading are used mainly for the purpose of reference or supplemental to the flood analysis.

(2) Hourly water level and runoff data

The hourly water level records observed by the automatic recorder (float type) are required to be collected for flood analysis and flood forecasting model. The collected hourly water level records are listed below.

Date of Flood	No. of Gauging Station			
	1801	1818	1820	1822
Mar. 1968	√			
Apr. 1972	√			
May 1973		√		
Mar. 1974	√	√		
Oct. 1974	√			
Dec. 1974		√		
Apr. 1975	√	√		
May 1975		√		
Apr. 1977	√	√		
Jan. 1978		√		
Jan. 1979	√	√		
Dec. 1979	√	√		
Mar. 1980	√			
Dec. 1987	√	√	√	√

4.1.3 Data for snowmelt runoff analysis

(1) Snow depth data

The snow depth data measured at DSİ, EİE and DMİ snow gauging stations in the Seyhan River basin in the case of major spring floods occurred by snowmelt runoff alone or combined with storm rainfall in the past decades such as spring floods in 1975 and 1980. The name of the snow gauging station is summarized below by its organization.

(a) DSİ

- Doğanbeyli (El. 1,410 m)
- Saimbeylı (El. 1,450 m)
- Avcıpınarı (El. 1,450 m)
- Ulukışla (El. 1,220 m)

(b) EİE

-	Gezbeli	(El. 1,900 m)
-	Hamidiye	(El. 1,400 m)
-	Çamardı	(El. 1,650 m)
-	Sarız	(El. 1,500 m)
-	Madazı	(El. 1,200 m)
-	Yalak	(El. 1,250 m)
-	Bakırdağ	(El. 1,200 m)
-	Yedioluk	(El. 1,250 m)

(c) DMİ

-	Pazarören	(El. 1,500 m)
-	Develi	(El. 1,180 m)
-	Feke	(El. 620 m)
-	Toklar	(El. 1,400 m)
-	Şıhlı	(El. 1,400 m)
-	Saimbeylı	(El. 1,100 m)
-	Tufanbeyli	(El. 1,350 m)
-	Karsantı	(El. 860 m)
-	Çiftehan	(El. 1,000 m)
-	Tomarza	(El. 1,400 m)
-	Pınarbaşı	(El. 1,470 m)
-	Sarız	(El. 1,500 m)
-	Mansurlu	(El. 1,050 m)
-	Çamardı	(El. 1,500 m)
-	Pozantı	(El. 778 m)

(2) Temperature data

The daily mean air temperature values observed at DMİ meteorological stations are collected in spring months in 1975 and 1980. The available data are obtained at the following stations.

(a) Tomarza
(b) Feke
(c) Tufanbeyli
(d) Pozantı
(e) Pınarbaşı
(f) Çamardı

(g) Sarız
(h) Saimbeylı

(3) Daily discharge data

The mean daily discharge data observed at EİE stream gauging stations in spring months in 1975 and 1980 are collected. The numbers of gauging stations are shown below.

(a) 1975 spring flood
- 1801 (Göksu River basin)
- 1805 (Göksu River basin)
- 1806 (Zamantı River basin)
- 1817 (Çakıt River basin)
- 1818 (Seyhan River basin)
- 1820 (Körkün River basin)
- 1821 (Eğlence River basin)
- 1822 (Zamantı River basin)
- 1823 (Zamantı River basin)

(b) 1980 spring flood
- 1801 (Göksu River basin)
- 1805 (Göksu River basin)
- 1820 (Körkün River basin)
- 1821 (Eğlence River basin)
- 1822 (Zamantı River basin)
- 1823 (Zamantı River basin)
- 1824 (Göksu River basin)

4.2 Flood Characteristics

4.2.1 Precipitation

The precipitation characteristics are grasped to formulate the allocation plan of rain gauge observation network and to prepare the rainfall data as an input for rainfall-runoff model.

(1) Rain storm area

The isohyetal map of rain storm experienced in the Seyhan River basin is constructed to grasp the rain storm area in the case of major flood. The floods are selected as follows, based on the flood magnitude and data availability:

(a) Flood in April 1975,
(b) Flood in March 1980, and
(c) Flood in December 1987.

The isohyetal map of rain storm for each flood is shown in Figures 4.2.1 to 4.2.3. Each isohyetal map is in agreement with the topographical features and the general inflow direction of the moist air masses to the basin. The major rain storm areas are described below:

(a) The middle reach of Çakıt, Körkün and Eğlence Rivers,
(b) The downstream of Zamantı River, and
(c) The downstream of Göksu River.

(2) Distribution of rainfall

The critical duration of storm rainfall is preliminarily estimated on a daily basis by the estimate of basin rainfall of each subbasin in the Seyhan River basin.
The results of the study are summarized below:

Sub-basin	Critical Duration of Rainfall		
	1975 Flood	1980 Flood	1987 Flood
Zamantı River	1.5 - day	1 - day	1 - day
Göksu River	2 - day	1 - day	1 - day
Eğlence River	1 - day	1 - day	1 - day
Körkün River	1 - day	1 - day	1 - day
Çakıt River	1 - day	1 - day	1 - day

4.2.2 Flood runoff

The following studies are carried out to grasp the flood runoff characteristics which shall be the basic data for flood runoff model.

(1) Schematization of Seyhan River system

Considering the river system's characteristics and the location of the flood control structures and water level gauging stations, the Seyhan River system is schematized based on the following two conditons:

(a) Without Çatalan Dam condition, and
(b) With Çatalan Dam condition.

The results of the schematization are shown in Figures 4.2.4 to 4.2.7.

(2) Subdivision of Seyhan River basin

Based on the above schematization study, the catchment area of each sub-basin is calculated and shown below:

No. of Sub-basin			Catchment Area (km^2)	
			Without Çatalan	With Çatalan
1.	Zamantı	(above 1822)	6,990	6,990
2.	Zamantı	(1822 to 1806)	1,833	1,833
3.	Göksu	(above 1801)	2,298	2,298
4.	Göksu	(1801 to 1805)	2,094	2,094
5.	Seyhan	(up to Çatalan HWL)	858	858
6.	Eğlence	(above 1825)	506	506
7.	Eğlence	(after 1825)	167	84
8.	Seyhan	(after Çatalan HWL)	572	655
9.	Körkün	(above 1820)	1,427	1,427
10.	Körkün	(up to Seyhan HWL)	120	120
11.	Üçürge		263	263
12.	Çatalan B. - Seyhan B.		435	435
13.	Çakıt	(above 1828)	1,769	1,769

(3) Subdivisin of Seyhan River course

Based on the selected water level gauging station as a base point for caliblation of flood runoff model and the flood control structures such as Seyhan and Çatalan Dams, the river length and channel slope are calculated and summarized below:

<u>River Length</u>

No. of River Course	River Length (km)	
	Without Çatalan	With Çatalan
1	94.0	94.0
2	60.5	60.5
3	39.6	35.0
4	22.7	10.0
5	21.0	21.0
6	49.9	-

River Channel Slope

No. of River Course	River Channel Slope	
	Without Çatalan	With Çatalan
1	1/109	1/109
2	1/169	1/169
3	1/220	1/200
4	1/223	1/130
5	1/263	1/263
6	1/998	-

4.2.3 Flood concentration time

(1) General

Flood concentration time is the time required for flood runoff to travel hydraulically from one point of the watershed outlet to the other point of reference downstream.

To estimate the travel time the approaches commonly used are: (a) stream routing, (b) Kirpich formula, and (c) study of historical record.

Kirpich gives a formula for time of concentration as below:

$$tc = 0.00032 \times L^{0.77} \times S^{-0.385}$$

where, tc = time of concentration (hr)

L = maximum length of travel of water (m)

S = slope, equal to H/L where H is the difference in elevation between the most remote point on the basin and the outlet (m)

The formula is basically for computing the time of concentration but it has been used for estimating the travel time between two stations by taking L and S of this reach. However, the results so obtained are generally very approximate.

(2) Travel time of past flood events

Travel time of past historical events is studied between different reaches. Travel time changes from flood to flood. The travel times of several observed floods are computed. However, this alone does not give very convincing results due to contributions from different tributaries at the station downstream.

The travel times observed at historical events are given as below:

Station Upstream	Station Downstream	Travel time (hr)	Note
1801 (Göksu)	1818 (Seyhan)	6.0	• Jan. '79 Flood • Automatic Recorder be installed at both stations.
1805 (Göksu)	1818	1.0	• Mar. '80 Flood • Peak water levels be observed by staff gauge reading.
		1.0	• Dec. '87 Flood • Staff gauge reading at 1805
1826 (Zamantı)	1818	1.0	• Dec. '87 Flood • Staff gauge reading at 1826
1818	Seyhan Br.	4.0 10.0	• Apr. '75 Flood • Jan. '79 Flood

The observed hourly and daily flood runoffs and its relevant estimated daily mean rainfall in the sub-basins are shown in Data Book A.

5. FLOOD RUNOFF ANALYSES

5.1 General

Surface water hydrology is basic to the design of many engineering works, and important in water quality and other management schemes. In addition, the ability to reliably forecast flows for short periods into the future is of signal value in operating storage and other works and in planning proper actions during times of flood. A good example is the operation of a reservoir with an uncontrolled inflow but having a means of regulating the outflow. If information on the nature of the inflow is determinable in advance, then the reservoir can be operated by some decision rule to minimize downstream flood damage. Such operations can be computerized to continually improve estimates based on incoming data and thus offer direction on the nature of the releases to be made. For river forecasts to be reliable, adequate, dependable data on various watersheds and meteorologic conditions are needed on a continuing basis. Modern monitoring stations capable of telemetering data to computer control centers provide an important support function for forecasting. The methods used to forecast flows are basically the same ones employed in design, namely, precipitation runoff equation, unit hydrographs, watershed models, and flow-routing techniques.

The several hydrologic models to be needed for flood runoff analysis are shown below. Snowmelt runoff model is separately explained in Chapter 6.

(1) Mean basin rainfall model
(2) Sub-basin rainfall runoff model
(3) River routing model
(4) Rainfall-runoff event simulation model

5.2 Mean Basin Rainfall Model

5.2.1 Estimate of daily mean rainfall in subbasins

Rainfall is the primary input vector of the surface water hydrologic cycle. For most hydrologic analyses, it is important to know the areal distribution of rainfall. Usually, average depths for representative portions of the watershed are determined and used for this purpose. The Thiessen method was applied for calculating areal rainfall averages in sub-basins in the Seyhan River basin even though this procedure is not suitable for mountainous areas because of orographic influences. The main reason for its use for the Project is that there are very few available daily rainfall data in and around the Seyhan River basin.

For the purpose of estimating the basin mean rainfall, the representative rainfall gauging station is selected among the existing rainfall gauging stations by the statistical method, namely, the multiple linear regression analysis on the observed storm rainfall records.

5.2.2 Estimate of hourly mean rainfall in subbasins

The number of rainfall gauging stations with a pluviograph is reported to be fourteen (14) in total in and around the Seyhan River basin. The available hourly rainfall records observed at the occurrence of major floods are collected only from ten (10) stations. The available periods of hourly rainfall records are very limited to be only from 1975 to 1987.

The hourly patterns of daily rainfall data for the representative stations that have no hourly records were estimated by the following procedure.

(1) The number of rainfall gauging stations with hourly data for the past major storms, such as 1975, 1980 and 1987 floods is nine (9) in total and shown below.

- Adana
- Feke
- Karaisalı
- Kozan
- Pozantı
- Pınarbaşı
- Ereğli
- Ulukışla
- Niğde

(2) The accumulated hourly rainfall curve of each storm for nine stations is drawn to know the time distribution of storm rainfall.

(3) The accumulated daily rainfall curve of each storm for the representative rainfall stations is also drawn. The number of the representative rainfall stations is sixteen (16) in total.

(4) The hourly patterns of the representative rainfall stations are estimated by careful comparisons between its daily pattern and several available hourly patterns of above-mentioned stations taken into consideration the following points.

- To select the most critical pattern

- To check results of daily simple regression analysis
- To consider the regional and areal rainfall distribution

Results of the estimate of hourly rainfall patterns of the representative rainfall stations are shown in Table 5.2.1.

5.2.3 Mean basin rainfall model

The model to calculate the mean hourly basin rainfall as an input for the rainfall-runoff model is constructed. The multiple linear regression equation obtained for the estimate of mean daily basin rainfall is applied for the estimate of mean hourly basin rainfall. The multiple linear regression equation is described below.

$$Y = a_1 X_1 + a_2 X_2 + \dots\dots\dots\dots + a_n X_n$$

where, Y = Mean hourly basin rainfall
n = Number of selected representative rainfall station
ai = Multiple regression coefficients (i = 1 to n)

The constant b of the equation is omitted since it can be theoretically negligible for rainfall estimates.

The results of the computations are shown in Table 5.2.2.

5.3 Subbasin Rainfall-Runoff Model

5.3.1 General

Unit hydrographs have been commonly used for design flood calculation as a simple rainfall-runoff model. It hypothesizes that rainfall-runoff process is linear transformation. However, actual runoff phenomenon is non-linear process. Unit hydrographs method has difficulties to be used for the practical model of flood forecasting and warning system.

Non-linear rainfall-runoff model, so called, Storage Function Model, was introduced by Dr. Kimura in 1961, which has been used extensively as a practical model both in Japan and overseas for more than three decades.

The main characteristics of Storage Function Model are summarized as follows.

(1) The basin storage process is additionally introduced between rainfall-runoff process.

(2) The basin storage is expressed as a catalytic function. The relationship between rainfall and runoff is expressed as an equation.

(3) By this equation, water budget of storage volume can be calculated. Finally, runoff hydrographs can be obtained.

5.3.2 Description of Storage Function Basin Model

As is briefly explained in 5.3.1, basin storage S_l is exponentially expressed by basin runoff Q_l as follows.

$$S_l = K\, Q_l^{p}$$

where,	S_l	:	Basin storage (m^3)
	Q_l	:	Basin runoff (m^3/sec)
	K, p	:	Constants for basin

Besides the above equation of motion as storage function, the equation of continuity is introduced as follows.

$$dS_l/dt = (1/3.6)\, f\, r_{ave}\, A - Q_l$$

where,	f	:	Runoff ratio
	r_{ave}	:	Basin mean rainfall (mm/hr)
	A	:	Catchment area (km^2)
	Q_l	:	Direct runoff from basin with time lag (m^3/sec)
			$Q_l(t) = Q_l(t + T_l)$
	T_l	:	Lag time (hr)
	S_l	:	Basin storage ($m^3/sec \cdot hr$)

Storage function between basin storage S and basin runoff Q, namely, constants K and p can be determined by the past rainfall and runoff records. If the relationship between S and Q is determined, Q can be calculated by inputting basin mean rainfall r_{ave} into the equation of continuity and by using S as a catalytic function.

5.3.3 Example of trial calculation for sub-basins

(1) Selection of flood hydrographs in the subbasins

The selection of flood hydrographs in the subbasins is firstly made as follows.

- Flood in December 1987 at 1825 for Eğlence subbasin
- Flood in December 1987 at 1801 for Göksu upstream subbasin

(2) Determination of lag time T_l

Given a lag time T_l, the values of basin storage s(mm) and basin runoff q(mm/hr) are calculated and graphed by the flood records. Trial calculations for several lag time T_l are continued until the s and q relationship can be regarded as equational. The determined equation is accepted as a storage function of the subbasin. The storage function is expressed as follows.

$$s_l = K(q - qi)_l{}^p$$

The trial calculations of the values of s and q for flood in 1987 at 1825 stream gauging station for Eğlence subbasin are plotted in Figure 5.3.1. Lag time $T_l = 1$ hr is determined by the s and q relationship which gives the best equational plot (the narrowest loop).

(3) Determination of K and p

The values of K and p can be estimated by the least square method on the log - log paper.

(4) Estimate of first degree runoff ratio f_1 and saturated rainfall Rsa

Firstly, the accumulated values of the observed and estimated (q - qi) are plotted with the values of $f_1 = 1.0$ and Rsa = 0.0 (mm) and shown in Figure 5.3.2. The first degree runoff ratio can be determined by the first slope of the curve, and saturated rainfall can be given by the point where the accumulated values of observed and estimated (q - qi) equals.

(5) Simulation of storage function basin model

Given the values of K, p, T_l, f1 and Rsa, the observed and estimated flood hydrographs can be compared as is shown in Figure 5.3.3.

(6) Interactive simulation by Extend

The interactive procedure of event simulation for storage function basin model is briefly illustrated in Figure 5.3.4. Figures 5.3.5 and 5.3.6 show the results of parameter settings for subbasins above 1825 and 1801 stream gauging stations.

5.4 River Routing Model

5.4.1 General

Flood forecasting projects generally utilize some form of routing technique. Routing is used to predict the temporal and spatial variations of a flood wave as it traverses a river reach or reservoir. Routing techniques can be classified into two categories, namely, hydrologic routing and hydraulic routing. Hydrologic routing employs the equation of continuity with either an analytic or an assumed relationship between storage and discharge within the system. Hydraulic routing, on the other hand, uses both the equation of continuity and the equation of motion, customarily the momentum equation. This particular form utilizes the partial differential equations for unsteady flow in open channels. It more adequately describes the dynamics of flow than does the hydrologic routing technique.

Applications of hydrologic routing techniques to problems of flood prediction are numerous. Most flood forecasting and warning systems instituted by Ministry of Construction in Japan or other organizations overseas incorporate some form of this technique to predict flood stages in advance of a severe storm. Additionally, the synthesis of runoff hydrographs from gauged and ungauged watersheds is possible by the use of basic assumption inherent in this approach.

Non-linear hydrologic river routing model was also introduced by Dr. Kimura with an assumption of the river channel storage. The main characteristics of Storage Function River Model are basically the same with Storage Function Basin Model.

5.4.2 Description of storage function river model

River channel storage S_l is also exponentially expressed by river channel runoff Q_l as follows.

$S_l = K\, Q_l^p$

where,	S_l	:	River channel storage (m^3)
	Q_l	:	River channel runoff (m^3/sec)
	K, p	:	Constants for river channel

Besides the above equation of motion as storage function, the equation of continuity is introduced as follows.

$dS_l/dt = f\, I - Q_l$

where,	f	:	Inflow coefficient
	I	:	Inflow into the river channel (m^3/sec)
	Q_l	:	Outflow from river channel with time lag (m^3/sec)
			$Q_l(t) = Q_l(t + T_l)$
	T_l	:	Lag time (hr)
	S_l	:	River channel storage ($m^3/sec{\bullet}hr$)

Storage function between river channel storage S and river channel runoff Q, namely, constants K and p can be determined by the past rainfall and runoff records. If the relationship between S and Q is determined, Q can be calculated by inputting inflow I into the equation of continuity and by using S as a catalytic function.

5.5 Rainfall-Runoff Event Simulation Model

5.5.1 General

Sequential simulation consists of step-by-step computation through the entire time period. Simulation of monthly or yearly streamflow or rainfall events is satisfactorily accomplished through this type of operation. However, for many hydrologic events that occur in shorter time intervals, the sheer amount of computation prohibits the sequential generation of these data for large-scale simulations. For example, the calculation of simulated rainfall depths hour by hour required 8760 hourly items for each year of record. To achieve efficiency in computation, including only short events significantly reduce the length of simulation time. Such a technique is called event simulation.

Event simulation model structures closely imitate the rainfall processes. Lumped parameter approaches, such as unit hydrograph method and storage function method, are generally incorporated even though a greater opportunity to use distributed parameter approaches is present. Preparation for implementing most event simulation models begins with a watershed subdivision into homogeneous subbasins. Computations, using processes, proceed from the most remote upstream subbasin in a downstream direction.

Simulation of one or more storm events over the basin is accomplished by conventional hand techniques that have been programmed for a digital computer. For example, the computer accepts parameters for upstream subbasin A; and computes the hydrograph resulting from the storm event; repeats the hydrograph computation for other upstream subbasin B; combines the two computed hydrographs into a single hydrograph; routed the hydrograph by conventional techniques through reach C to the upstream end of reservoir R, where it is combined with the computed hydrograph for residual subbasin C; then at the reservoir R the combined hydrograph is routed through reservoir R.

Hydrograph computations for subbasins are determined using storage function method. The rainfall hyetograph is input uniformly over the subbasin area, and rainfall losses are abstracted, leaving an excess rainfall hyetograph that is convoluted with the storage function to produce a surface runoff hydrograph for the subbasin. Subsurface flows and waters derived from groundwater storage are transformed into a subsurface runoff hydrograph that, when combined with the surface runoff hydrograph, form the total streamflow hydrograph at the subbasin outlet. This hydrograph can then be routed downstream, combined with another contributing hydrograph, or simply output if this subbasin is the only, or the final, subbasin being considered. River routing can be determined using storage function method.

5.5.2 Storage function basin and river model for the entire Seyhan River basin

The rainfall-runoff event simulation model by storage function method is constructed for the Seyhan River basin as a main flood forecasting computer program. The parameter setting of the models is undertaken based on the comparison of observed and simulated values at the base points for the calibration of the models.

5.5.3 Use of interactive computer software for simulation

For the purpose of creating an easy-to-use model, the interactive computer software for simulation, namely, Extend, version 2.0 is used.

6. SNOWMELT RUNOFF ANALYSIS

6.1 General

In many cases snow is the dominant source of streamflow in spring months. Mountainous areas in the Seyhan River basin are prime examples. It is important to understand the nature and distribution of snowfall and the mechanisms involved in the snowmelt process to make adequate estimates of the streamflow derived from this source. Snowmelt usually begins in the spring. Some of the greatest floods result from combined large-scale rainstorms and snowmelt. Streamflow forecasting is highly dependent upon adequate knowledge of the extent and characteristics of snow fields within the watershed.

As in the rainfall-runoff process, geographic, geologic, topographic, and vegetative factors also are operative in the snow accumulation-snowmelt process.

For rainfall-runoff relationships point rainfall measures are used in estimating areal and time distribution over the basin. A similar approach is taken in snow hydrology although the point-areal relationships are usually more complex.

The estimation of areal snow depth and water equivalent from point measurement data is highly important in hydrologic forecasting the estimates of basin-wide water equivalent and areal snow cover is examined.

Various approaches to runoff determination from snowmelt have been introduced. They range from relatively simple correlation analyses that completely ignore the physical snowmelt process to relatively sophisticated methods using physical equation. Most techniques can be considered as based on degree-day correlation, analyses of recession curves, correlation analyses, physical equation, or various indexes.

The atmospheric temperature is an extremely useful parameter in snowmelt determination. It reflects the extent of radiation and the vapor pressure of the air; it is also sensitive to air motion. Frequently, it is the only adequate meteorological variable regularly on hand so that widespread use has been made of degree-day relationships in snowmelt computations.

6.2 Area Elevation Relationship of Subbasins

How the area within a drainage basin is distributed between contours is of interest for comparing drainage basins and gaining insight into the snowpack and snowmelt characteristics of the basin. For such studies, an area distribution curve is used. The curve can be obtained by planimetering the areas between adjacent contours. The area elevation relationships of subbasins are shown in Figures 6.2.1 to 6.2.3. Figure 6.2.4 shows the topographical map of the Seyhan River basin with the contour lines, such as, 1000, 1500 and, 2000 El.m.

6.3 Determination of Snow Line Elevation

6.3.1 General

Unlike the case of rainfall, snowmelt analysis needs the careful consideration of other factors. First, basin cannot be assumed to be a homogeneous system because of the fact that in that case when only snowmelt flows, the contributing area is not the entire drainage area, but only the portion of area with a snow cover. Secondly, the altitude is of paramount importance in snow hydrology as the rates of snowmelt decrease with elevation due to a general reduction of temperature with height. Thirdly, the basin-wide melt and cover area increase with an increase in height as the snow line (defined as the line of zero snow depth) is approached, then diminish with elevation over higher places normally completely snow-covered until late in the season.

6.3.2 Estimate of snowmelt starting elevation

The several estimates of the snowmelt starting elevation at the beginning of snowmelt season are made by the following previous studies in and around the Seyhan River basin. Recommended value by U.S. Army Corps of Engineers is also shown as a reference one.

Estimates of Snowmelt Starting Elevation

Name of Study	Snowmelt Starting Elevation
Lower Seyhan Basin Master Plan (1980)	1,500 El.m
Sir Dam and Hydroelectric Project Design Flood Studies (Revised, 1985)	1,250 or 1,500 El.m
Ermenek Dam and Hydroelectric Project Hydrological Study, EIE	1,250 El.m
U.S. Army Corps of Engineers Snow Hydrology, (1956)	1,500 El.m

As seen in the above table, either 1,250 or 1,500 El.m is adopted as a general snowmelt starting elevation for design flood studies.

6.4 Average Temperature of Snow-covered Area above Snow Line Elevation

6.4.1 General

As is briefly mentioned in Section 6.3.1, basin cannot be assumed to be a homogeneous system because of the fact that in that case when only snowmelt flows, the contributing area is not the entire drainage area, but only the portion of area with a snow cover. Therefore, it is needed to establish the formula for the estimate of average temperature of snow melting zone of the subbasins.

6.4.2 Relationship between temperature and elevation

(1) Freezing level

Highest elevation of melting zone at which freezing temperature of 0 °C is given can be estimated by the following formula.

$$Ef = Ei + (Ti - 0)/t \times 100$$

where,

Ef	:	Freezing level with temperature of 0 °C (El.m)
Ei	:	Elevation at temperature index station (El.m)
Ti	:	Temperature at temperature index station (°C)
t	:	Temperature decrease per 100 m increase in elevation (°C)

The several estimates of the temperature decrease per 100 m increase in elevation, t are made by the following previous studies in and around the Seyhan River basin. Recommended value by U.S. Army Corps of Engineers is also shown as a reference one.

Estimates of t

Name of Study	Value of t
Lower Seyhan Basin Master Plan (1980)	0.7 or 1.0 °C per 100 m
Sir Dam and Hydroelectric Project *Design Flood Studies (Revised, 1985)*	0.7 °C per 100 m
Ermenek Dam and Hydroelectric Project Hydrological Study, EIE	0.7 °C per 100 m
U.S. Army Corps of Engineers Snow Hydrology, (1956)	0.5 °C per 100 m

As seen in the above table, 0.7 °C per 100 m is commonly adopted as a general value of t for design flood studies.

The temperature index station in each subbasin is considered to be the selected representative temperature gauging station.

(2) Temperature at snow line

The temperature at snow line is given by

$$Ts = Ti + t/100 \times (Es - Ei)$$

where,

Ts	:	Temperature at snow line (El.m)
Es	:	Elevation at snow line (El.m)

(3) Average temperature over melting zone

The average temperature over melting zone is given by

$$T_{ave} = (Ts + 0)/2$$

where,

Tave	:	Average temperature over melting zone (°C)

6.5 Critical Area of Snowmelting

6.5.1 General

The area between the snow line and the freezing level is regarded as a critical area of snowmelting. Furthermore, it is essential to obtain the updated and reliable estimate of snowmelting zone in each subbasin.

6.5.2 Computation method of critical area of snowmelting in the subbasins

The critical area of snowmelting in the subbasins can be computed by the use of the area-elevation distribution curve of a subbasin which is shown in Figures 6.2.1 to 6.2.3. The critical snowmelting area is given by

$$Am = As - Af$$

where,

Am	:	Area between snow line and freezing level in a subbasin (km^2)
As	:	Area above snow line in a subbasin (km^2)
Af	:	Area above freezing level in a subbasin (km^2)

6.6 Determination of Basin Snowmelt Rate and Snowmelt Runoff in the Seyhan River Basin

6.6.1 General

The rate of snowmelt is defined as the rate of conversion of ice into water within the snowpack rather than the rate of drainage. The rate of snowmelt tends to vary greatly, causing rapid changes in the introduction of the liquid water into a snowpack. This fluctuation is dampened, however, in passing through the snow so that the rate of drainage from the snowpack is often relatively steady.

6.6.2 Previous studies on snowmelt rate

Atmospheric temperature is one of the most useful parameters. This one parameter not only reflects the extent of radiation and vapour pressure of the air, but also gives an idea of air motion indirectly. Its use is made in computations of snowmelt runoff through an index known as degree-day. A degree-day, in its broadest sense, is a unit expressing the amount of heat in terms of the persistence of a temperature for a 24-hour period 1 of °C from a reference temperature. In snowmelt computations the reference temperature is usually taken as 0 °C. Thus, the degree-day for snowmelt studies is often computed by subtracting the average of the daily maximum and daily minimum temperatures from 0 °C.

The standard practice is to correlate degree-days with the basin runoff. However, in some cases, other factors are also introduced into the above relationship to take care of the forest cover effects and other influences.

The point melt rate in centimeters per degree-day above 0 °C varies between 0.038 and 0.5 cm/degree-day. For a spring snowmelt period, an average of 0.13 cm/degree-day may be used, but with discretion. Such point melt values for centimeter of melt per day must, however, be distinguished from the basin-index melt values.

Linsley and others state that the basin melt rate in centimeters per degree-day above 0 °C varies between 0.15 and 0.38 cm/degree-day under conditions of continuous snow cover and at melting temperatures.

The several estimates of the basin snowmelt rate at the beginning of snowmelt season were made by the following previous studies in and around the Seyhan River basin.

Estimates of Basin Snowmelt Rate, Rs

Name of Study	Basin Snowmelt Rate, Rs
Lower Seyhan Basin Master Plan (1980)	0.1 or 0.15 cm/℃-day (as the maximum basin snowmelt rate)
Sir Dam and Hydroelectric Project Design Flood Studies (Revised, 1985)	0.128 cm/°C-day (as the maximum basin snowmelt rate)
Ermenek Dam and Hydroelectric Project Hydrological Study, EIE	0.388 cm/°C-day (as the maximum basin snowmelt rate)

As seen in the above table, the values between 0.1 and 0.388 are adopted as a general basin snowmelt rate for design flood studies.

6.6.3 Basin snowmelt runoff in the Seyhan River subbasins

The snowmelt runoff in each subbasin can be computed by the above-explained temperature index utilized as a prediction equation. The computation procedure is described as follows.

First, the average degree-days above 0 °C over the critical melting zone is given by

$$Td = Tave - 0$$

where,

Td : Average degree-days above 0 °C

Then, the total snowmelt therefore is given by

$$Qs = Td \times Rs \times Am$$

where,

Qs : Total melt in subbasin (cm•km^2)

Rs : Degree-day factor (cm/degree-day)

6.7 Simple Snowmelt Runoff Model

6.7.1 General

So far in the previous chapters, the several factors, such as, snow line, relationship between temperature and elevation, snowmelting zone and snowmelt rate in a basin are discussed regarding the snowmelt runoff process and the prediction equations to estimate the snowmelt due to the temperature increase in a basin are presented.

Various approaches have been applied to determine the runoff from snowmelt ranging from the *simple technique of regression analysis (ignoring the physics of the snowmelt process) to* more sophisticated techniques based on degree-day or various indexes. The techniques used are:

(1) Regression analysis
(2) Physical equations for basin snowmelt
(3) Analysis of hydrograph recessions
(4) Hydrograph syntheses

However, reflected upon the availability of data required for the snowmelt runoff estimate, the simple snowmelt runoff model by regression analysis is adopted for the Seyhan River flood forecasting system.

6.7.2 Adopted snowmelt runoff model

(1) General

To perform regression analysis for the computation of snowmelt runoff, certain independent variables called indexes need to be selected. The advantage of indexes is that they are more easily measured than the dependent snowmelt runoff. The adequacy of an index is based on:

(a) Ability of the index to adequately describe the physical process it represents
(b) Degree to which point observation is typical of actual conditions
(c) Random variability of the observation
(d) Nature of variability between point measurement and basin means

Indexes could be equations or simple coefficients, and variables or constants. The common indexes are:

(a) Thermal budget indexes
(b) Temperature indexes

However, in most cases, the data required for the thermal budget indexes are generally not available and considered not to be suitable for the Study. Therefore, the temperature indexes are selected to estimate the snowmelt runoff because of the easiness of data availability.

(2) Snowmelt runoff model by temperature indexes

The flow chart of snowmelt runoff determination by the temperature indexes is described in Figure 6.7.1.

The several data required for the snowmelt runoff model are categorized below:

(a) Data eventually given by the location
- Ei : Elevation at the index temperature station (El.m)

(b) Data estimated hypothetically
- t : Temperature decrease per 100 m increase in elevation (°C)
- Es : Elevation at snow line (El.m)
- Rs : Degree-day factor (cm/degree-day)

The hypothetical values for t, Es and Rs are determined for the Study below, taking consideration the previous studies:

t = 0.7 (°C)
Es = 1,250 (El.m)
Rs = 0.1 (cm/degree-day)

(c) Data measured at the index temperature station
- Ti : Temperature at temperature index station (°C)

(d) Data computed by the snowmelt runoff model
- Ef : Freezing level with temperature of 0 °C (El.m)
- As : Area above snow line in a subbasin (km^2)
- Af : Area above freezing level in a subbasin (km^2)
- Ts : Temperature at snow line (El.m)
- Tave : Average temperature over melting zone (°C)
- Am : Area between snow line and freezing level (km^2)
- Td : Average degree-days above 0 °C
- Qs : Total melt in subbasin (cm•km^2)

(3) Estimate of snowmelt runoff in 1980 flood

Based on the flow chart and data hypothetically estimated in a subbasin and measured at the meteorological gauging stations, the estimate of snowmelt runoff in 1980 flood is made as a typical example of the snowmelt runoff in the Seyhan River basin. The results of the estimate are summarized below and shown in Table 6.7.1.

Estimated Snowmelt Runoff in 1980

Unit : (m^3/s)

Date	Basin No.1	Basin No.2	Basin No.3	Basin No.4	Basin No.5	Basin No.6	Basin No.9	Basin No.11	Basin No.13	Total Basin
3/24	236	37	88	52	8	7	33	2	35	498
3/25	347	56	115	67	12	12	52	3	54	718
3/26	369	60	121	70	13	12	55	3	57	760
3/27	364	60	62	37	12	11	49	3	51	649
3/28	224	35	20	14	7	6	27	2	29	364
3/29	129	21	36	23	5	4	18	2	20	258
3/30	236	37	53	32	7	7	30	2	32	436
3/31	249	39	69	41	9	9	38	3	40	497

(4) Calibration of snowmelt runoff and setting of parameters of the model

The calibration of snowmelt runoff and setting of parameters of the model are carried out by the combination of rainfall flood runoff and explained in 7.2.3.

7. EVALUATION OF FLOOD RUNOFF MODEL

7.1 Calibration of Runoff Calculation Models

7.1.1 General

The calibration of flood runoff models in the Seyhan River basin is carried out by the following procedures.

(1) Selection of typical floods

The typical floods are selected for the evaluation of the models for non-snowmelt season and snowmelt season as follows.

(a) Flood in December 1987 for non-snowmelt season
(b) Flood in March 1980 for snowmelt season

(2) Parameter settings for storage function basin and river models

The parameter settings for storage function basin and river models are made based on the following procedures.

(a) Parameter settings for basin model
The hydrological and hydraulic parameters of the basin model for the gauged subbasins can firstly be determined by the method explained in Chapter 5. The parameters of the basin model for the ungauged subbasins are roughly estimated by the basin characteristics.

(b) Parameter settings for river model
The hydraulic parameters of the river model for the river channels can be determined by the river channel characteristics.

(3) Calibration methods

The calibration of the event simulation model presented in Chapter 5 is carried out by the following basic consideration.

(a) The calibration of the event simulation combined with basin and river models in the entire Seyhan River basin is mainly carried out at the gauged base points.

(b) The calibration of the event simulation is mainly carried out at the Seyhan dam taken into consideration the consistency of the parameters in terms of the basin and river characteristics.

7.1.2 Parameter settings for storage function river model

(1) Collection of river cross section

The reliable river cross section data are collected at the following stream gauging stations.

(a) 1801 in upper Göksu river basin
(b) 1805 in lower Göksu river basin
(c) 1818 in middle Seyhan river basin
(d) 1825 in Eğlence river basin

(2) Estimate of average river cross section at river channels

The estimate of average river cross section at the proposed river channels are preliminarily made utilizing the above available cross section data.

Estimate of Average River Cross Section at River Channels

No. of River Channel	Applied River Cross Section
1	Same cross section as No. 2
2	Ave. cross section of 1801 and 1805
3	Ave. cross section of 1805 and 1818
4	Cross section of 1825
5	Same cross section as No. 4
6	Cross section of 1818

(3) Determination of K and p

Based on the estimate of average river cross section at river channels, river channel storage, s and uniform flow, Q can be calculated as equations by water depth, H. Then, hydraulic parameters, K and p can be computed by the least square method.

Several conditions for the calculation of uniform flow are as follows.

(a) Manning's roughness coefficient n = 0.040 for meandering river
(b) i = average river gradient
(c) L = river length (km)
(d) Lag time $T_l = 7.36 / 10000\ L\ i^{-0.5}$

Results of the calculation to determine K and p is shown in Table 7.1.1. The values of K, p and Tl are summarized in Table 7.1.2.

7.1.3 Parameter settings for storage function basin model

(1) Calibration by gauged base points (Case 1)

The calibration method by the gauged base points in the Seyhan River is applied for the parameter settings.

The gauged base points utilized for the calibration are summarized below.

Station No.	1980 Flood	1987 Flood
1801	√	√
1805	√	√
1822	√	√
1806		√
1818	√	√
1820	√	√
1825		√
Seyhan Dam	√	√

(2) Calibration by integrated storage function method (Case 2)

The calibration by the integrated storage function method in the entire Seyhan River basin is applied for the parameter settings.

The parameter settings are made mainly by the comparison of DSİ's previous estimate of inflow into the Seyhan dam and calculated inflow by the storage function model. Parameters are integrated by the subbasin's characters and locations.

(3) Comparison of calibration methods

Results of the calibration by two methods are shown in Table 7.1.2 and Figures 7.1.1 to 7.1.2.

The comparison of calibration results by two methods are made by several indexes and summarized below.

Index	'87 Flood Observed	'87 Flood Case 1 Simulated	'87 Flood Case 2 Simulated	'80 Flood Observed	'80 Flood Case 1 Simulated	'80 Flood Case 2 Simulated
Deviation of Peak Time (hr)		+ 1 hr	+ 4.7 hr		+ 3 hr	+ 2 hr
Peak Inflow (m^3/s)	2,442	2,538 (+ 3.9 %)	2,587 (+ 5.9 %)	6,040	5,682 (- 6.6 %)	5,679 (- 6.4 %)
Inflow Volume Ratio		1.23	1.27		1.18	1.20
R		0.92	0.92		0.95	0.94

7.2 Determination of Runoff Models

7.2.1 General

The proposed flood runoff model in the Seyhan River basin is selected by the evaluation of the results of the comparative study on the calibration methods. The selection is made for non-snowmelt season and snowmelt season.

7.2.2 Runoff model for non-snowmelt season

(1) Evaluation of models by different calibration methods

The several points are observed by comparative study on the calibration methods.

Point of Evaluation	Calibration by Gauged Base Points	Calibration by Integrated Storage Function Method
Estimate of first degree runoff ratio, f1 in subbasins	Having a tendency to undervaluate f1 in subbasins with less rain-fall	Having a capability to set safer parameter of f1 in subbasins with less rainfall
Degree of influence by unreliable flood water level records	Having a tendency to set inconsistent parameters	Having a capability to set consistent parameters
Flood water balance at gauged base points	Having a tendency to set inconsistent parameters	Having a capability to set consistent parameters

Based on the above evaluation, the calibration method by the integrated storage function is considered to be much more reliable and safer than the calibration method by the gauged base points.

7.2.3 Runoff model for snowmelt season

The proposed flood runoff model for snowmelt season is composed of the following models.

(1) Storage function basin and river model for snowmelt season

(2) Snowmelt runoff model

Two models (1) and (2) can be combined by the event simulation of Extend. Results of computation model for flood in 1980 are described in Figures 7.2.1.

8. RAINFALL FORECAST

8.1 General

In general, the storm rainfalls in the Seyhan River basin can be classified as the consecutive storm rainfall with no typical distribution of intensity and with a long duration of more than 1 day. The hourly rainfall mass curves obtained at meteorological stations in case of major floods indicate the said rainfall characteristics, as shown in Figure 8.1.1.

The typical rainfall pattern with a certain accuracy expressed by the accumulated rainfall curve is hardly identified for the entire consecutive storm rainfall. But, within a certain duration, i.e., a few hours, it is generally considered that the rainfall forecast can be made by the hypothesis that nearly the same amount of rainfall can be given since the rainfall mass curve is relatively smooth within a few hours.

To forecast the expected flood in a few hours, taken into the consideration the lag time in the subbasins and river channels, two methods can be adopted as follows.

(1) The measured rainfall amounts can be used within the lag time hours

(2) The average of rainfall amounts of the previous hours can be used after the lag time hours

8.2 Procedure of Rainfall Forecast for Consecutive Storm Rainfall

The moving average method for rainfall forecast is introduced. for the above-explained method (2). The schematic diagram for the method of rainfall forecast is explained in Figure 8.2.1. Figure 8.2.1 shows the example of rainfall forecast which adopted the 3-hour moving average with 2-hour time lag in a subbasin.

8.3 Determination of Moving Average in Subbasins

Trial forecasting example which adopts the 3 hour moving average method for rainfall forecast for 1987-year flood in the Körkün subbasin is made as an example. The results show that the forecasting error is within 15%.

9. FLOOD FORECASTING PROCEDURE FOR RUNOFF SIMULATION MODEL

9.1 General Procedure

The general flood forecasting procedure for runoff simulation to be applied for the Seyhan River basin is shown in Figure 9.1.1.

Referring to Figure 9.1.1, the general concepts of the forecasting procedure are briefly explained below.

9.2 Data Required

To execute the runoff simulation by the computer program, the following data are required:

(a) Telemetered data from the hydrometeorological observation network (each time interval)
- Rainfall
- Temperature
- River water level
- Reservoir water level at Çatalan Dam

(b) Operational data at Çatalan Dam (each time interval)
- Gate openings
- Power generation

(c) Other data (incorporated in advance)
- Parameters for storage function basin and river models (for both non-snowmelt and snowmelt seasons)
- Rating curve at each water level gauging station
- Relationship between reservoir water level and reservoir storage volume at Çatalan Dam
- Relationship among reservoir water level, gate openings and spillway discharge at Çatalan Dam
- Relationship between power generation and utilized water to be released at Çatalan Dam
- Latest information on snow line elevation and snow depth in each subbasin

9.3 Mean Basin Rainfall for Each Subbasin

Mean basin rainfall is estimated for each subbasin by the Thiessen method which is determined by the hydrometeorological study.

9.4 Rainfall Forecast

Moving average method is to be incorporated for rainfall forecast in the forecasting procedure.

9.5 Conversion of Water Level into Discharge

Observed water level data at the telemetering water level gauging stations are converted to discharge using the latest rating curve which is prepared in advance for each station.

9.6 Reservoir Operation at Catalan Dam

As shown in Figure 9.1.1, which is describing the flood forecasting model diagram of the Seyhan River basin, the runoff simulation shall involve the flood operation at the Çatalan Dam as a major subbasin.

In this respect, the calculation of dam discharge to be released from the Çatalan Dam shall be incorporated in the forecasting procedure.

Dam discharge to be released is estimated on the basis of the forecast inflow and the actual fluctuation of the reservoir water level in accordance with the flood control operation rule.

The reservoir routing procedure is as follows:

(a) Calculation of the actual reservoir inflow based on the information on gate openings, power generation and reservoir water level.

$$Qt = ((St\text{-}1) - St) / T + Qs + Qp$$

where,

Qt : Reservoir inflow (m^3/sec)

St : Storage volume (m^3) at time of t converted from the observed reservoir water level at time of t

St-1 : Storage volume (m^3) at time of t-1 converted from the observed reservoir water level at time of t-1

T : Time interval (sec) between time of t-1 and t

Qs : Average outflow from spillway gate (m^3/sec)
Qp : Average outflow from power generation (m^3/sec)

(b) Calculation of rainfall forecast based on the information on the observed rainfall data.

(c) Calculation of forecast inflow by the storage function model on the basis of the forecast rainfall.

(d) Calculation of the dam discharge to be released in accordance with the flood control operation rule.

9.7 Runoff Calculation

Runoff calculation consists of the following three computations:

(a) Rainfall runoff from each subbasin (13 subbasins) by storage function basin model

(b) Snowmelt runoff from each subbasin (9 subbasins) by simple snowmelt runoff model

(c) River routing (6 river channels) by storage function river model

Flood forecasting by runoff simulation is to be performed for each river channel applying the model diagram discussed in Chapter 5.

Base points for water level observation and forecast are assumed to be located just downstream of a river channel. The general concepts of the runoff simulation adopted in the forecasting procedure are as follows:

(a) The inflow to a river channel is the forecast runoff at the upstream base point.

(b) The inflow to a river channel is the forecast runoff from a subbasin, if the upstream base point does not exist.

(c) The inflow to a river channel is once stored in the river channel and the stored inflow is discharged from the river channel to the base point in question with a lag time.

(d) The forecast runoff from a subbasin between the upstream base point and the base point in question is added to the discharged runoff from the river channel.

(e) Accordingly, the forecast runoff is calculated through the combination of both the forecast runoffs from a river and a subbasin.

For the T-th time of forecasting, the observed discharges at the base point in question and the upstream base point are obtained based on the observed water level.

For the time T + 1 to T + lead time, the forecast inflow from the upper river channel is calculated by the river routing using the forecast runoff at the upper base point.

Subsequently, the forecast outflow from a subbasin is also estimated for the T +1 to T + lead time by the runoff calculation using the forecast rainfall. In this calculation the difference between the observed discharge values at the upstream base point for the time T-lag time of the river channel and the base point in question for the time T is used as an initial discharge from a subbasin for the time T.

Accordingly, the forecast hydrograph at the base point in question in the period of T + 1 to T + lead time is to be obtained.

For the next time step of T + 1, the observed discharge is updated at the water level gauging stations. Therefore, by using the updated discharge, the above mentioned forecasting procedure is repeated until the flood is judged to be terminated.

10. RECOMMENDATIONS

10.1 Observation of Flood

Both DSI and EIE carry out the observation of flood in the main stream together with the major tributaries. The observed data are valuable for the establishment of the flood forecasting model with higher accuracy.

The storage function basin and river models and simple snowmelt runoff model are established for the Seyhan River basin through the past major flood records by the Study. And the estimated flood hydrographs show the sufficient goodness of fit to the observed ones from the forecasting viewpoints.

However, it is considered that more accurate and reliable models shall be developed and established against several types of flood before the forecasting system is installed where the updated models are to be loaded in the proposed computer system.

In view of the above, the following works and studies are to be carried out by both DSİ and EİE:

(a) Continuation of flood observation
(b) Continuation of periodical discharge measurement
(c) Updating of rating curves
(d) Continuation of snow depth and related observations

10.2 Observation of Snow

For the better estimate of snowmelt and reliable forecast of snowmelt runoff in each subbasin, frequent observation and quick estimate of snow line elevation in subbasins during snowmelt season are needed for flood forecasting system.

10.3 Flood Studies

In connection with the observation of flood, hydrometeorological data at the representative gauging stations of the proposed telemetering observation network shall be continually collected and compiled in the data base of the computer.

The compiled data are to be utilized to establish the more reliable flood forecasting models for the whole river basin through the flood studies since the flood forecast can be realized by the runoff calculation from subbasins and river routing of the flood in the river.

Reflecting upon the above, the calibration of flood runoff models shall be carried out to improve the forecasting accuracy. The following items for analysis are to be reviewed and improved if necessary:

(a) Hydraulic and hydrologic parameters for the storage function basin model in the subbasins
(b) Hydraulic parameters for the storage function river models in the rivers
(c) Rating curves at the water level stations
(d) Water stage correlations, if possible, among water level gauging stations
(e) Time lags among water level gauging stations
(f) Confirmation of the representativity of the selected rainfall gauging stations
(g) Classification of the typical rainfall patterns causing flood, if possible

10.4 Rainfall Forecast

It is recommended that DSİ shall apply the proposed rainfall forecast to the existing off-line flood forecasting system at Seyhan and Çatalan dams prior to the installation of the proposed FFWS to assess the forecasting accuracy.

In this respect, the softwares to forecast the reservoir inflow shall be prepared by DSİ with the aid of the Study. The forecast inflows by the several trial calculations i case of the actual flood are to be compared with the observed inflows computed on the basis of the reservoir water level and the released discharge from the dam.

10.5 Extension of Observation Network

The computerized flood forecasting system proposed herein can be established at the time of the installation of telemetering system and computer system. However, this system bring the low accuracy in flood forecast for several occurrences of flood in future because of the poor rainfall gauging network from the hydrometeorological viewpoint of gauging density in the whole basin. The proposed system shall be considered to be an urgent plan against the overall plan.

In this respect, the future extension to enhance the flood forecasting system in the whole Seyhan River basin shall be followed by the hydrological studies based on the telemetered flood data as given below:

(a) Study on the reliability of the representativity of the telemetering rainfall gauging station

(b) Study on the additional representative rainfall gauging stations, if necessary

(c) Study on the additional water level gauging stations from the following viewpoints:
- To supplement flood observations in the significant tributaries
- To add the significant tributaries
- To attain or improve the forecasting accuracy
- To afford the effective information in warning operations

In parallel with the above, the following examinations might be included in the future extension:

(a) Introduction of the Radar rain gauge observation system to intensively supplement the rainfall observation network

(b) Introduction of the filtering technique to the storage function model for the betterment of the flood forecasting procedure

(c) Introduction of the more accurate snowmelt runoff model

Tables

Table 3.1.1 List of DSİ and DMİ Rainfall Gauging Stations (1/2)

Station Name	Name of River Basin	Elevation (m)	First Year of Record	Last Year of Record	Complete Years	Records held by	Remarks
Adana	Seyhan	20	1,929	1,992	64	DMİ	Auto
Camlıyayla	-	625	1,964	1,992	27	DMİ	
Çatalan	Seyhan	65	1,954	1,992	31	DMİ	
Çokak	Ceyhan	1,350	1,969	1,992	23	DMİ	
Feke	Göksu	620	1,942	1,992	51	DMİ	Auto
Gülek	-	950	1,957	1,992	34	DMİ	
İmamoğlu	-	100	1,963	1,992	30	DMİ	
Kamışlı	Körkün	1,225	1,963	1,992	30	DSİ	
Karaisalı	Üçürge	400	1,950	1,992	41	DMİ	Auto
Karsantı	Seyhan	860	1,960	1,992	-	DMİ	
Kozan	Ceyhan	150	1,951	1,992	42	DMİ	Auto
Kozan Brj.	Ceyhan	150	1,967	1,992	26	DSİ	
Mansurlu	Göksu	1,050	1,964	1,992	-	DMİ	
Pozantı	Çakıt	778	1,937	1,988	32	DMİ	
Saimbeyli	Göksu	1,100	1,957	1,992	36	DMİ	
Seyhan Brj.	Seyhan	55	1,974	1,992	19	DSİ	
Tarsus	-	33	1,950	1,992	41	DMİ	
Tufanbeyli	Göksu	1,350	1,957	1,992	31	DMİ	
Bakırdağ	Zamantı	1,300	1,960	1,992	-	DMİ	
Develi	-	1,180	1,951	1,992	42	DMİ	Auto
Elbaşı	Zamantı	1,425	1,965	1,992	28	DMİ	
Kaynar	Zamantı	1,550	1,964	1,992	29	DMİ	
Kazancık	Zamantı	1,585	1,966	1,992	27	DSİ	
Musahacılı	-	950	1,974	1,992	19	DSİ	
Örenşehir	Zamantı	1,600	1,964	1,992	29	DMİ	
Pazarören	Zamantı	1,500	1,964	1,992	29	DMİ	
Pınarbaşı	Zamantı	1,470	1,950	1,992	43	DMİ	Auto
Sarız	Göksu	1,500	1,951	1,992	42	DMİ	Auto
Şıhlı	Zamantı	1,400	1,969	1,992	24	DMİ	
Toklar	Zamantı	1,400	1,965	1,988	24	DMİ	
Tomarza	Zamantı	1,400	1,963	1,992	30	DMİ	
Uzunpınar	Zamantı	1,740	1,960	1,992	33	DMİ	

Table 3.1.1 List of DSİ and DMİ Rainfall Gauging Stations (2/2)

Station Name	Name of River Basin	Elevation (m)	First Year of Record	Last Year of Record	Complete Years	Records held by	Remarks
Yahyalı	-	1,260	1,964	1,992	28	DMİ	
M. Başören	Zamantı	1,670	1,967	1,992	26	DSİ	
Yazyurdu	-	1,750	1,965	1,992	28	DMİ	
Göksun	-	1,344	1,954	1,992	39	DMİ	Auto
Akkaya Brj.	-	1,195	1,966	1,992	27	DSİ	
Bor	-	1,100	1,964	1,992	-	DMİ	
Çamardı	Körkün	1,500	1,961	1,992	-	DMİ	Auto
Çiftehan	Çakıt	1,000	1,954	1,992	-	DMİ	
Ereğli	-	1,044	1,950	1,992	43	DMİ	Auto
Gümüşler	-	1,340	1,972	1,992	21	DSİ	
Konaklı	-	1,265	1,966	1,992	-	DSİ	
Niğde	-	1,208	1,935	1,992	58	DMİ	Auto
Ulukışla	Çakıt	1,451	1,929	1,992	59	DMİ	Auto
Zanapa	-	1,175	1,966	1,992	27	DMİ	

Table 3.1.2 List of DSİ Stream Gauging Stations (Under Operation) 1/2

Station No.	Station Name	River	Latitude	Longitude	Elevation (m)	Catchment Area (km²)	Evaluated Data Period (Water Year) 1930–1990
18-08	Tacin	Tacin	-	-	1,536	9.9	1964 1987 1989 1991
18-12	Kamışlı	Körkün	-	-	1,109	1,065.0	1971 1979 1981 1992
18-16	Nergizlik	Üçürge	-	-	400	121.0	1978 1992
18-17	Darıdere	Göksu	-	-	1,542	315.6	1983 1991
18-18	Hasan Çavuslar	İnderesi	-	-	1,400	136.0	1982 1992
18-19	Feke	Asmaca	-	-	550	619.0	1982 1992
18-20	B. Çakır	Zamantı	-	-	586	7,769.3	1983 '86 '88
18-21	Kapuz	Kapuz	-	-	618	394.5	1986 1988
18-22	B.Sofulu	Aksu	-	-	960	98.0	1986 1992
18-23	Yeniköy	Yağdeğleme	-	-	870	23.5	1986 1992
18-24	Çamlıca	Yayla	-	-	865	173.7	1987 1988
18-25	Çamlıca Köp	Zamantı	-	-	860	7,418.0	1987 1988
18-26	Çamlıca Köyü	Zamantı	-	-	850	7,594.1	1987
18-27	Elekgölü Köp	Ecemiş	-	-	1,550	1,833.0	
18-28	Çukurbey	Ecemiş	-	-	-	-	
18-29	Değirmenocağı	Zamantı	-	-	721	7,674.6	
18-30	Mustafa Oruç	Zamantı	-	-	626	7,754.5	
18-31	Göktaş	Zamantı	-	-	500	8,291.5	
18-32	Şarköy	Göksu	-	-	1,400	752.4	1989 1992

Table 3.1.2 List of DSİ Stream Gauging Stations (Under Operation)

2/2

Station		River	Latitude	Longitude	Elevation	Catchment Area	Evaluated Data Period (Water Year)						
No.	Name				(m)	(km²)	1930	1940	1950	1960	1970	1980	1990
18-33	Akgedik	Demirözü	-	-	-	-						1990	1992
18-34	Hocalı	Deliçay	-	-	115	35.4						1991	1992
18-35	Kazaklıpınar	Bağlama	-	-	1,660	10.9							

Table 3.1.3 List of DSİ Stream Gauging Stations (Closed)

No.	Name	River	Latitude	Longitude	Elevation (m)	Catchment Area (km²)	Evaluated Data Period (Water Year) 1930–1990
18-01	Eğner	Seyhan	-	-	190	13,780.0	1960 1965 1968
18-03	Sol. Sh. Sul. Kn.	Seyhan	-	-	26	-	
18-04	Demirköprü	Seyhan	-	-	25	19,376.0	1959 1961
18-05	Hacılı	Körkün	-	-	255	1,454.0	1959 61 64 66 71
18-06	Şekerpınarı	Çakıt	-	-	800	1,234.0	1961 1962
18-07	Bakırdağ	Zamantı	-	-	1,297	6,158.0	1964 1968
18-09	Örencik	Beypınar	-	-	1,562	36.0	1966 1979
18-10	Yeniköy	Terece	-	-	1,494	26.9	1967
18-11	Emeğil	Zamantı	-	-	1,451	2,751.2	1967 1971
18-13	Saydere	Saydere	-	-	223	16.0	
18-14	Hacıhasanlı	Üçürge	-	-	222	144.9	1971 1972
18-15	Göl Gözlem	Seyhan	-	-	-	-	

Table 3.1.4 List of EİE Stream Gauging Stations (Under Operation)

Station No.	Station Name	River	Latitude	Longitude	Elevation (m)	Catchment Area (km²)	Evaluated Data Period (Water Year)
1801	Himmetli	Göksu	37-51'-57"N	36-03'-34"E	665	2,596.8	1936–1989
1805	Gökdere	Göksu	37-36'-49"N	35-36'-50"E	350	4,242.8	1939–1989
1818	Üçtepe	Seyhan	37-22'-19"N	35-29'-03"E	100	13,846.0	1962–1989
1820	Hacılıköprü	Körkün	37-17'-44"N	35-09'-04"E	170	1,440.8	1969–1989
1822	Fraktın	Zamantı	30-14'-41"N	35-37'-33"E	1,270	6,334.8	1969–1989
1823	Emeğil	Zamantı	37-39'-15"N	35-34'-35"E	1,451	2,756.0	1974–1989
1824	Çukurkışla	Göksu	-	-	1,200	1,526.4	1979–1989
1825	Eğribük	Eğlence	37-21'-50"N	35-11'-35"E	222	602.0	1987–1989
1826	Ergenuşağı	Zamantı	37-39'-54"N	35-34'-44"E	347	8,698.1	1988–1989
1827	Değirmen	Zamantı	37-51'-19"N	35-29'-08"E	760	7,718.0	1988–1989
1828	Salbaş	Çakıt	37-06'-23"N	35-06'-26"E	80	1,896.9	
1829	Kamışlı	Körkün	37-33'-23"N	34-57'-22"E	1,107	1,065.0	
1830	Karakuz	Körkün	37-29'-00"N	35-04'-10"E	900	-	

Table 3.1.5 List of EİE Stream Gauging Stations (Closed)

Station No.	Station Name	River	Latitude	Longitude	Elevation (m)	Catchment Area (km²)	Evaluated Data Period (Water Year) 1930–1990
1802	Faraşa	Zamantı	-	-	1,000	7,558.0	1936 1954
1803	Fraktın	Zamantı	-	-	1,265	6,788.8	1939 1944
1804	Söğütlü	Zamantı	-	-	1,345	4,389.2	1941 1955 1962 1968
1806	Ergenuşağı	Zamantı	-	-	347	8,698.4	1939 1956 1961 1979
1807	Taşköprü	Seyhan	-	-	22	19,352.4	1953 1955 1971 1972
1808	Çatalan	Seyhan	-	-	100	14,416.4	
1809	Çakıt	Çakıt	-	-	80	2,925.6	1953 1955
1810	Elekgölü	Ecemiş	-	-	1,385	289.2	1962
1811	Boztahta	Eğlence	-	-	254	546.0	1966 1970
1812	Pınarbaşı	Zamantı	-	-	1,425	2,623.2	1955 1973
1813	Çerkezkaraboğazı	Zamantı	-	-	1,521	2,144.4	1962 1974
1814	Malıhıdırlı	Seyhan	-	-	88	14,006.0	1954 1966
1815	Salbaşköy	Çakıt	-	-	125	1,826.8	1959 1963
1816	Yukarı Karagöz	Karagöz	-	-	1,450	137.2	1962 1966
1817	Arapali	Çakıt	-	-	150	1,582.4	1964 '66'68 1971 1979 1981 1989
1819	Şekerpınarı	Çakıt	-	-	800	1,220.0	1969 1970
1821	Sarımehmetli	Eğlence	-	-	75	628.8	1970 1986

Table 3.1.6 List of DSİ and EİE Snow Measurement Stations

Station Name	Name of River Basin	Latitude	Longitude	Elevation (m)	First Year of Record	Records held by
Tekir	Çakıt	34-48'-15"N	37-20'-00"E	1,200	1,979	DSİ
Ulukışla	Çakıt	-	-	1,500	1,979	DSİ
Hamidiye	Körkün	-	-	1,400	1,972	EİE
Çamardı	Körkün	-	-	1,650	1,973	EİE
Karsantı	Seyhan	35-23'-45"N	37-30'-45"E	1,100	1,979	DSİ
Madazı	Zamantı	-	-	1,300	1,978	EİE
Bakırdağ	Zamantı	-	-	1,300	1,978	EİE
Sıhbarak	Zamantı	-	-	1,370	-	DSİ
Pazarören	Zamantı	-	-	1,830	-	DSİ
Tacin	Zamantı	-	-	1,500	-	DSİ
Kazancık	Zamantı	-	-	1,585	-	DSİ
Çukryurt	Zamantı	-	-	1,950	1,974	EİE
Gezbeli	Zamantı	-	-	1,950	1,973	EİE
Yedioluk	Zamantı	-	-	1,760	1,978	EİE
Maraşlı	Zamantı	-	-	1,800	1,971	EİE
Ziyarettepesi	Zamantı	-	-	2,100	1,969	EİE
Doğanbeyli	Göksu	36-08'-15"N	38-07'-30"E	1,400	1,974	DSİ
Say.-Tuf	Göksu	-	-	1,450	1,974	DSİ
Avcıpınarı	Göksu	36-00'-20"N	38-00'-00"E	1,450	1,974	DSİ
Hostahone	Göksu	36-16'-00"N	38-14'-10"E	1,350	1,974	DSİ
Yalak	Göksu	-	-	1,540	1,978	EİE
Sarız	Göksu	-	-	1,670	1,978	EİE

Table 4.1.1 List of Collected Rainfall Data(1/3)

Station	River Basin	EL. (m)	First Year of Record	Last Year of Record	Complete Years	Records held by	Collected Rainfall Data																			
							'37 Dec.	'46 May	'47 Nov.-Dec.	'48 Feb.	'50 May	'52 Feb.	'52 Mar.	'52 Apl.	'53 Apl.	'57 Jun.	'57 Jul.	'57 Dec.	'61 Dec.	'69 Dec.-'70 Jan.	'72 Jun.	'73 May	'73 Jun.	'75 Apl.-May	'80 Mar.-Apl.	'87 Dec.
Çatalan	Seyhan	65	1,954	1,992	31	DMİ																				
Karsantı	Seyhan	860	1,960	1,992	-	DMİ																				
Seyhan Brj.	Seyhan	55	1,974	1,992	19	DSİ																				
Çiftehan	Çakıt	1,000	1,954	1,992	-	DMİ																				
Pozantı*	Çakıt	778	1,937	1,988	32	DMİ																				
Karaisalı*	Üçürge	400	1,950	1,992	41	DMİ																				
Kamışlı	Körkün	1,225	1,963	1,992	30	DSİ																				
Çamardı*	Körkün	1,500	1,961	1,992	-	DMİ																				
Feke*	Göksu	620	1,942	1,992	51	DMİ																				
Mansurlu*	Göksu	1,050	1,964	1,992	-	DMİ																				
Saimbeyli	Göksu	1,100	1,957	1,992	36	DMİ																				
Tufanbeyli	Göksu	1,350	1,957	1,992	31	DMİ																				
Sarız*	Göksu	1,500	1,951	1,992	42	DMİ																				
Bakırdağ	Zamantı	1,300	1,960	1,992	-	DMİ																				
Elbaşı	Zamantı	1,425	1,965	1,992	28	DMİ																				
Kaynar	Zamantı	1,550	1,964	1,992	29	DMİ																				
Kazancık	Zamantı	1,585	1,966	1,992	27	DSİ																				
Örenşehir	Zamantı	1,600	1,964	1,992	29	DMİ																				
Pazarören	Zamantı	1,500	1,964	1,992	29	DMİ																				

* Station with Pluviograph

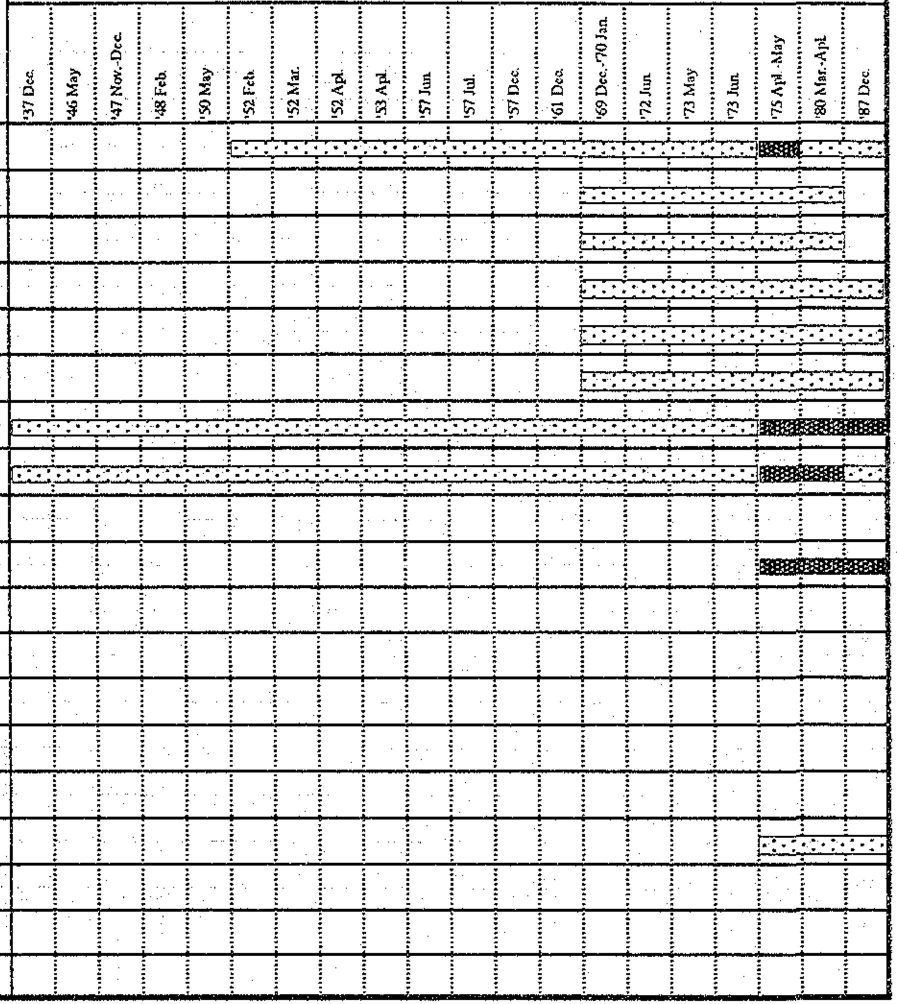
Daily Rainfall

Daily and Hourly Rainfall

Table 4.1.1 List of Collected Rainfall Data(2/3)

Station	River Basin	EL. (m)	First Year of Record	Last Year of Record	Complete Years	Records held by
Pınarbaşı*	Zamantı	1,470	1,950	1,992	43	DMİ
Şıhlı	Zamantı	1,400	1,969	1,992	24	DMİ
Toklar	Zamantı	1,400	1,965	1,988	24	DMİ
Tomarza	Zamantı	1,400	1,963	1,992	30	DMİ
Uzunpınar	Zamantı	1,740	1,960	1,992	33	DMİ
M. Boşören	Zamantı	1,670	1,967	1,992	26	DSİ
Adana*	-	20	1,929	1,992	64	DMİ
Ulukışla*	-	1,451	1,929	1,992	59	DMİ
Çokak	-	1,350	1,969	1,992	23	DMİ
Kozan*	-	150	1,951	1,992	42	DMİ
Kozan Brj.	-	150	1,967	1,992	26	DSİ
Camlıyayla	-	625	1,964	1,992	27	DMİ
Gülek	-	950	1,957	1,992	34	DMİ
İmamoğlu	-	100	1,963	1,992	30	DMİ
Tarsus	-	33	1,950	1,992	41	DMİ
Develi*	-	1,180	1,951	1,992	42	DMİ
Musahacılı	-	950	1,974	1,992	19	DSİ
Yahyalı	-	1,260	1,964	1,992	28	DMİ
Yazyurdu	-	1,750	1,965	1,992	28	DMİ

Collected Rainfall Data



* Station with Pluviograph

Daily Rainfall

Daily and Hourly Rainfall

Table 4.1.1 List of Collected Rainfall Data(3/3)

Station	River Basin	EL. (m)	First Year of Record	Last Year of Record	Complete Years	Records held by	Collected Rainfall Data																			
							'37 Dec.	'46 May	'47 Nov.-Dec.	'48 Feb.	'50 May	'52 Feb.	'52 Mar.	'52 Apl.	'53 Apl.	'57 Jun.	'57 Jul.	'57 Dec.	'61 Dec.	'69 Dec.-'70 Jan.	'72 Jun.	'73 May	'73 Jun.	'75 Apl.-May	'80 Mar.-Apl.	'87 Dec.
Göksun*	-	1,344	1,954	1,992	39	DMİ																		■		□
Akkaya Brj.	-	1,195	1,966	1,992	27	DSİ																				
Bor	-	1,100	1,964	1,992	-	DMİ																				
Ereğli*	-	1,044	1,950	1,992	43	DMİ																		■		□
Gümüşler	-	1,340	1,972	1,992	21	DSİ																				
Konaklı	-	1,265	1,966	1,992	-	DSİ																				
Niğde*	-	1,208	1,935	1,992	58	DMİ																		■	■	□
Zanapa	-	1,175	1,966	1,992	27	DMİ																				

* Station with Pluviograph
□ Daily Rainfall
■ Daily and Hourly Rainfall

Table 5.2.1 The Results of the Estimate of Hourly Rainfall Patterns of the Representative Rainfall Stations

Rainfall Gauging Station \ Flood	1975 Flood		1980 Flood		1987 Flood
	Apr.17 - 23	Apr.25 - May 1	Mar.24 - 30	Apr.2 - 8	Dec.20 - 25
Available Hourly Rainfall Records					
Adana	√	√	√	√	√
Feke	√	√	√	√	√
Karaisalı	√	√	√	√	√
Kozan	√	√	√	√	√
Pozantı	√	√		√	
Pınarbaşı		√		√	
Ereğli	√	√		√	
Ulukışla	√	√		√	
Niğde		√		√	
Adopted Rainfall Pattern for the Representative Rainfall Station					
Çatalan	Karaisalı	Karaisalı	Karaisalı	Pozantı	Karaisalı
Karsantı	Feke	Feke	Karaisalı	Pozantı	Feke
Çiftehan	Pozantı	Feke	Karaisalı	Pınarbaşı	Karaisalı
Pozantı	√	√	Karaisalı	√	Karaisalı
Karaisalı	√	√	√	√	√
Kamışlı	Pozantı	Karaisalı	Karaisalı	Pozantı	Karaisalı
Çamardı	Karaisalı	Feke	Karaisalı	Pozantı	Karaisalı
Feke	√	√	√	√	√
Mansurlu	Feke	Kozan	Feke	Feke	Feke
Saimbeyli	Feke	Feke	Feke	Feke	Feke
Kazancık	Ereğli	Feke	Feke	Feke	Kozan
Pınarbaşı	Karaisalı	√	Feke	√	Kozan
Şıhlı	Karaisalı	Feke	Feke	Feke	Adana
Toklar	Kozan	Feke	Feke	Feke	Feke
Tomarza	Karaisalı	Feke	Feke	Pınarbaşı	Feke
Tufanbeyli	Feke	Feke	Feke	Feke	Kozan

√ : with Pluviograph

Table 5.2.2 Multiple Regression Coefficient of the Representative Rainfall Gauging Stations

Sub - basin	Multiple Regression Coefficient (ai)																Constant
	Çatalan	Karsantı	Çiftehan	Pozantı*	Karaisalı*	Kamışlı	Çamardı*	Feke	Mansurlu*	Saimbeyli	Tufanbeyli	Kazancık	Pınarbaşı*	Şıhlı	Toklar	Tomarza	b
1 Zamantı up to 1822												0.263	0.318		0.129	0.307	0.140
2 Zamantı up to 1806		0.192							0.385					0.346			0.114
3 Göksu up to 1801										0.496	0.411						0.215
4 Göksu up to 1805								0.386	0.250	0.244							0.183
5 Zamantı - Göksu joint to Çatalan HWL		0.973															0.063
6 Eğlence up to 1825		0.367				0.608											0.017
7 Eğlence up to Seyhan R.	0.569				0.374												0.337
(7) (Eğlence up to Çatalan HWL)		(0.213)			(0.739)												(0.147)
8 Zamantı-Göksu after Çatalan HWL	0.681	0.325															-0.032
(8) (")	(0.722)	(0.289)															(-0.029)
9 Körkün up to 1820						0.425	0.571										0.008
10 Kürkön up to Seyhan HWL					0.965												0.117
11 Üçürge				0.273	0.724												0.016
12 Çatalan Brj.- Seyhan Brj.	0.534				0.462												0.024
13 Çakıt up to 1828			0.684		0.254												0.229

( ) : with Çatalan Dam
* : Station with Pluviograph

Table 6.7.1 The Results of the Estimate of Snowmelt Runoff (1/9)

Tomarza (1,400 Elm)
DMİ

1. Upper Zamantı
Emax=3,000 m
Emin=1,270 m

Year	Month	Date	Ti(1400)	t	Ts(1270)	As	Ef	Af	Am	Ts	Rs	Q(cmkm2)	Q(m3/s)
1980	3	1	-4.3	0.7	-3.39	0	785.71	0.00	0.00	-1.70	0.1	0.00	0.00
		2	-6.5	0.7	-5.59	0	471.43	0.00	0.00	-2.80	0.1	0.00	0.00
		3	-9.6	0.7	-8.69	0	28.57	0.00	0.00	-4.35	0.1	0.00	0.00
		4	-2.2	0.7	-1.29	0	1,085.71	0.00	0.00	-0.65	0.1	0.00	0.00
		5	-3.5	0.7	-2.59	0	900.00	0.00	0.00	-1.30	0.1	0.00	0.00
		6	-10.8	0.7	-9.89	0	-142.86	0.00	0.00	-4.95	0.1	0.00	0.00
		7	-5.3	0.7	-4.39	0	642.86	0.00	0.00	-2.20	0.1	0.00	0.00
		8	2.0	0.7	2.91	6,990	1,685.71	3,671.40	3,318.60	1.46	0.1	482.86	55.89
		9	2.5	0.7	3.41	6,990	1,757.14	3,010.40	3,979.60	1.71	0.1	678.52	78.53
		10	4.7	0.7	5.61	6,990	2,071.43	708.50	6,281.50	2.81	0.1	1,761.96	203.93
		11	0.4	0.7	1.31	6,990	1,457.14	5,688.14	1,301.86	0.66	0.1	85.27	9.87
		12	0.1	0.7	1.01	6,990	1,414.29	5,986.27	1,003.73	0.51	0.1	50.69	5.87
		13	-0.2	0.7	0.71	6,990	1,371.43	6,284.41	705.59	0.36	0.1	25.05	2.90
		14	-1.0	0.7	-0.09	0	1,257.14	0.00	0.00	-0.05	0.1	0.00	0.00
		15	0.8	0.7	1.71	6,990	1,514.29	5,290.62	1,699.38	0.86	0.1	145.30	16.82
		16	-2.0	0.7	-1.09	0	1,114.29	0.00	0.00	-0.55	0.1	0.00	0.00
		17	2.3	0.7	3.21	6,990	1,728.57	3,274.80	3,715.20	1.61	0.1	596.29	69.02
		18	0.4	0.7	1.31	6,990	1,457.14	5,688.14	1,301.86	0.66	0.1	85.27	9.87
		19	-2.9	0.7	-1.99	0	985.71	0.00	0.00	-1.00	0.1	0.00	0.00
		20	-2.7	0.7	-1.79	0	1,014.29	0.00	0.00	-0.90	0.1	0.00	0.00
		21	1.9	0.7	2.81	6,990	1,671.43	3,803.60	3,186.40	1.41	0.1	447.69	51.82
		22	4.9	0.7	5.81	6,990	2,100.00	686.70	6,303.30	2.91	0.1	1,831.11	211.93
		23	4.6	0.7	5.51	6,990	2,057.14	719.40	6,270.60	2.76	0.1	1,727.55	199.95
		24	5.5	0.7	6.41	6,990	2,185.71	621.30	6,368.70	3.21	0.1	2,041.17	236.25
		25	8.1	0.7	9.01	6,990	2,557.14	337.90	6,652.10	4.51	0.1	2,996.77	346.85
		26	8.6	0.7	9.51	6,990	2,628.57	283.40	6,706.60	4.76	0.1	3,188.99	369.10
		27	8.5	0.7	9.41	6,990	2,614.29	294.30	6,695.70	4.71	0.1	3,150.33	364.62
		28	5.2	0.7	6.11	6,990	2,142.86	654.00	6,336.00	3.06	0.1	1,935.65	224.03
		29	3.4	0.7	4.31	6,990	1,885.71	1,820.60	5,169.40	2.16	0.1	1,114.01	128.94
		30	5.5	0.7	6.41	6,990	2,185.71	621.30	6,368.70	3.21	0.1	2,041.17	236.25
		31	5.8	0.7	6.71	6,990	2,228.57	588.60	6,401.40	3.36	0.1	2,147.67	248.57

Table 6.7.1 The Results of the Estimate of Snowmelt Runoff (2/9)

Tomarza (1,400 Elm) 2. Lower Zamantı
DMİ Emax=3,600 m
Emin=347 m

Year	Month	Date	Ti(1400)	t	Ts(1250)	As	Ef	Af	Am	Ts	Rs	Q(cmkm2)	Q(m3/s)
1980	3	1	-4.3	0.7	-3.25	0.00	785.71	0.00	0.00	-1.63	0.1	0.00	0.00
		2	-6.5	0.7	-5.45	0.00	471.43	0.00	0.00	-2.73	0.1	0.00	0.00
		3	-9.6	0.7	-8.55	0.00	28.57	0.00	0.00	-4.28	0.1	0.00	0.00
		4	-2.2	0.7	-1.15	0.00	1,085.71	0.00	0.00	-0.58	0.1	0.00	0.00
		5	-3.5	0.7	-2.45	0.00	900.00	0.00	0.00	-1.23	0.1	0.00	0.00
		6	-10.8	0.7	-9.75	0.00	-142.86	0.00	0.00	-4.88	0.1	0.00	0.00
		7	-5.3	0.7	-4.25	0.00	642.86	0.00	0.00	-2.13	0.1	0.00	0.00
		8	2.0	0.7	3.05	1,312.00	1,685.71	738.17	573.83	1.53	0.1	87.51	10.13
		9	2.5	0.7	3.55	1,312.00	1,757.14	656.31	655.69	1.78	0.1	116.38	13.47
		10	4.7	0.7	5.75	1,312.00	2,071.43	361.13	950.88	2.88	0.1	273.38	31.64
		11	0.4	0.7	1.45	1,312.00	1,457.14	1,179.43	132.57	0.73	0.1	9.61	1.11
		12	0.1	0.7	1.15	1,312.00	1,414.29	1,206.86	105.14	0.58	0.1	6.05	0.70
		13	-0.2	0.7	0.85	1,312.00	1,371.43	1,234.29	77.71	0.43	0.1	3.30	0.38
		14	-1.0	0.7	0.05	1,312.00	1,257.14	0.00	1,312.00	0.03	0.1	3.28	0.38
		15	0.8	0.7	1.85	1,312.00	1,514.29	934.63	377.37	0.93	0.1	34.91	4.04
		16	-2.0	0.7	-0.95	0.00	1,114.29	0.00	0.00	-0.48	0.1	0.00	0.00
		17	2.3	0.7	3.35	1,312.00	1,728.57	689.06	622.94	1.68	0.1	104.34	12.08
		18	0.4	0.7	1.45	1,312.00	1,457.14	1,179.43	132.57	0.73	0.1	9.61	1.11
		19	-2.9	0.7	-1.85	0.00	985.71	0.00	0.00	-0.93	0.1	0.00	0.00
		20	-2.7	0.7	-1.65	0.00	1,014.29	0.00	0.00	-0.83	0.1	0.00	0.00
		21	1.9	0.7	2.95	1,312.00	1,671.43	754.54	557.46	1.48	0.1	82.22	9.52
		22	4.9	0.7	5.95	1,312.00	2,100.00	354.38	957.63	2.98	0.1	284.89	32.97
		23	4.6	0.7	5.65	1,312.00	2,057.14	364.50	947.50	2.83	0.1	267.67	30.98
		24	5.5	0.7	6.55	1,312.00	2,185.71	334.13	977.88	3.28	0.1	320.25	37.07
		25	8.1	0.7	9.15	1,312.00	2,557.14	246.38	1,065.63	4.58	0.1	487.52	56.43
		26	8.6	0.7	9.65	1,312.00	2,628.57	229.50	1,082.50	4.83	0.1	522.31	60.45
		27	8.5	0.7	9.55	1,312.00	2,614.29	232.87	1,079.13	4.78	0.1	515.28	59.64
		28	5.2	0.7	6.25	1,312.00	2,142.86	344.25	967.75	3.13	0.1	302.42	35.00
		29	3.4	0.7	4.45	1,312.00	1,885.71	508.97	803.03	2.23	0.1	178.67	20.68
		30	5.5	0.7	6.55	1,312.00	2,185.71	334.13	977.88	3.28	0.1	320.25	37.07
		31	5.8	0.7	6.85	1,312.00	2,228.57	324.00	988.00	3.43	0.1	338.39	39.17

Table 6.7.1 The Results of the Estimate of Snowmelt Runoff (3/9)

Feke (620 Elm)
DMİ

3. Upper Göksü
Emax=3,000 m
Emin=665 m

Year	Month	Date	Temp.	t	Ts(1250)	As	Ef	Af	Am	Ts	Rs	Q(cmkm2)	Q(m3/s)
1980	3	1	2.5	0.7	-1.91	0	977.14	0.00	0.00	-0.955	0.1	0.00	0.00
		2	3.2	0.7	-1.21	0	1,077.14	0.00	0.00	-0.605	0.1	0.00	0.00
		3	3.5	0.7	-0.91	0	1,120.00	0.00	0.00	-0.455	0.1	0.00	0.00
		4	6.0	0.7	1.59	1,950	1,477.14	1,674.70	275.30	0.795	0.1	21.89	2.53
		5	4.9	0.7	0.49	1,950	1,320.00	1,865.16	84.84	0.245	0.1	2.08	0.24
		6	3.8	0.7	-0.61	0	1,162.86	0.00	0.00	-0.305	0.1	0.00	0.00
		7	5.4	0.7	0.99	1,950	1,391.43	1,778.59	171.41	0.495	0.1	8.48	0.98
		8	9.0	0.7	4.59	1,950	1,905.71	511.81	1,438.19	2.295	0.1	330.06	38.20
		9	8.6	0.7	4.19	1,950	1,848.57	671.70	1,278.30	2.095	0.1	267.80	31.00
		10	8.7	0.7	4.29	1,950	1,862.86	631.73	1,318.27	2.145	0.1	282.77	32.73
		11	8.0	0.7	3.59	1,950	1,762.86	911.53	1,038.47	1.795	0.1	186.41	21.57
		12	6.8	0.7	2.39	1,950	1,591.43	1,391.18	558.82	1.195	0.1	66.78	7.73
		13	7.3	0.7	2.89	1,950	1,662.86	1,191.33	758.67	1.445	0.1	109.63	12.69
		14	6.8	0.7	2.39	1,950	1,591.43	1,391.18	558.82	1.195	0.1	66.78	7.73
		15	6.5	0.7	2.09	1,950	1,548.57	1,511.10	438.90	1.045	0.1	45.87	5.31
		16	8.8	0.7	4.39	1,950	1,877.14	591.75	1,358.25	2.195	0.1	298.13	34.51
		17	9.5	0.7	5.09	1,950	1,977.14	311.95	1,638.05	2.545	0.1	416.88	48.25
		18	8.5	0.7	4.09	1,950	1,834.29	711.67	1,238.33	2.045	0.1	253.24	29.31
		19	8.6	0.7	4.19	1,950	1,848.57	671.70	1,278.30	2.095	0.1	267.80	31.00
		20	7.9	0.7	3.49	1,950	1,748.57	951.50	998.50	1.745	0.1	174.24	20.17
		21	10.8	0.7	6.39	1,950	2,162.86	207.61	1,742.39	3.195	0.1	556.69	64.43
		22	10.5	0.7	6.09	1,950	2,120.00	218.24	1,731.76	3.045	0.1	527.32	61.03
		23	13.3	0.7	8.89	1,950	2,520.00	119.04	1,830.96	4.445	0.1	813.86	94.20
		24	12.8	0.7	8.39	1,950	2,448.57	136.75	1,813.25	4.195	0.1	760.66	88.04
		25	14.9	0.7	10.49	1,950	2,748.57	62.35	1,887.65	5.245	0.1	990.07	114.59
		26	15.4	0.7	10.99	1,950	2,820.00	44.64	1,905.36	5.495	0.1	1,047.00	121.18
		27	10.6	0.7	6.19	1,950	2,134.29	214.70	1,735.30	3.095	0.1	537.08	62.16
		28	7.9	0.7	3.49	1,950	1,748.57	951.50	998.50	1.745	0.1	174.24	20.17
		29	8.9	0.7	4.49	1,950	1,891.43	551.78	1,398.22	2.245	0.1	313.90	36.33
		30	9.8	0.7	5.39	1,950	2,020.00	243.04	1,706.96	2.695	0.1	460.03	53.24
		31	11.2	0.7	6.79	1,950	2,220.00	193.44	1,756.56	3.395	0.1	596.35	69.02

Table 6.7.1 The Results of the Estimate of Snowmelt Runoff (4/9)

Feke (620 Elm)
DMİ

4. Lower Göksu
Emax=3,000 m
Emin=350 m

Year	Month	Date	Temp.	t	Ts(1250)	As	Ef	Af	Am	Ts	Rs	Q(cmkm2)	Q(m3/s)
1980	3	1	2.5	0.7	-1.91	0	977.14	0.00	0.00	-0.955	0.1	0.00	0.00
		2	3.2	0.7	-1.21	0	1,077.14	0.00	0.00	-0.605	0.1	0.00	0.00
		3	3.5	0.7	-0.91	0	1,120.00	0.00	0.00	-0.455	0.1	0.00	0.00
		4	6.0	0.7	1.59	1,125	1,477.14	780.65	344.35	0.795	0.1	27.38	3.17
		5	4.9	0.7	0.49	1,125	1,320.00	1,018.88	106.12	0.245	0.1	2.60	0.30
		6	3.8	0.7	-0.61	0	1,162.86	0.00	0.00	-0.305	0.1	0.00	0.00
		7	5.4	0.7	0.99	1,125	1,391.43	910.59	214.41	0.495	0.1	10.61	1.23
		8	9.0	0.7	4.59	1,125	1,905.71	218.57	906.43	2.295	0.1	208.03	24.08
		9	8.6	0.7	4.19	1,125	1,848.57	292.86	832.14	2.095	0.1	174.33	20.18
		10	8.7	0.7	4.29	1,125	1,862.86	274.29	850.71	2.145	0.1	182.48	21.12
		11	8.0	0.7	3.59	1,125	1,762.86	404.29	720.71	1.795	0.1	129.37	14.97
		12	6.8	0.7	2.39	1,125	1,591.43	627.14	497.86	1.195	0.1	59.49	6.89
		13	7.3	0.7	2.89	1,125	1,662.86	534.29	590.71	1.445	0.1	85.36	9.88
		14	6.8	0.7	2.39	1,125	1,591.43	627.14	497.86	1.195	0.1	59.49	6.89
		15	6.5	0.7	2.09	1,125	1,548.57	682.86	442.14	1.045	0.1	46.20	5.35
		16	8.8	0.7	4.39	1,125	1,877.14	255.71	869.29	2.195	0.1	190.81	22.08
		17	9.5	0.7	5.09	1,125	1,977.14	125.71	999.29	2.545	0.1	254.32	29.43
		18	8.5	0.7	4.09	1,125	1,834.29	311.43	813.57	2.045	0.1	166.38	19.26
		19	8.6	0.7	4.19	1,125	1,848.57	292.86	832.14	2.095	0.1	174.33	20.18
		20	7.9	0.7	3.49	1,125	1,748.57	422.86	702.14	1.745	0.1	122.52	14.18
		21	10.8	0.7	6.39	1,125	2,162.86	80.37	1,044.63	3.195	0.1	333.76	38.63
		22	10.5	0.7	6.09	1,125	2,120.00	84.48	1,040.52	3.045	0.1	316.84	36.67
		23	13.3	0.7	8.89	1,125	2,520.00	46.08	1,078.92	4.445	0.1	479.58	55.51
		24	12.8	0.7	8.39	1,125	2,448.57	52.94	1,072.06	4.195	0.1	449.73	52.05
		25	14.9	0.7	10.49	1,125	2,748.57	24.14	1,100.86	5.245	0.1	577.40	66.83
		26	15.4	0.7	10.99	1,125	2,820.00	17.28	1,107.72	5.495	0.1	608.69	70.45
		27	10.6	0.7	6.19	1,125	2,134.29	83.11	1,041.89	3.095	0.1	322.47	37.32
		28	7.9	0.7	3.49	1,125	1,748.57	422.86	702.14	1.745	0.1	122.52	14.18
		29	8.9	0.7	4.49	1,125	1,891.43	237.14	887.86	2.245	0.1	199.32	23.07
		30	9.8	0.7	5.39	1,125	2,020.00	94.08	1,030.92	2.695	0.1	277.83	32.16
		31	11.2	0.7	6.79	1,125	2,220.00	74.88	1,050.12	3.395	0.1	356.52	41.26

Table 6.7.1 The Results of the Estimate of Snowmelt Runoff (5/9)

Pozanti (778 Elm)
DMI

5. 1818-Confluence
Emax=3500 m
Emin=100 m

Year	Month	Date	Temp.	t	Ts(1250)	As	Ef	Af	Am	Ts	Rs	Q(cmkm2)	Q(m3/s)
1980	3	1	0.3	0.7	-3.004	0	820.86	0.00	0.00	-1.502	0.1	0.00	0.00
		2	0.4	0.7	-2.904	0	835.14	0.00	0.00	-1.452	0.1	0.00	0.00
		3	0.8	0.7	-2.504	0	892.29	0.00	0.00	-1.252	0.1	0.00	0.00
		4	3.9	0.7	0.596	251	1,335.14	211.15	39.85	0.298	0.1	1.19	0.14
		5	4.6	0.7	1.296	251	1,435.14	164.35	86.65	0.648	0.1	5.61	0.65
		6	2.3	0.7	-1.004	0	1,106.57	0.00	0.00	-0.502	0.1	0.00	0.00
		7	4.0	0.7	0.696	251	1,349.43	204.47	46.53	0.348	0.1	1.62	0.19
		8	6.8	0.7	3.496	251	1,749.43	88.60	162.40	1.748	0.1	28.39	3.29
		9	7.8	0.7	4.496	251	1,892.29	62.60	188.40	2.248	0.1	42.35	4.90
		10	8.9	0.7	5.596	251	2,049.43	41.58	209.42	2.798	0.1	58.59	6.78
		11	3.0	0.7	-0.304	0	1,206.57	0.00	0.00	-0.152	0.1	0.00	0.00
		12	4.2	0.7	0.896	251	1,378.00	191.10	59.90	0.448	0.1	2.68	0.31
		13	4.7	0.7	1.396	251	1,449.43	157.67	93.33	0.698	0.1	6.51	0.75
		14	4.6	0.7	1.296	251	1,435.14	164.35	86.65	0.648	0.1	5.61	0.65
		15	7.9	0.7	4.596	251	1,906.57	60.00	191.00	2.298	0.1	43.89	5.08
		16	6.9	0.7	3.596	251	1,763.71	86.00	165.00	1.798	0.1	29.67	3.43
		17	7.8	0.7	4.496	251	1,892.29	62.60	188.40	2.248	0.1	42.35	4.90
		18	7.7	0.7	4.396	251	1,878.00	65.20	185.80	2.198	0.1	40.84	4.73
		19	8.0	0.7	4.696	251	1,920.86	57.40	193.60	2.348	0.1	45.46	5.26
		20	7.4	0.7	4.096	251	1,835.14	73.00	178.00	2.048	0.1	36.45	4.22
		21	8.4	0.7	5.096	251	1,978.00	47.00	204.00	2.548	0.1	51.98	6.02
		22	8.0	0.7	4.696	251	1,920.86	57.40	193.60	2.348	0.1	45.46	5.26
		23	10.0	0.7	6.696	251	2,206.57	37.08	213.92	3.348	0.1	71.62	8.29
		24	9.8	0.7	6.496	251	2,178.00	37.90	213.10	3.248	0.1	69.22	8.01
		25	12.8	0.7	9.496	251	2,606.57	25.61	225.39	4.748	0.1	107.01	12.39
		26	13.2	0.7	9.896	251	2,663.71	23.97	227.03	4.948	0.1	112.33	13.00
		27	12.3	0.7	8.996	251	2,535.14	27.66	223.34	4.498	0.1	100.46	11.63
		28	8.8	0.7	5.496	251	2,035.14	41.99	209.01	2.748	0.1	57.44	6.65
		29	7.8	0.7	4.496	251	1,892.29	62.60	188.40	2.248	0.1	42.35	4.90
		30	9.3	0.7	5.996	251	2,106.57	39.94	211.06	2.998	0.1	63.27	7.32
		31	10.7	0.7	7.396	251	2,306.57	34.21	216.79	3.698	0.1	80.17	9.28

Table 6.7.1 The Results of the Estimate of Snowmelt Runoff (5/9)

Pozantı (778 Elm) 5. 1818-Confluence
DMİ Emax=3,500 m
Emin=100 m

Year	Month	Date	Temp.	t	Ts(1250)	As	Ef	Af	Am	Ts	Rs	Q(cmkm2)	Q(m3/s)
1980	3	1	0.3	0.7	-3.004	0	820.86	0.00	0.00	-1.502	0.1	0.00	0.00
		2	0.4	0.7	-2.904	0	835.14	0.00	0.00	-1.452	0.1	0.00	0.00
		3	0.8	0.7	-2.504	0	892.29	0.00	0.00	-1.252	0.1	0.00	0.00
		4	3.9	0.7	0.596	251	1,335.14	211.15	39.85	0.298	0.1	1.19	0.14
		5	4.6	0.7	1.296	251	1,435.14	164.35	86.65	0.648	0.1	5.61	0.65
		6	2.3	0.7	-1.004	0	1,106.57	0.00	0.00	-0.502	0.1	0.00	0.00
		7	4.0	0.7	0.696	251	1,349.43	204.47	46.53	0.348	0.1	1.62	0.19
		8	6.8	0.7	3.496	251	1,749.43	88.60	162.40	1.748	0.1	28.39	3.29
		9	7.8	0.7	4.496	251	1,892.29	62.60	188.40	2.248	0.1	42.35	4.90
		10	8.9	0.7	5.596	251	2,049.43	41.58	209.42	2.798	0.1	58.59	6.78
		11	3.0	0.7	-0.304	0	1,206.57	0.00	0.00	-0.152	0.1	0.00	0.00
		12	4.2	0.7	0.896	251	1,378.00	191.10	59.90	0.448	0.1	2.68	0.31
		13	4.7	0.7	1.396	251	1,449.43	157.67	93.33	0.698	0.1	6.51	0.75
		14	4.6	0.7	1.296	251	1,435.14	164.35	86.65	0.648	0.1	5.61	0.65
		15	7.9	0.7	4.596	251	1,906.57	60.00	191.00	2.298	0.1	43.89	5.08
		16	6.9	0.7	3.596	251	1,763.71	86.00	165.00	1.798	0.1	29.67	3.43
		17	7.8	0.7	4.496	251	1,892.29	62.60	188.40	2.248	0.1	42.35	4.90
		18	7.7	0.7	4.396	251	1,878.00	65.20	185.80	2.198	0.1	40.84	4.73
		19	8.0	0.7	4.696	251	1,920.86	57.40	193.60	2.348	0.1	45.46	5.26
		20	7.4	0.7	4.096	251	1,835.14	73.00	178.00	2.048	0.1	36.45	4.22
		21	8.4	0.7	5.096	251	1,978.00	47.00	204.00	2.548	0.1	51.98	6.02
		22	8.0	0.7	4.696	251	1,920.86	57.40	193.60	2.348	0.1	45.46	5.26
		23	10.0	0.7	6.696	251	2,206.57	37.08	213.92	3.348	0.1	71.62	8.29
		24	9.8	0.7	6.496	251	2,178.00	37.90	213.10	3.248	0.1	69.22	8.01
		25	12.8	0.7	9.496	251	2,606.57	25.61	225.39	4.748	0.1	107.01	12.39
		26	13.2	0.7	9.896	251	2,663.71	23.97	227.03	4.948	0.1	112.33	13.00
		27	12.3	0.7	8.996	251	2,535.14	27.66	223.34	4.498	0.1	100.46	11.63
		28	8.8	0.7	5.496	251	2,035.14	41.99	209.01	2.748	0.1	57.44	6.65
		29	7.8	0.7	4.496	251	1,892.29	62.60	188.40	2.248	0.1	42.35	4.90
		30	9.3	0.7	5.996	251	2,106.57	39.94	211.06	2.998	0.1	63.27	7.32
		31	10.7	0.7	7.396	251	2,306.57	34.21	216.79	3.698	0.1	80.17	9.28

Table 6.7.1 The Results of the Estimate of Snowmelt Runoff (6/9)

Pozantı (778 Elm)
DMİ

6. Eğlence
Emax=3600 m
Emin=222m

Year	Month	Date	Temp.	t	Ts(1250)	As	Ef	Af	Am	Ts	Rs	Q(cmkm2)	Q(m3/s)
1980	3	1	0.3	0.7	-3.004	0	820.86	0.00	0.00	-1.502	0.1	0.00	0.00
		2	0.4	0.7	-2.904	0	835.14	0.00	0.00	-1.452	0.1	0.00	0.00
		3	0.8	0.7	-2.504	0	892.29	0.00	0.00	-1.252	0.1	0.00	0.00
		4	3.9	0.7	0.596	251	1,335.14	221.37	29.63	0.298	0.1	0.88	0.10
		5	4.6	0.7	1.296	251	1,435.14	186.57	64.43	0.648	0.1	4.18	0.48
		6	2.3	0.7	-1.004	0	1,106.57	0.00	0.00	-0.502	0.1	0.00	0.00
		7	4.0	0.7	0.696	251	1,349.43	216.40	34.60	0.348	0.1	1.20	0.14
		8	6.8	0.7	3.496	251	1,749.43	113.62	137.38	1.748	0.1	24.01	2.78
		9	7.8	0.7	4.496	251	1,892.29	84.76	166.24	2.248	0.1	37.37	4.33
		10	8.9	0.7	5.596	251	2,049.43	61.05	189.95	2.798	0.1	53.15	6.15
		11	3.0	0.7	-0.304	0	1,206.57	0.00	0.00	-0.152	0.1	0.00	0.00
		12	4.2	0.7	0.896	251	1,378.00	206.46	44.54	0.448	0.1	2.00	0.23
		13	4.7	0.7	1.396	251	1,449.43	181.60	69.40	0.698	0.1	4.84	0.56
		14	4.6	0.7	1.296	251	1,435.14	186.57	64.43	0.648	0.1	4.18	0.48
		15	7.9	0.7	4.596	251	1,906.57	81.87	169.13	2.298	0.1	38.87	4.50
		16	6.9	0.7	3.596	251	1,763.71	110.73	140.27	1.798	0.1	25.22	2.92
		17	7.8	0.7	4.496	251	1,892.29	84.76	166.24	2.248	0.1	37.37	4.33
		18	7.7	0.7	4.396	251	1,878.00	87.64	163.36	2.198	0.1	35.91	4.16
		19	8.0	0.7	4.696	251	1,920.86	78.99	172.01	2.348	0.1	40.39	4.67
		20	7.4	0.7	4.096	251	1,835.14	96.30	154.70	2.048	0.1	31.68	3.67
		21	8.4	0.7	5.096	251	1,978.00	67.44	183.56	2.548	0.1	46.77	5.41
		22	8.0	0.7	4.696	251	1,920.86	78.99	172.01	2.348	0.1	40.39	4.67
		23	10.0	0.7	6.696	251	2,206.57	54.87	196.13	3.348	0.1	65.67	7.60
		24	9.8	0.7	6.496	251	2,178.00	55.99	195.01	3.248	0.1	63.34	7.33
		25	12.8	0.7	9.496	251	2,606.57	39.12	211.88	4.748	0.1	100.60	11.64
		26	13.2	0.7	9.896	251	2,663.71	36.87	214.13	4.948	0.1	105.95	12.26
		27	12.3	0.7	8.996	251	2,535.14	41.93	209.07	4.498	0.1	94.04	10.88
		28	8.8	0.7	5.496	251	2,035.14	61.62	189.38	2.748	0.1	52.04	6.02
		29	7.8	0.7	4.496	251	1,892.29	84.76	166.24	2.248	0.1	37.37	4.33
		30	9.3	0.7	5.996	251	2,106.57	58.80	192.20	2.998	0.1	57.62	6.67
		31	10.7	0.7	7.396	251	2,306.57	50.93	200.07	3.698	0.1	73.99	8.56

Table 6.7.1 The Results of the Estimate of Snowmelt Runoff (7/9)

Pozantı (778 Elm)
DMİ

9. Körkün
Emax=3700 m
Emin=170m

Year	Month	Date	Temp.	t	Ts(1250)	As	Ef	Af	Am	Ts	Rs	Q(cmkm2)	Q(m3/s)
1980	3	1	0.3	0.7	-3.004	0	820.86	0.00	0.00	-1.502	0.1	0.00	0.00
		2	0.4	0.7	-2.904	0	835.14	0.00	0.00	-1.452	0.1	0.00	0.00
		3	0.8	0.7	-2.504	0	892.29	0.00	0.00	-1.252	0.1	0.00	0.00
		4	3.9	0.7	0.596	1,171	1,335.14	1,103.91	67.09	0.298	0.1	2.00	0.23
		5	4.6	0.7	1.296	1,171	1,435.14	1,025.11	145.89	0.648	0.1	9.45	1.09
		6	2.3	0.7	-1.004	0	1,106.57	0.00	0.00	-0.502	0.1	0.00	0.00
		7	4.0	0.7	0.696	1,171	1,349.43	1,092.65	78.35	0.348	0.1	2.73	0.32
		8	6.8	0.7	3.496	1,171	1,749.43	655.73	515.27	1.748	0.1	90.07	10.42
		9	7.8	0.7	4.496	1,171	1,892.29	473.44	697.56	2.248	0.1	156.81	18.15
		10	8.9	0.7	5.596	1,171	2,049.43	326.23	844.77	2.798	0.1	236.37	27.36
		11	3.0	0.7	-0.304	0	1,206.57	0.00	0.00	-0.152	0.1	0.00	0.00
		12	4.2	0.7	0.896	1,171	1,378.00	1,070.14	100.86	0.448	0.1	4.52	0.52
		13	4.7	0.7	1.396	1,171	1,449.43	1,013.85	157.15	0.698	0.1	10.97	1.27
		14	4.6	0.7	1.296	1,171	1,435.14	1,025.11	145.89	0.648	0.1	9.45	1.09
		15	7.9	0.7	4.596	1,171	1,906.57	455.21	715.79	2.298	0.1	164.49	19.04
		16	6.9	0.7	3.596	1,171	1,763.71	637.50	533.50	1.798	0.1	95.92	11.10
		17	7.8	0.7	4.496	1,171	1,892.29	473.44	697.56	2.248	0.1	156.81	18.15
		18	7.7	0.7	4.396	1,171	1,878.00	491.67	679.33	2.198	0.1	149.32	17.28
		19	8.0	0.7	4.696	1,171	1,920.86	436.99	734.01	2.348	0.1	172.35	19.95
		20	7.4	0.7	4.096	1,171	1,835.14	546.36	624.64	2.048	0.1	127.93	14.81
		21	8.4	0.7	5.096	1,171	1,978.00	364.07	806.93	2.548	0.1	205.61	23.80
		22	8.0	0.7	4.696	1,171	1,920.86	436.99	734.01	2.348	0.1	172.35	19.95
		23	10.0	0.7	6.696	1,171	2,206.57	295.17	875.83	3.348	0.1	293.23	33.94
		24	9.8	0.7	6.496	1,171	2,178.00	300.82	870.18	3.248	0.1	282.63	32.71
		25	12.8	0.7	9.496	1,171	2,606.57	216.11	954.89	4.748	0.1	453.38	52.47
		26	13.2	0.7	9.896	1,171	2,663.71	204.82	966.18	4.948	0.1	478.07	55.33
		27	12.3	0.7	8.996	1,171	2,535.14	230.23	940.77	4.498	0.1	423.16	48.98
		28	8.8	0.7	5.496	1,171	2,035.14	329.05	841.95	2.748	0.1	231.37	26.78
		29	7.8	0.7	4.496	1,171	1,892.29	473.44	697.56	2.248	0.1	156.81	18.15
		30	9.3	0.7	5.996	1,171	2,106.57	314.94	856.06	2.998	0.1	256.65	29.70
		31	10.7	0.7	7.396	1,171	2,306.57	275.41	895.59	3.698	0.1	331.19	38.33

Table 6.7.1 The Results of the Estimate of Snowmelt Runoff (8/9)

Pozantı (778 Elm) 11. Üçürge
DMİ Emax=1,900 m
Emin=67.5 m

Year	Month	Date	Temp.	t	Ts(1250)	As	Ef	Af	Am	Ts	Rs	Q(cmkm2)	Q(m3/s)
1980	3	1	0.3	0.7	-3.004	0	820.86	0.00	0.00	-1.502	0.1	0.00	0.00
		2	0.4	0.7	-2.904	0	835.14	0.00	0.00	-1.452	0.1	0.00	0.00
		3	0.8	0.7	-2.504	0	892.29	0.00	0.00	-1.252	0.1	0.00	0.00
		4	3.9	0.7	0.596	61	1,335.14	52.83	8.17	0.298	0.1	0.24	0.03
		5	4.6	0.7	1.296	61	1,435.14	43.23	17.77	0.648	0.1	1.15	0.13
		6	2.3	0.7	-1.004	0	1,106.57	0.00	0.00	-0.502	0.1	0.00	0.00
		7	4.0	0.7	0.696	61	1,349.43	51.45	9.55	0.348	0.1	0.33	0.04
		8	6.8	0.7	3.496	61	1,749.43	13.93	47.07	1.748	0.1	8.23	0.95
		9	7.8	0.7	4.496	61	1,892.29	0.71	60.29	2.248	0.1	13.55	1.57
		10	8.9	0.7	5.596	61	2,049.43	0.00	61.00	2.798	0.1	17.07	1.98
		11	3.0	0.7	-0.304	0	1,206.57	0.00	0.00	-0.152	0.1	0.00	0.00
		12	4.2	0.7	0.896	61	1,378.00	48.71	12.29	0.448	0.1	0.55	0.06
		13	4.7	0.7	1.396	61	1,449.43	41.85	19.15	0.698	0.1	1.34	0.15
		14	4.6	0.7	1.296	61	1,435.14	43.23	17.77	0.648	0.1	1.15	0.13
		15	7.9	0.7	4.596	61	1,906.57	0.00	61.00	2.298	0.1	14.02	1.62
		16	6.9	0.7	3.596	61	1,763.71	12.61	48.39	1.798	0.1	8.70	1.01
		17	7.8	0.7	4.496	61	1,892.29	0.71	60.29	2.248	0.1	13.55	1.57
		18	7.7	0.7	4.396	61	1,878.00	2.04	58.97	2.198	0.1	12.96	1.50
		19	8.0	0.7	4.696	61	1,920.86	0.00	61.00	2.348	0.1	14.32	1.66
		20	7.4	0.7	4.096	61	1,835.14	6.00	55.00	2.048	0.1	11.26	1.30
		21	8.4	0.7	5.096	61	1,978.00	0.00	61.00	2.548	0.1	15.54	1.80
		22	8.0	0.7	4.696	61	1,920.86	0.00	61.00	2.348	0.1	14.32	1.66
		23	10.0	0.7	6.696	61	2,206.57	0.00	61.00	3.348	0.1	20.42	2.36
		24	9.8	0.7	6.496	61	2,178.00	0.00	61.00	3.248	0.1	19.81	2.29
		25	12.8	0.7	9.496	61	2,606.57	0.00	61.00	4.748	0.1	28.96	3.35
		26	13.2	0.7	9.896	61	2,663.71	0.00	61.00	4.948	0.1	30.18	3.49
		27	12.3	0.7	8.996	61	2,535.14	0.00	61.00	4.498	0.1	27.44	3.18
		28	8.8	0.7	5.496	61	2,035.14	0.00	61.00	2.748	0.1	16.76	1.94
		29	7.8	0.7	4.496	61	1,892.29	0.71	60.29	2.248	0.1	13.55	1.57
		30	9.3	0.7	5.996	61	2,106.57	0.00	61.00	2.998	0.1	18.29	2.12
		31	10.7	0.7	7.396	61	2,306.57	0.00	61.00	3.698	0.1	22.56	2.61

Table 6.7.1 The Results of the Estimate of Snowmelt Runoff (9/9)

Pozantı (778 Elm)
DMİ

13. Çakıt
Emax=3,200 m
Emin=80 m

Year	Month	Date	Temp.	t	Ts(1250)	As	Ef	Af	Am	Ts	Rs	Q(cmkm2)	Q(m3/s)
1980	3	1	0.3	0.7	-3.004	0	820.86	0.00	0.00	-1.502	0.1	0.00	0.00
		2	0.4	0.7	-2.904	0	835.14	0.00	0.00	-1.452	0.1	0.00	0.00
		3	0.8	0.7	-2.504	0	892.29	0.00	0.00	-1.252	0.1	0.00	0.00
		4	3.9	0.7	0.596	1,064	1,335.14	955.70	108.30	0.298	0.1	3.23	0.37
		5	4.6	0.7	1.296	1,064	1,435.14	828.50	235.50	0.648	0.1	15.26	1.77
		6	2.3	0.7	-1.004	0	1,106.57	0.00	0.00	-0.502	0.1	0.00	0.00
		7	4.0	0.7	0.696	1,064	1,349.43	937.53	126.47	0.348	0.1	4.40	0.51
		8	6.8	0.7	3.496	1,064	1,749.43	455.17	608.83	1.748	0.1	106.42	12.32
		9	7.8	0.7	4.496	1,064	1,892.29	288.59	775.41	2.248	0.1	174.31	20.17
		10	8.9	0.7	5.596	1,064	2,049.43	156.29	907.71	2.798	0.1	253.98	29.40
		11	3.0	0.7	-0.304	0	1,206.57	0.00	0.00	-0.152	0.1	0.00	0.00
		12	4.2	0.7	0.896	1,064	1,378.00	901.18	162.82	0.448	0.1	7.29	0.84
		13	4.7	0.7	1.396	1,064	1,449.43	810.33	253.67	0.698	0.1	17.71	2.05
		14	4.6	0.7	1.296	1,064	1,435.14	828.50	235.50	0.648	0.1	15.26	1.77
		15	7.9	0.7	4.596	1,064	1,906.57	271.94	792.06	2.298	0.1	182.02	21.07
		16	6.9	0.7	3.596	1,064	1,763.71	438.51	625.49	1.798	0.1	112.46	13.02
		17	7.8	0.7	4.496	1,064	1,892.29	288.59	775.41	2.248	0.1	174.31	20.17
		18	7.7	0.7	4.396	1,064	1,878.00	305.25	758.75	2.198	0.1	166.77	19.30
		19	8.0	0.7	4.696	1,064	1,920.86	255.28	808.72	2.348	0.1	189.89	21.98
		20	7.4	0.7	4.096	1,064	1,835.14	355.22	708.78	2.048	0.1	145.16	16.80
		21	8.4	0.7	5.096	1,064	1,978.00	188.65	875.35	2.548	0.1	223.04	25.81
		22	8.0	0.7	4.696	1,064	1,920.86	255.28	808.72	2.348	0.1	189.89	21.98
		23	10.0	0.7	6.696	1,064	2,206.57	134.94	929.06	3.348	0.1	311.05	36.00
		24	9.8	0.7	6.496	1,064	2,178.00	138.82	925.18	3.248	0.1	300.50	34.78
		25	12.8	0.7	9.496	1,064	2,606.57	80.61	983.39	4.748	0.1	466.91	54.04
		26	13.2	0.7	9.896	1,064	2,663.71	72.85	991.15	4.948	0.1	490.42	56.76
		27	12.3	0.7	8.996	1,064	2,535.14	90.31	973.69	4.498	0.1	437.97	50.69
		28	8.8	0.7	5.496	1,064	2,035.14	158.23	905.77	2.748	0.1	248.91	28.81
		29	7.8	0.7	4.496	1,064	1,892.29	288.59	775.41	2.248	0.1	174.31	20.17
		30	9.3	0.7	5.996	1,064	2,106.57	148.52	915.48	2.998	0.1	274.46	31.77
		31	10.7	0.7	7.396	1,064	2,306.57	121.36	942.64	3.698	0.1	348.59	40.35

Table 7.1.1 The Results of the Calculation to Determine K and p of River Channels (1/9)

(River Channel No.1)

n = 0.040 I = 0.0092 L = 94.000 km Tl = 2596.7 sec.

Tl = 0.721 hr

1801Q (m3/s)	1801S (10^3m3)	1805Q (m3/s)	1805S (10^3m3)	Q (m3/s)	S (10^3m3)	TlQ (10^3m3)	S-TlQ (10^3m3)	S/t+Q/2 (m3/s)	log Q	log S
0.00	0.000	0.000	0.000	0.000	0.000	0.0	0.0	0.00	#NUM!	#NUM!
1.10	102.850	0.361	45.375	0.729	74.113	1.9	72.2	20.43	-0.138	4.859
4.07	251.680	2.361	176.660	3.216	214.170	8.4	205.8	58.78	0.507	5.313
16.51	731.990	12.615	627.990	14.563	679.990	37.8	642.2	185.66	1.163	5.808
41.92	1440.808	39.197	1412.675	40.561	1426.741	105.3	1321.4	387.34	1.608	6.121
82.00	2359.682	84.574	2289.320	83.287	2324.501	216.3	2108.2	627.26	1.921	6.324
139.94	3470.220	142.269	3192.585	141.104	3331.402	366.4	2965.0	894.16	2.150	6.472
220.21	4773.208	211.968	4130.940	216.089	4452.074	561.1	3891.0	1188.87	2.335	6.590
313.72	6223.635	292.990	5108.620	303.356	5666.128	787.7	4878.4	1506.79	2.482	6.688
441.00	7803.048	376.330	6117.760	408.666	6960.404	1061.2	5899.2	1843.01	2.611	6.771
578.80	9469.642	401.953	7238.220	490.377	8353.931	1273.3	7080.6	2212.02	2.691	6.850
726.63	11305.454	576.011	8439.145	651.321	9872.299	1691.3	8181.0	2598.17	2.814	6.913

K= 94,092

p= 0.695

Table 7.1.1 The Results of the Calculation to Determine K and p of River Channels (2/9)

(River Channel No.2)

n = 0.040 I = 0.0059 L = 60.500 km Tl = 2083.9 sec.

Tl = 0.579 hr

1801Q	1801S	1805Q	1805S	Q	S	TlQ	S-TlQ	S/t+Q/2	log Q	log S
(m3/s)	(10^3m3)	(m3/s)	(10^3m3)	(m3/s)	(10^3m3)	(10^3m3)	(10^3m3)	(m3/s)		
0.00	0.000	0.000	0.000	0.000	0.000	0.0	0.0	0.00	#NUM!	#NUM!
1.10	102.850	0.361	45.375	0.729	74.113	1.5	72.6	20.53	-0.138	4.861
4.07	251.680	2.361	176.660	3.216	214.170	6.7	207.5	59.24	0.507	5.317
16.51	731.990	12.615	627.990	14.563	679.990	30.3	649.6	187.74	1.163	5.813
41.92	1440.808	39.197	1412.675	40.561	1426.741	84.5	1342.2	393.12	1.608	6.128
82.00	2359.682	84.574	2289.320	83.287	2324.501	173.6	2150.9	639.13	1.921	6.333
139.94	3470.220	142.269	3192.585	141.104	3331.402	294.1	3037.3	914.26	2.150	6.482
220.21	4773.208	211.968	4130.940	216.089	4452.074	450.3	4001.8	1219.64	2.335	6.602
313.72	6223.635	292.990	5108.620	303.356	5666.128	632.2	5034.0	1550.00	2.482	6.702
441.00	7803.048	376.330	6117.760	408.666	6960.404	851.6	6108.8	1901.21	2.611	6.786
578.80	9469.642	401.953	7238.220	490.377	8353.931	1021.9	7332.0	2281.86	2.691	6.865
726.63	11305.454	576.011	8439.145	651.321	9872.299	1357.3	8515.0	2690.93	2.814	6.930

K= 94,233

p= 0.700

Table 7.1.1 The Results of the Calculation to Determine K and p of River Channels (3/9)

(River Channel No.2)

n = 0.040 I = 0.0059 L = 60.500 km Tl = 2083.9 sec.

Tl = 0.579 hr

H	A	P	R	R^2/3	V	Q	S	TlQ	S-TlQ	S/t+Q/2	log Q	log S
(m)	(m2)	(m)	(m)		(m/s)	(m3/s)	(10^3m3)	(10^3m3)	(10^3m3)	(m3/s)		
0.00	0.000	0.00	0.000	0.000	0.000	0.000	0.0	0.0	0.0	0.00	#NUM!	#NUM!
0.25	1.700	8.75	0.194	0.335	0.645	1.097	102.9	2.3	100.6	28.48	0.040	5.002
0.50	4.160	11.46	0.363	0.509	0.979	4.071	251.7	8.5	243.2	69.59	0.610	5.386
1.00	12.099	20.24	0.598	0.710	1.365	16.511	732.0	34.4	697.6	202.03	1.218	5.844
1.50	23.815	27.19	0.876	0.915	1.760	41.925	1440.8	87.4	1353.4	396.92	1.622	6.131
2.00	39.003	34.12	1.143	1.093	2.102	82.000	2359.7	170.9	2188.8	649.00	1.914	6.340
2.50	57.359	40.14	1.429	1.269	2.440	139.940	3470.2	291.6	3178.6	952.91	2.146	6.502
3.00	78.896	45.12	1.749	1.451	2.791	220.210	4773.2	458.9	4314.3	1308.52	2.343	6.635
3.50	102.870	51.51	1.997	1.586	3.050	313.722	6223.6	653.8	5569.9	1704.04	2.497	6.746
4.00	128.976	54.40	2.371	1.778	3.419	441.001	7803.0	919.0	6884.0	2132.73	2.644	6.838
4.50	156.523	58.70	2.666	1.923	3.698	578.801	9469.6	1206.2	8263.5	2584.80	2.763	6.917
5.00	186.867	64.99	2.875	2.022	3.888	726.631	11305.5	1514.3	9791.2	3083.09	2.861	6.991

K= 94,164

p= 0.708

Table 7.1.1 The Results of the Calculation to Determine K and p of River Channels (4/9)

(River Channel No.2)

n = 0.040 I = 0.0059 L = 60.500 km Tl = 2083.9 sec.

Tl = 0.579 hr

H (m)	A (m2)	P (m)	R (m)	R^2/3	V (m/s)	Q (m3/s)	S (10^3m3)	TlQ (10^3m3)	S-TlQ (10^3m3)	S/t+Q/2 (m3/s)	log Q	log S
0.00	0.000	0.00	0.000	0.000	0.000	0.000	0.0	0.0	0.0	0.00	#NUM!	#NUM!
0.25	0.750	6.00	0.125	0.250	0.481	0.361	45.4	0.8	44.6	12.58	-0.443	4.650
0.50	2.920	10.71	0.273	0.420	0.809	2.361	176.7	4.9	171.7	48.89	0.373	5.235
1.00	10.380	20.66	0.502	0.632	1.215	12.615	628.0	26.3	601.7	173.45	1.101	5.779
1.50	23.350	28.63	0.816	0.873	1.679	39.197	1412.7	81.7	1331.0	389.32	1.593	6.124
2.00	37.840	30.20	1.253	1.162	2.235	84.574	2289.3	176.2	2113.1	629.25	1.927	6.325
2.50	52.770	31.79	1.660	1.402	2.696	142.269	3192.6	296.5	2896.1	875.61	2.153	6.462
3.00	68.280	33.29	2.051	1.614	3.104	211.968	4130.9	441.7	3689.2	1130.77	2.326	6.567
3.50	84.440	34.84	2.424	1.804	3.470	292.990	5108.6	610.6	4498.0	1395.95	2.467	6.653
4.00	101.120	37.56	2.692	1.935	3.722	376.330	6117.8	784.2	5333.5	1669.70	2.576	6.727
4.50	119.640	51.81	2.309	1.747	3.360	401.953	7238.2	837.6	6400.6	1978.91	2.604	6.806
5.00	139.490	44.33	3.147	2.147	4.129	576.011	8439.1	1200.4	7238.8	2298.78	2.760	6.860

K= 96,520

p= 0.687

Table 7.1.1 The Results of the Calculation to Determine K and p of River Channels (5/9)

(River Channel No.3)

n = 0.040 I = 0.0045 L = 39.600 km Tl = 1556.4 sec.

Tl = 0.432 hr

1805Q (m3/s)	1805S (10^3m3)	1818Q (m3/s)	1818S (10^3m3)	Q (m3/s)	S (10^3m3)	TlQ (10^3m3)	S-TlQ (10^3m3)	S/t+Q/2 (m3/s)	log Q	log S
0.00	0.000	0.000	0.000	0.000	0.0	0.0	0.0	0.00	#NUM!	#NUM!
0.32	29.700	1.554	125.136	0.935	77.4	1.5	76.0	21.57	-0.029	4.881
2.07	115.632	7.234	348.084	4.652	231.9	7.2	224.6	64.72	0.668	5.351
11.06	411.048	29.059	1021.284	20.058	716.2	31.2	684.9	200.29	1.302	5.836
34.35	924.660	78.713	2212.056	56.533	1568.4	88.0	1480.4	439.48	1.752	6.170
74.12	1498.464	167.515	3790.908	120.819	2644.7	188.0	2456.6	742.81	2.082	6.390
124.69	2089.692	303.463	5706.756	214.075	3898.2	333.2	3565.0	1097.33	2.331	6.552
185.77	2703.888	495.717	7709.724	340.746	5206.8	530.3	4676.5	1469.40	2.532	6.670
256.78	3343.824	727.357	9766.548	492.071	6555.2	765.8	5789.3	1854.19	2.692	6.763
329.83	4004.352	990.613	11826.936	660.220	7915.6	1027.5	6888.1	2243.47	2.820	6.838
352.28	4737.744	1289.493	13929.696	820.888	9333.7	1277.6	8056.1	2648.26	2.914	6.906
504.83	5523.804	1614.065	16026.912	1059.448	10775.4	1648.9	9126.5	3064.86	3.025	6.960

K= 83,781

p= 0.686

Table 7.1.1 The Results of the Calculation to Determine K and p of River Channels (6/9)

(River Channel No.3)

n = 0.040 I = 0.0045 L = 39.600 km Tl = 1556.4 sec.

Tl = 0.432 hr

H	A	P	R	R^2/3	V	Q	S	TlQ	S-TlQ	S/t+Q/2	log Q	log S
(m)	(m2)	(m)	(m)		(m/s)	(m3/s)	(10^3m3)	(10^3m3)	(10^3m3)	(m3/s)		
0.00	0.000	0.00	0.000	0.000	0.000	0.000	0.0	0.0	0.0	0.00	#NUM!	#NUM!
0.25	0.750	6.00	0.125	0.250	0.421	0.316	29.7	0.5	29.2	8.27	-0.500	4.466
0.50	2.920	10.71	0.273	0.420	0.709	2.069	115.6	3.2	112.4	32.26	0.316	5.051
1.00	10.380	20.66	0.502	0.632	1.065	11.056	411.0	17.2	393.8	114.93	1.044	5.595
1.50	23.350	28.63	0.816	0.873	1.471	34.353	924.7	53.5	871.2	259.18	1.536	5.940
2.00	37.840	30.20	1.253	1.162	1.959	74.123	1498.5	115.4	1383.1	421.26	1.870	6.141
2.50	52.770	31.79	1.660	1.402	2.363	124.688	2089.7	194.1	1895.6	588.91	2.096	6.278
3.00	68.280	33.29	2.051	1.614	2.721	185.775	2703.9	289.1	2414.8	763.65	2.269	6.383
3.50	84.440	34.84	2.424	1.804	3.041	256.784	3343.8	399.6	2944.2	946.22	2.410	6.469
4.00	101.120	37.56	2.692	1.935	3.262	329.826	4004.4	513.3	3491.0	1134.64	2.518	6.543
4.50	119.640	51.81	2.309	1.747	2.945	352.283	4737.7	548.3	4189.5	1339.88	2.547	6.622
5.00	139.490	44.33	3.147	2.147	3.619	504.832	5523.8	785.7	4738.1	1568.56	2.703	6.676

K= 69,170

p= 0.687

Table 7.1.1 The Results of the Calculation to Determine K and p of River Channels (7/9)

(River Channel No.3)

n = 0.040 I = 0.0045 L = 39.600 km Tl = 1556.4 sec.

Tl = 0.432 hr

H	A	P	R	R^2/3	V	Q	S	TlQ	S-TlQ	S/t+Q/2	log Q	log S
(m)	(m2)	(m)	(m)		(m/s)	(m3/s)	(10^3m3)	(10^3m3)	(10^3m3)	(m3/s)		
0.00	0.000	0.00	0.000	0.000	0.000	0.000	0.0	0.0	0.0	0.00	#NUM!	#NUM!
0.25	3.160	20.04	0.158	0.292	0.492	1.554	125.1	2.4	122.7	34.87	0.192	5.089
0.50	8.790	25.76	0.341	0.488	0.823	7.234	348.1	11.3	336.8	97.18	0.859	5.527
1.00	25.790	47.18	0.547	0.669	1.127	29.059	1021.3	45.2	976.1	285.66	1.463	5.989
1.50	55.860	73.07	0.764	0.836	1.409	78.713	2212.1	122.5	2089.5	619.79	1.896	6.320
2.00	95.730	90.49	1.058	1.038	1.750	167.515	3790.9	260.7	3530.2	1064.37	2.224	6.548
2.50	144.110	103.19	1.397	1.249	2.106	303.463	5706.8	472.3	5234.5	1605.75	2.482	6.719
3.00	194.690	104.85	1.857	1.511	2.546	495.717	7709.7	771.5	6938.2	2175.14	2.695	6.841
3.50	246.630	106.55	2.315	1.750	2.949	727.357	9766.5	1132.0	8634.5	2762.16	2.862	6.936
4.00	298.660	108.18	2.761	1.968	3.317	990.613	11826.9	1541.7	10285.2	3352.30	2.996	7.012
4.50	351.760	109.66	3.208	2.175	3.666	1289.493	13929.7	2006.9	11922.8	3956.63	3.110	7.076
5.00	404.720	111.19	3.640	2.366	3.988	1614.065	16026.9	2512.1	13514.9	4561.16	3.208	7.131

K= 94,830

p= 0.685

Table 7.1.1 The Results of the Calculation to Determine K and p of River Channels (8/9)

(River Channel No.4)

n = 0.040 I = 0.0045 L = 22.700 km Tl = 898.6 sec.

Tl = 0.250 hr

H	A	P	R	R^2/3	V	Q	S	TlQ	S-TlQ	S/t+Q/2	log Q	log S
(m)	(m2)	(m)	(m)		(m/s)	(m3/s)	(10^3m3)	(10^3m3)	(10^3m3)	(m3/s)		
0.00	0.000	0.00	0.000	0.000	0.000	0.000	0.0	0.0	0.0	0.00	#NUM!	#NUM!
0.25	3.390	21.93	0.155	0.288	0.482	1.634	77.0	1.5	75.5	21.78	0.213	4.878
0.50	9.940	30.84	0.322	0.470	0.787	7.819	225.6	7.0	218.6	64.63	0.893	5.340
1.00	28.760	42.98	0.669	0.765	1.280	36.817	652.9	33.1	619.8	190.57	1.566	5.792
1.50	51.510	47.85	1.076	1.050	1.758	90.534	1169.3	81.4	1087.9	347.47	1.957	6.037
2.00	76.300	52.06	1.466	1.290	2.159	164.734	1732.0	148.0	1584.0	522.36	2.217	6.200
2.50	103.240	56.30	1.834	1.498	2.507	258.813	2343.5	232.6	2111.0	715.79	2.413	6.324
3.00	137.420	81.64	1.683	1.415	2.368	325.382	3119.4	292.4	2827.0	947.98	2.512	6.451
3.50	184.470	107.91	1.709	1.430	2.392	441.314	4187.5	396.6	3790.9	1273.69	2.645	6.579
4.00	243.070	124.17	1.958	1.565	2.619	636.483	5517.7	571.9	4945.7	1692.06	2.804	6.694
4.50	280.220	126.06	2.223	1.703	2.850	798.655	6361.0	717.7	5643.3	1966.92	2.902	6.752
5.00			#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

K= 51,151

p= 0.694

Table 7.1.1 The Results of the Calculation to Determine K and p of River Channels (9/9)

(River Channel No.6)

n = 0.040 I = 0.0010 L = 49.900 km Tl = 4176.8 sec.

Tl = 1.160 hr

H	A	P	R	R^2/3	V	Q	S	TlQ	S-TlQ	S/t+Q/2	log Q	log S
(m)	(m2)	(m)	(m)		(m/s)	(m3/s)	(10^3m3)	(10^3m3)	(10^3m3)	(m3/s)		
0.00	0.000	0.00	0.000	0.000	0.000	0.000	0.0	0.0	0.0	0.00	#NUM!	#NUM!
0.25	3.160	20.04	0.158	0.292	0.231	0.730	157.7	3.0	154.6	43.32	-0.137	5.189
0.50	8.790	25.76	0.341	0.488	0.386	3.397	438.6	14.2	424.4	119.60	0.531	5.628
1.00	25.790	47.18	0.547	0.669	0.529	13.644	1286.9	57.0	1229.9	348.47	1.135	6.090
1.50	55.860	73.07	0.764	0.836	0.662	36.959	2787.4	154.4	2633.0	749.88	1.568	6.420
2.00	95.730	90.49	1.058	1.038	0.822	78.654	4776.9	328.5	4448.4	1274.99	1.896	6.648
2.50	144.110	103.19	1.397	1.249	0.989	142.486	7191.1	595.1	6595.9	1903.45	2.154	6.819
3.00	194.690	104.85	1.857	1.511	1.196	232.756	9715.0	972.2	8742.8	2544.95	2.367	6.942
3.50	246.630	106.55	2.315	1.750	1.385	341.519	12306.8	1426.5	10880.4	3193.08	2.533	7.037
4.00	298.660	108.18	2.761	1.968	1.557	465.126	14903.1	1942.8	12960.4	3832.67	2.668	7.113
4.50	351.760	109.66	3.208	2.175	1.721	605.460	17552.8	2528.9	15023.9	4476.04	2.782	7.177
5.00	404.720	111.19	3.640	2.366	1.873	757.858	20195.5	3165.4	17030.1	5109.51	2.880	7.231

K= 200,640

p= 0.685

Table 7.1.2 Comparison of the Parameter for Flood Runoff Analyses

Basin No. (River Channel No.)	Parameter	'87Flood Case1	'87Flood Case2	'80Flood Case1	'80Flood Case2
1	Area (Km2)	6990	6990	6990	6990
	K value	33.5	33.5	33.5	33.5
	p value	0.85	0.85	0.85	0.85
	Tl (hr.)	11	11	3	3
	Base flow (m3/s)	31	31	31	31
	f1	0.01	0.1	0.12	0.2
	f2	1	1	1	1
	Rsa (mm)	200	200	130	130
(1)	K value	94092	94092	94092	94092
	p value	0.695	0.695	0.695	0.695
	Tl (min.)	43.28	43.28	43.28	43.28
2	Area (Km2)	1833	1833	1833	1833
	K value	47	47	40	47
	p value	0.7	0.7	0.7	0.7
	Tl (hr.)	0	3	0	3
	Base flow (m3/s)	14	14	14	14
	f1	0.17	0.2	0.98	0.98
	f2	1	1	1	1
	Rsa (mm)	200	200	130	130
3	Area (Km2)	2298	2298	2298	2298
	K value	33.5	33.5	33.5	33.5
	p value	0.85	0.85	0.85	0.85
	Tl (hr.)	11	11	11	11
	Base flow (m3/s)	24	24	24	24
	f1	0.132	0.132	0.45	0.45
	f2	1	1	1	1
	Rsa (mm)	200	200	130	130
(2)	K value	94233	94233	94233	94233
	p value	0.7	0.7	0.7	0.7
	Tl (min.)	50	50	50	50
4	Area (Km2)	2099	2099	2099	2099
	K value	28	30	28	28
	p value	0.65	0.65	0.65	0.65
	Tl (hr.)	0	3	0	0
	Base flow (m3/s)	10	10	10	10
	f1	0.25	0.25	0.85	0.85
	f2	1	1	1	1
	Rsa (mm)	200	200	130	130
(3)	K value	125000	84000	83000	84000
	p value	0.79	0.65	0.65	0.65
	Tl (min.)	50	50	50	50
5	Area (Km2)	858	858	858	858
	K value	29	35	29	29
	p value	0.5	0.65	0.5	0.5
	Tl (hr.)	1	3	1	1
	Base flow (m3/s)	2.5	2.5	2.5	2.5
	f1	0.7	0.45	0.9	0.9
	f2	1	1	1	1
	Rsa (mm)	200	200	130	130

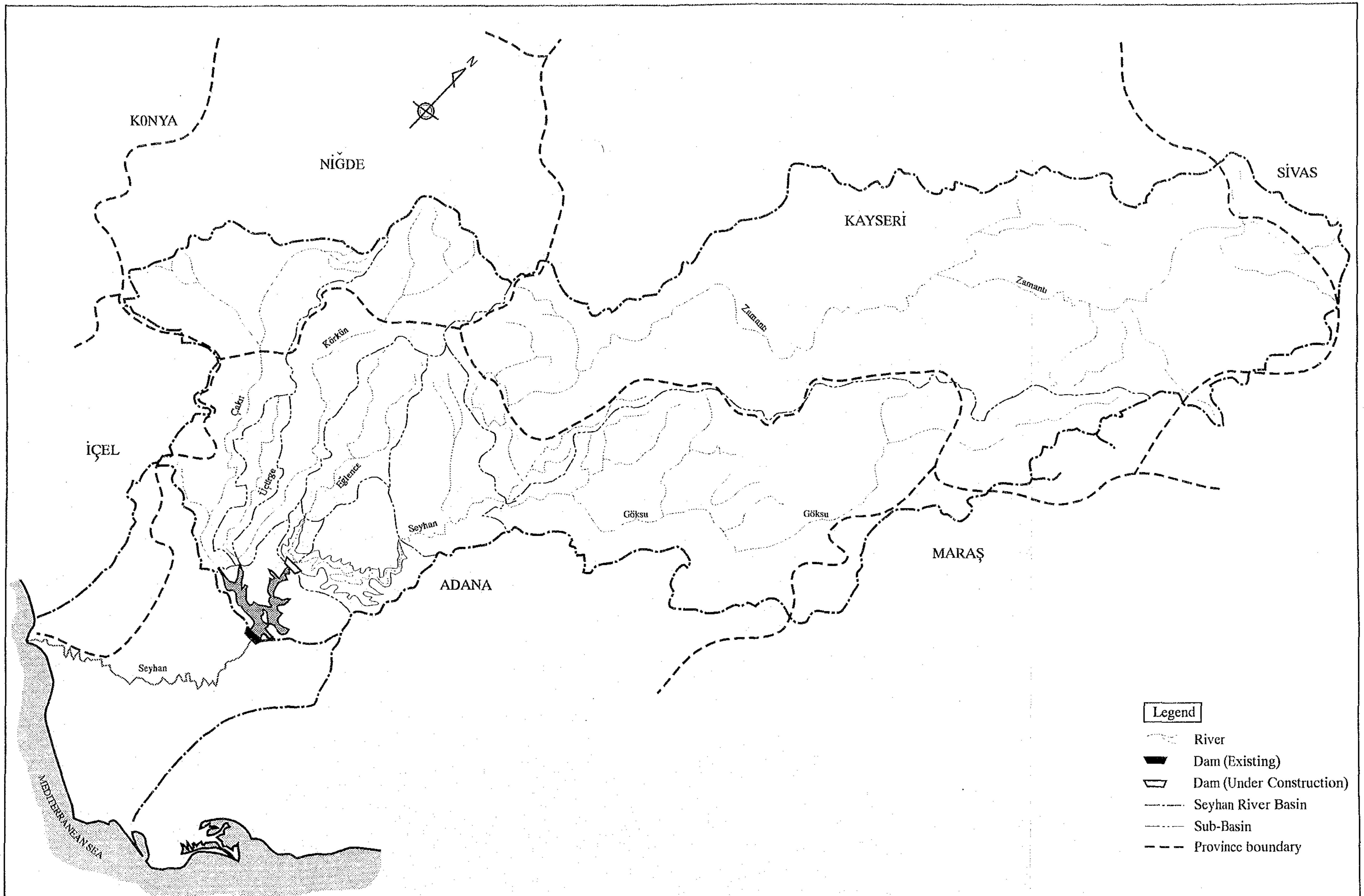
Table 7.1.2 Comparison of the Parameter for Flood Runoff Analyses

Basin No. (River Channel No.)	Parameter	'87Flood Case1	'87Flood Case2	'80Flood Case1	'80Flood Case2
6	Area (Km2)	506	506	506	506
	K value	29.5	35	29	29
	p value	0.67	0.67	0.5	0.5
	Tl (hr.)	1	1	3	3
	Base flow (m3/s)	3.3	3.3	3.3	3.3
	f1	0.42	0.42	0.9	0.9
	f2	1	1	1	1
	Rsa (mm)	200	200	100	100
(4)	K value	60000	53000	60000	60000
	p value	0.7	0.7	0.7	0.7
	Tl (min.)	15	60	15	15
7	Area (Km2)	167	167	167	167
	K value	45	50	45	45
	p value	0.7	0.68	0.7	0.7
	Tl (hr.)	3	3	3	3
	Base flow (m3/s)	0.5	0.5	0.5	0.5
	f1	0.33	0.24	0.8	0.8
	f2	1	1	1	1
	Rsa (mm)	200	200	100	100
8	Area (Km2)	572	572	572	572
	K value	45	50	45	45
	p value	0.7	0.68	0.7	0.7
	Tl (hr.)	3	3	3	3
	Base flow (m3/s)	0.5	0.5	0.5	0.5
	f1	0.33	0.24	0.8	0.8
	f2	1	1	1	1
	Rsa (mm)	200	200	100	100
(6)	K value	210000	180000	200000	180000
	p value	0.7	0.65	0.69	0.65
	Tl (min.)	90	80	90	90
9	Area (Km2)	1427	1427	1427	1427
	K value	25	50	25	25
	p value	0.64	0.7	0.64	0.64
	Tl (hr.)	1	1	3	3
	Base flow (m3/s)	18.7	18.7	18.7	18.7
	f1	0.11	0.2	0.35	0.35
	f2	1	1	1	1
	Rsa (mm)	300	300	130	130
(5)	K value	60000	80000	80000	80000
	p value	0.7	0.7	0.75	0.7
	Tl (min.)	15	80	60	80
10	Area (Km2)	120	120	120	120
	K value	45	50	45	45
	p value	0.8	0.68	0.8	0.8
	Tl (hr.)	3	3	3	3
	Base flow (m3/s)	0.5	0.5	0.5	0.5
	f1	0.32	0.24	0.6	0.6
	f2	1	1	1	1
	Rsa (mm)	300	300	100	100

Table 7.1.2 Comparison of the Parameter for Flood Runoff Analyses

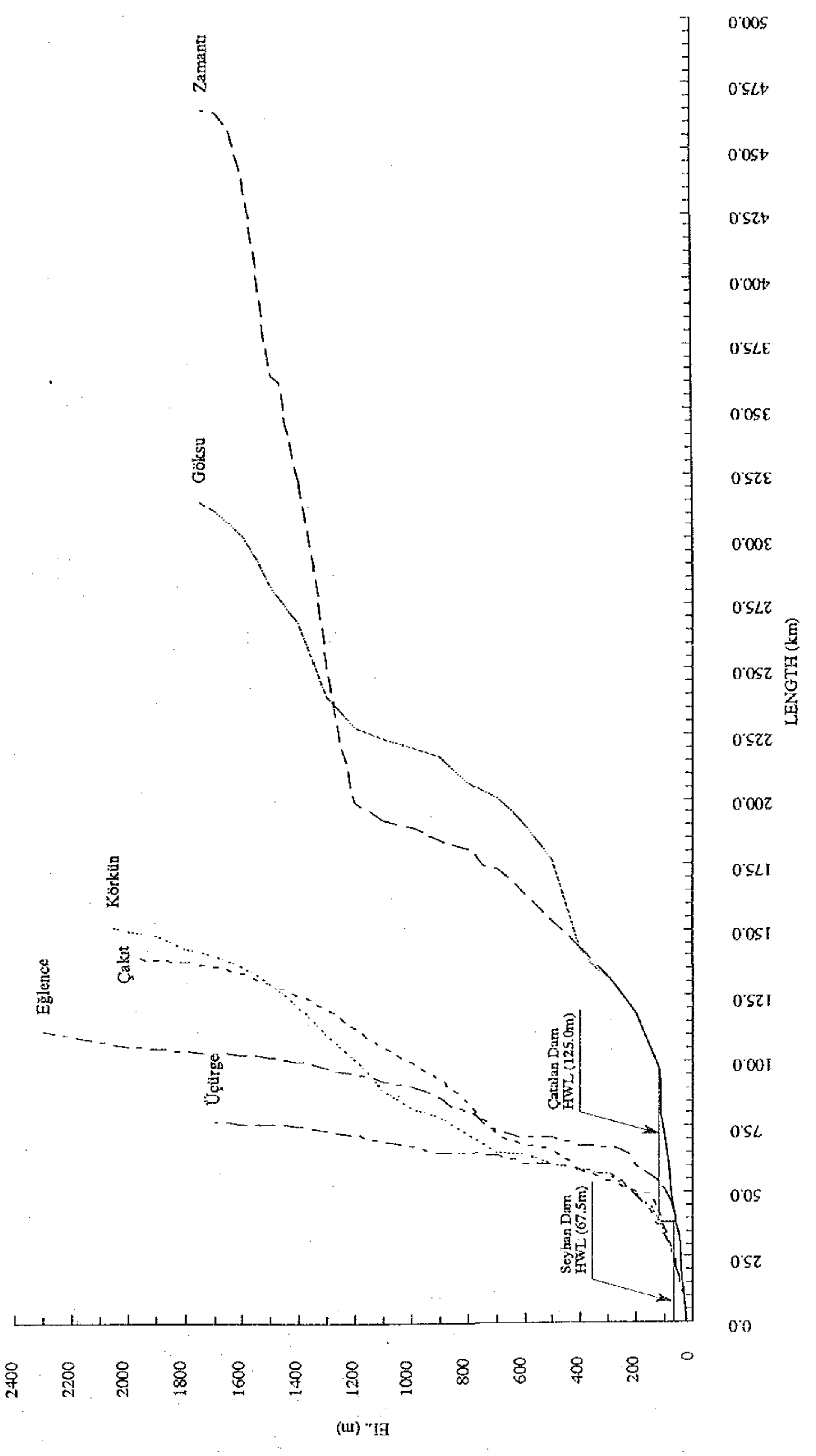
Basin No. (River Channel No.)	Parameter	'87Flood Case1	'87Flood Case2	'80Flood Case1	'80Flood Case2
11	Area (Km2)	263	263	263	263
	K value	45	50	45	50
	p value	0.8	0.68	0.8	0.68
	Tl (hr.)	3	3	3	3
	Base flow (m3/s)	1	1	1	1
	f1	0.11	0.2	0.9	0.9
	f2	1	1	1	1
	Rsa (mm)	280	300	100	100
12	Area (Km2)	435	435	435	435
	K value	40	50	40	50
	p value	0.7	0.68	0.7	0.68
	Tl (hr.)	3	3	3	3
	Base flow (m3/s)	0	0	0	0
	f1	0.2	0.24	1	1
	f2	1	1	1	1
	Rsa (mm)	270	270	100	100
13	Area (Km2)	1769	1769	1769	1769
	K value	45	50	45	50
	p value	0.7	0.68	0.7	0.68
	Tl (hr.)	3	3	3	3
	Base flow (m3/s)	2	2	2	2
	f1	0.1	0.2	0.9	0.9
	f2	1	1	1	1
	Rsa (mm)	280	280	100	100

Figures

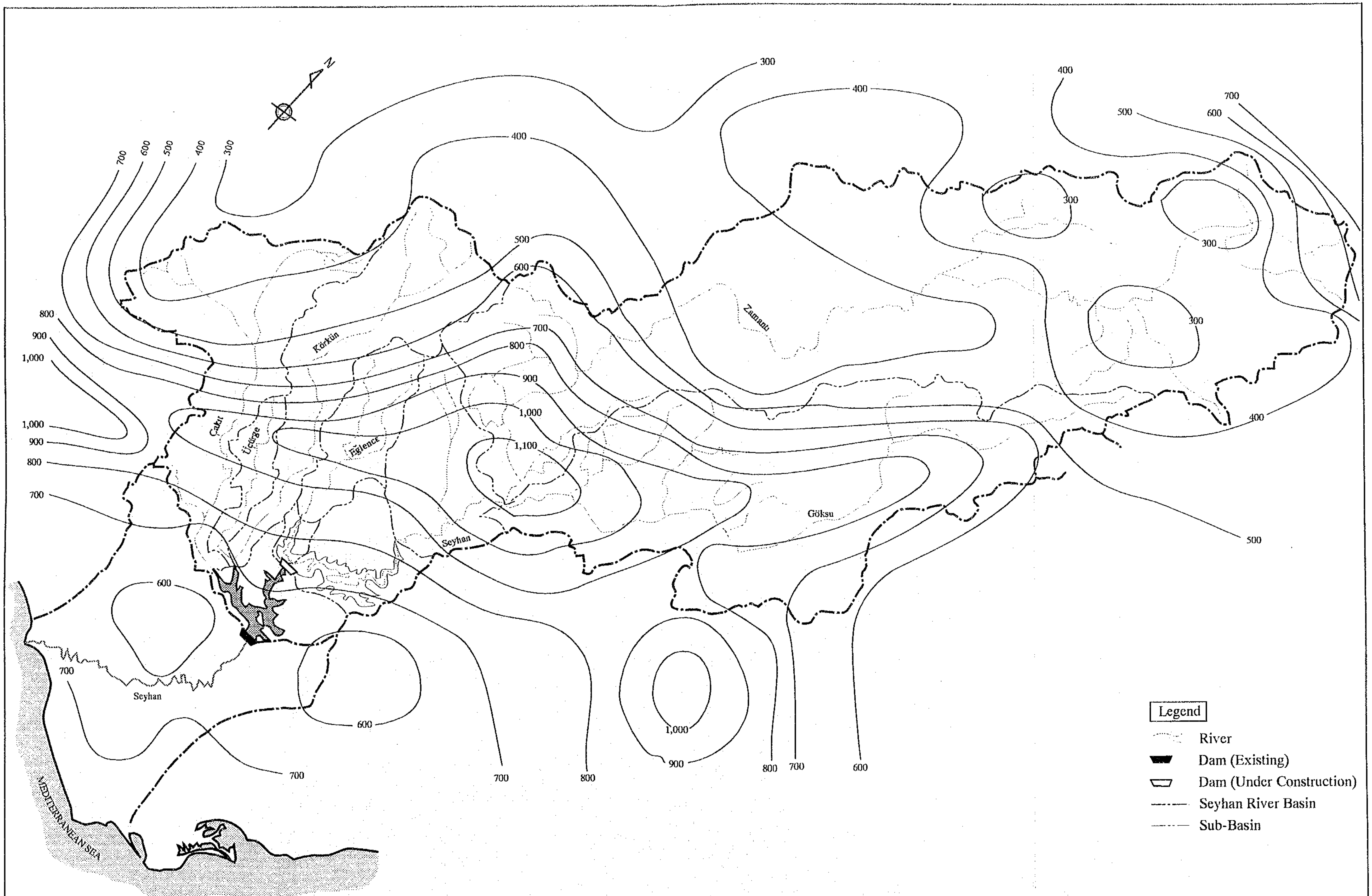


THE REPUBLIC OF TURKEY DEVLET SU İŞLERİ GENEL MÜDÜRLÜGÜ	*FLOOD CONTROL, FORECASTING* AND WARNING SYSTEM FOR SEYHAN RIVER BASIN JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE Figure 2.1.1 LOCATION MAP OF THE SEYHAN RIVER BASIN

FIG. NO.



THE REPUBLIC OF TURKEY DEVLET SU İŞLERİ GENEL MÜDÜLÜĞÜ	FLOOD CONTROL, FORECASTING AND WARNING SYSTEM FOR SEYHAN RIVER BASIN JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE Figure 2.3.1 RIVER PROFILE OF THE SUB-BASINS



SCALE
0 10 20 30 40 50km

THE REPUBLIC OF TURKEY DEVLET SU İŞLERİ GENEL MÜDÜRLÜGÜ	FLOOD CONTROL, FORECASTING AND WARNING SYSTEM FOR SEYHAN RIVER BASIN JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE Figure 2.4.1 ISOHYETAL MAP OF THE SEYHAN RIVER BASIN