

JAPAN INTERNATIONAL COOPERATION AGENCY

THE REPUBLIC OF TURKEY
MINISTRY OF PUBLIC WORKS AND SETTLEMENT
GENERAL DIRECTORATE OF STATE HYDRAULIC WORKS

**DRAFT REPORT
OF
ENVIRONMENTAL IMPACT STUDY
ON
KÖPRÜBAŞI HYDROELECTRIC
POWER DEVELOPMENT PROJECT**

DECEMBER 1994

ELECTRIC POWER DEVELOPMENT CO., LTD.

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Introduction

The present Environmental Effect Evaluation Report (draft) has been prepared by JICA on the basis of DSI's request. The survey items cover 16 items in the field of natural environment and 7 items in the field of social environment, in conformity to the "Regulation for Environmental Effect Evaluation (1992)" of the Republic of Turkey.

Apart from the technical assistance as JICA's Feasibility Study, this draft has been prepared the purpose of sufficiently satisfying the Environmental Effect Evaluation Report by your nation's effect evaluation document at the stage of Feasibility Study. However, the survey for effect evaluation covers such an item as requiring a long period of time and also such an item as needing its details, which is not enough to be evaluated by such a short period of time investigation as the present survey period, and therefore, several points were left over as additional surveys.

The additional surveys are described inside the parenthesis () of each item in the report. In the future, it is desirable that the fact grasping and the confirmation work shall be done by the enforcement of surveys and the description to the evaluation document can be conducted.

Chapter I Purpose of Project

The buried volumes of 57×10^6 tons of petroleum, 13×10^6 tons of coal and 41,000 MW of latent hydraulic power have been confirmed as the major energy sources being produced in our country. Out of them, the hydraulic power of 6,600 MW which equals to 16% has been developed by end 1989.

According to the long term power source development plant, the electric power demand is shifting at a high average rate of 8.7% every year in the future.

Against this electric power demand, its target is for developing 32,900 MW of thermal power generation and 21,000 MW of hydraulic power generation up to 2010. Especially, the development of hydraulic power development which is a clean energy is being positively pushed forward at the pure national production, and in addition to the construction of 4,800 MW which is being conducted, the feasibility study has been ended or under progress as to 114 points (6,000 MW). However, even all these points should be totalled, the electric power generation is 17,700 MW, which means that the development of electric power generation will be ended in 2005.

DSI prepared in 1987 the matter plan concerning the Filyos River Basin Development of major rivers pouring into the Black Sea, and confirms the irrigation projects with the hydraulic power generation development projects at 7 points and 3,200 ha land as the objects.

Because Köprübaşı Hydraulic Power Generation Development Project has the economical merits such as this location is the nearest to the electric power demand site out of the said 7 points and its power distribution cost can be the cheapest, and hence this location is positioned as the project which should be studied at an earlier time.

Chapter II Location of the Area Selected for Project

II.1 Location

The project area (Figure II-1, II-2) is at the boundary area between Bolu Province and Zonguldak Province in the north east area of Capital City Ankara and is located at the middle stream area of Devrek River which is one branch stream of Filyos River water system.

II.2 Location of the Activity Units

This project is to install one power station of dam water channel system. Köprübaşı Hydraulic Power Generation Project is to construct a rock fill dam at 5 km point on the upper stream side of Köprübaşı Village, guide the water of reservoir up to the power station through a raceway tunnel, and after the power generation, release the water to the right bank of Devrek River at the vicinity of backwater point of Çay Project by a drainage canal.

Table II-1 shows the outline of this project.

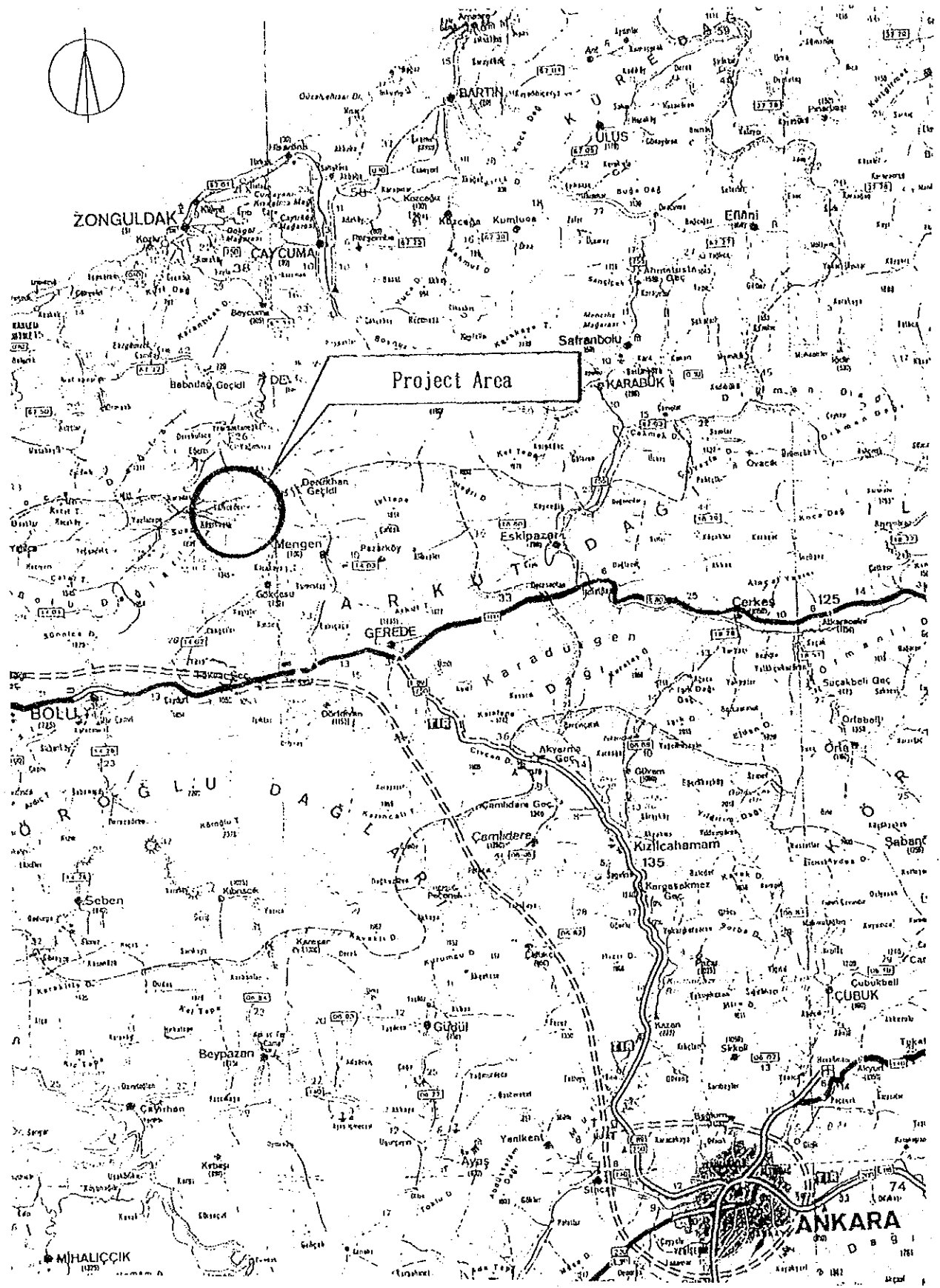


Figure II-1 Location of Project Area

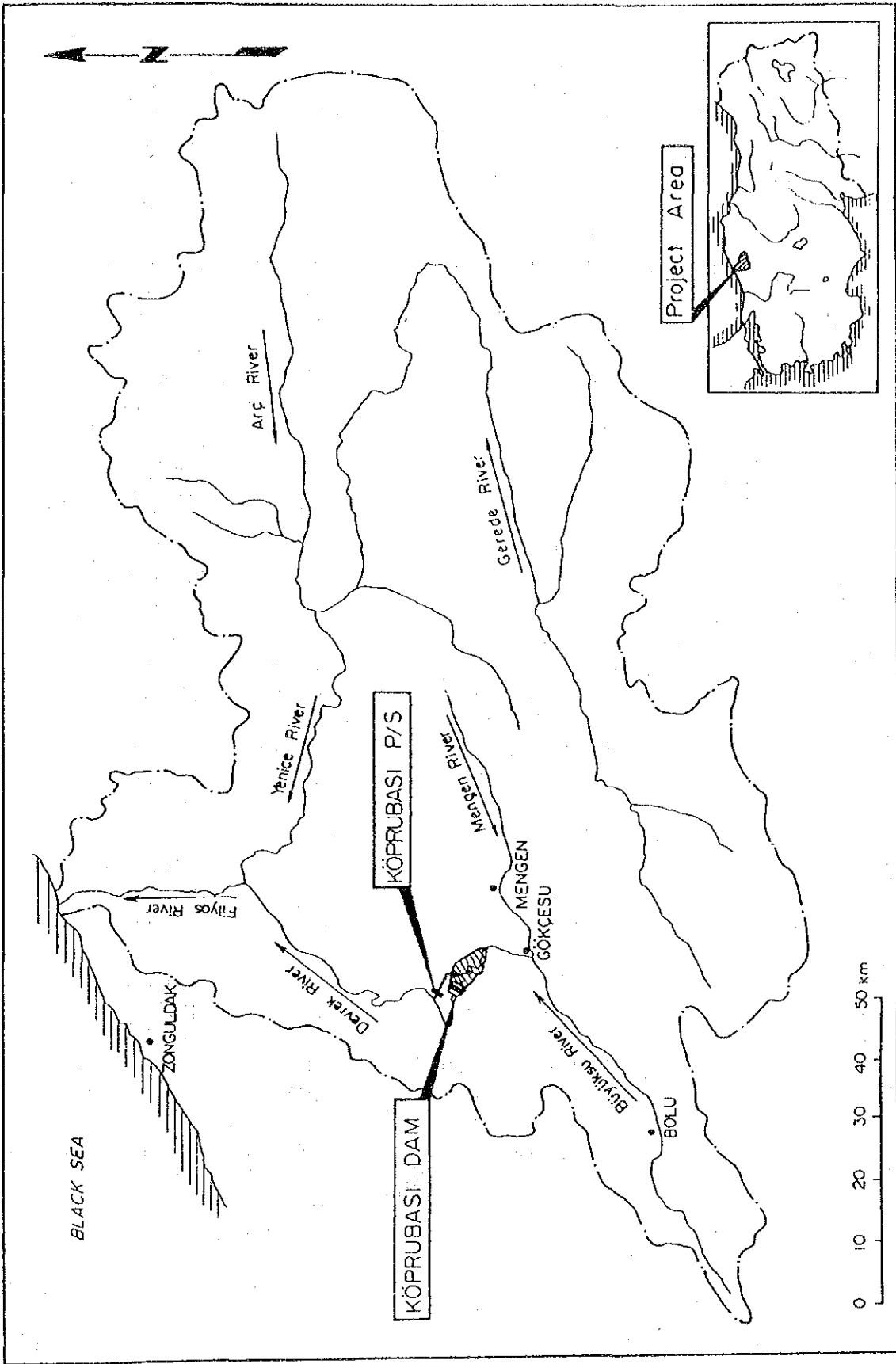


Figure II-2 Location of Köprübaşı Project Site

Table II-1

Outline of Köprübaşı Project

Reservoir Layout	Catchment Area	(Km ²)	1,994.00
	Annual Inflow	(m ³ /s)	14.39
	High Water Level	(m)	437.00
	Normal Water Level	(m)	422.00
	Low Water Level	(m)	392.00
	Available Drawdown	(m)	45.00
	Gross Storage Capacity	(10 ⁶ m ³)	197.70
	Effective Storage Capacity	(10 ⁶ m ³)	163.20
	Reservoir Area	(Km ²)	5.31
Dam Type	Hight from Foundation	(m)	110
	Crest Length	(m)	530
	Volume	(10 ³ m ³)	4,669
Headrace Tunnel	Type		Pressure
	Diameter	(m)	4.6
	Length	(m)	0.00
Penstock	Type		Tunnel Emb
	Diameter	(m)	3.4
	Length	(m)	250.00
Power House	Type		Underground
Tailrace Tunnel	Type		Nonpress.
	Diameter	(m)	4.6
	Length(Tunnel)	(m)	4,960.00
	(Channel)	(m)	200.00
Development Plan	Firm Discharge	(m ³ /s)	10.77
	Maximum Discharge	(m ³ /s)	43.10
	Tail Water Level	(m)	233.00
	Gross Head		
	Maximum	(m)	214.00
	Normal	(m)	199.00
	Minimum	(m)	169.00
	Loss of Head	(m)	7.89
	Effective Head		
	Maximum	(m)	206.11
	Normal	(m)	191.11
	Minimum	(m)	161.11
	Installed Capacity	(MW)	71.3
	Firm Peak Power	(MW)	65.2
	Annual Energy		
Average	(GWh)	214.9	
Firm	(GWh)	142.8	
Secondary	(GWh)	72.1	

Chapter III Economical and Social Aspects of Project

III.1 Investment Program and Financing Source

III.2 Processes Relating to Enforcement

III.3 Cost Benefit of Project

III.4 Others

(DSI describes the contents of this chapter).

Chapter IV Environmental Characteristics of the Area Selected for Project

IV.1 Physical and Biological Characteristics and Utilization of Natural Resources

IV.1.1 Meteorological and Climate Conditions

(1) Vicinity of the Project Area

The central and north side areas of Filyos basin are subjected to the influence of the Black Sea but its area is also influenced by the central Anatolia's climate by the topography.

The climate of the Black Sea creates a diversity of agriculture by its rich rainfall, but the rainfall at the plain and valley in this region is less than the north side area, and snow falls in winter and the climate dries up in summer.

Bolu, Gerede and its periphery are cold during the winter season similar to that in the Eastern Anatolia.

This area is occupied by the Continental Climate which is characterized by a dried up summer season and a cold winter season.

Annual average atmospheric temperature¹⁾ is 13.5°C at Devrek, 10.2°C at Bolu and 9.5°C at Pazarköy. The annual average rainfall¹⁾ is 775 mm at Devrek, 537 mm at Bolu, 640 mm at Pazarköy.

Filyos basin has rainfall during all the seasons and the quantity is much during the winter and the spring seasons.

In addition, southern part of this area has the characteristic that the precipitation is obtained as snow in winter season, whereas the northern area has it as rain.

The average wind velocity¹⁾ is 1.6 m/sec at Devrek and Safranbolu, 1.9 m/sec at Gerece and 2.4 m/sec at Çerkes. The maximum wind velocity is 28.5 m/sec in the direction of southwest.

(2) Project Area

4 meteorological observatories are (Figure IV-1) located at Bolu, Yeniçağa, Pazarköy and Gökçesu near planned area. According to the meteorological observation data²⁾, the mean annual rain fall in the basin is 500 ~ 680 mm, and it increases at northern part of basin. Monthly rainfall is about 50 ~ 60 mm (Table IV-1), and is much in the term from December to June.

Annual mean temperature and humidity are shown in Table IV-2 and IV-3. Wind direction and velocity are shown in Table IV-4.

Number of snowing days in the project area is shown in Table IV-5.

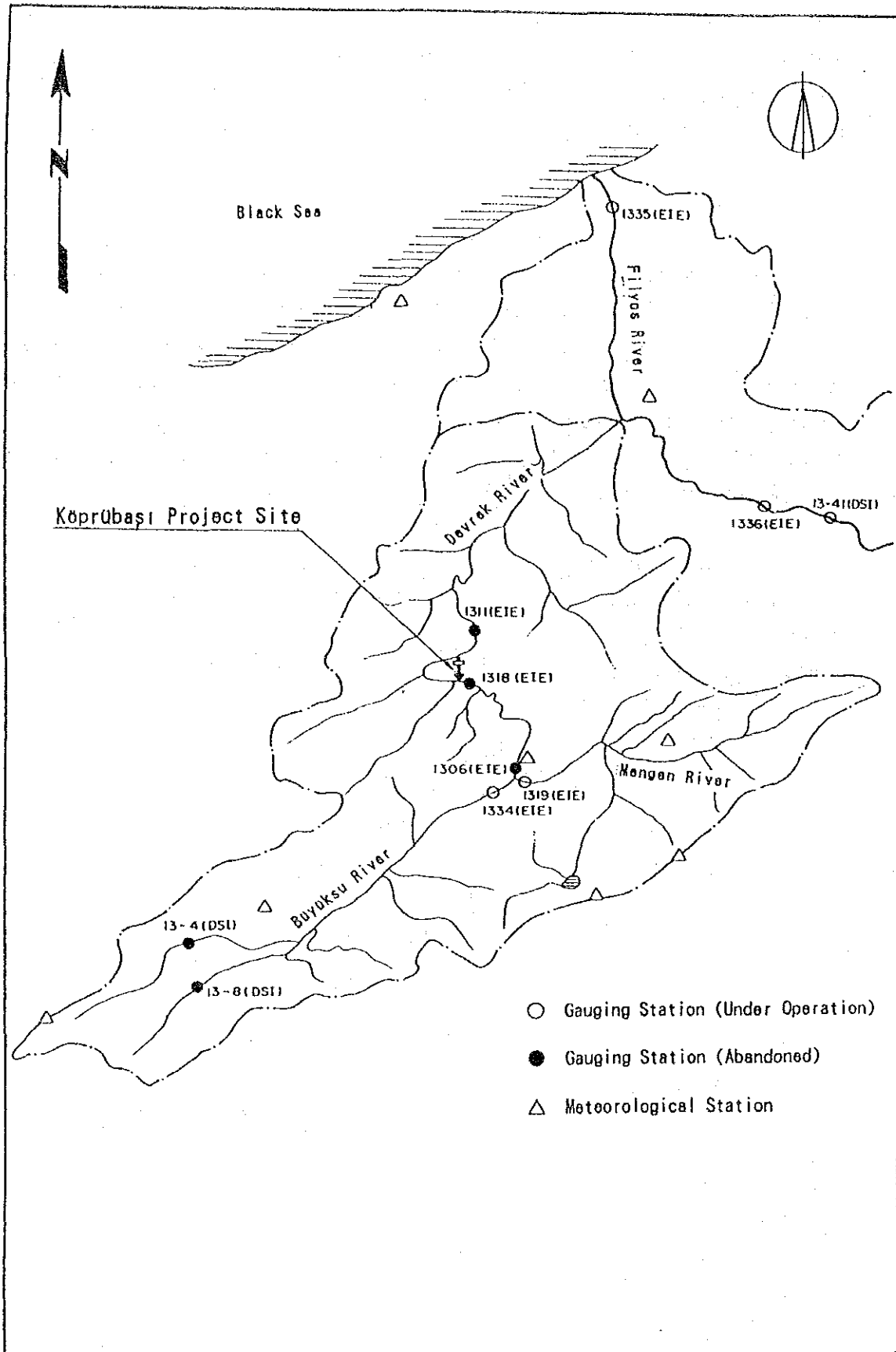


Figure IV-1

Location of Meteorological Stations and Gauging Stations

Table IV-1 Monthly Average Precipitation in the Project Area and Vicinity

Station	Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Bolu	1929-90	58.5	47.8	48.1	48.7	58.4	52.0	26.5	20.4	28.8	37.1	49.1	61.7	537.1
Yeniçağa	1964-87	46.2	36.4	44.0	49.0	69.7	56.7	27.5	27.9	26.1	34.5	40.0	53.6	511.4
Pazarköy	1943-90	62.2	52.3	57.0	65.4	78.0	66.3	32.8	26.8	34.9	49.3	53.1	62.2	640.3
Gökçesu	1955-90	71.1	47.5	52.8	62.1	74.4	59.9	35.1	43.0	30.1	57.0	64.8	85.7	683.5
Gerede	1957-90	64.7	51.2	58.0	65.8	87.5	71.4	35.9	25.3	34.9	39.0	52.0	72.6	658.3
Devrek	1950-91	80.0	63.6	57.6	53.0	63.5	60.5	48.0	49.6	52.2	75.1	84.8	87.1	775.0
Zonguldak	1931-90	141.3	102.5	92.1	69.2	53.8	69.9	72.8	86.5	95.2	144.7	146.4	145.7	1220.1

Unit: mm

Table IV-2 Monthly Mean Temperature in the Project Area and Vicinity

Station	Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Average
Bolu	1929-90	0.4	1.6	4.5	9.5	13.8	17.0	19.4	19.5	15.7	11.5	6.9	2.7	10.2
Pazarköy	1965-91	0.3	1.7	4.6	9.1	13.0	16.2	18.4	18.1	14.7	10.5	5.9	2.1	9.5
Gerede	1963-86	-2.5	-1.0	2.3	6.9	11.0	14.3	16.7	16.5	13.3	9.1	4.5	-0.1	7.6
Devrek	1965-90	4.7	5.6	7.6	12.6	16.6	20.1	22.5	22.2	18.8	14.0	10.1	6.5	13.5
Zonguldak	1937-90	6.0	6.2	7.2	11.0	15.2	19.4	21.6	21.4	18.4	14.9	11.7	8.5	13.5

Unit: °C

Table IV-3 Monthly Average Humidity in the Project Area and Vicinity

Station	Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Average
Bolu	1930-90	77	75	72	69	72	71	68	67	70	74	76	78	72
Pazarköy	1964-90	80	77	74	70	73	72	72	71	75	78	79	81	75
Gerede	1954-90	77	73	69	61	62	64	61	61	62	63	68	76	65
Devrek	1964-90	72	71	67	63	65	64	64	65	66	68	69	72	67
Zonguldak	1937-90	70	70	71	72	74	73	73	73	73	74	70	69	72

Unit: %

Table IV-4 Monthly Maximum Wind Velocity and Direction in the Project Area and Vicinity

Station	Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Max.
Bolu	1937-90	24.5	23.6	28.5	26.9	21.6	21.0	20.9	28.9	18.1	20.5	24.0	23.5	28.9
		S	S	SW	SSE	S	H	H	H	H	H	WSH	NW	H
Zonguldak	1937-90	36.4	31.8	29.5	31.5	27.8	28.2	23.8	31.5	28.4	25.2	32.0	29.2	36.4
		N	SSE	SSH	SW	H	SSE	WSH	WNW	NW	NNE	SSE	SSH	N

Unit: m/s

Table IV-5 Number of Snowing Days in the Project Area and Vicinity

Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total	Unit: day	
Bolu	7.5	7.2	4.5	0.5	-	-	-	-	-	0.1	1.3	4.3	25.4		
Yeniçaga	6.6	6.0	4.4	1.5	0.0	-	-	-	-	0.1	1.7	4.6	24.9		
Pazarköy	8.0	7.7	4.9	0.7	-	-	-	-	-	-	1.5	4.6	27.4		
Gökçesu	5.8	4.8	3.2	-	-	-	-	-	-	-	1.3	2.8	17.9		
Gerede	12.4	11.0	8.1	3.3	0.2	-	-	-	-	0.7	2.4	8.6	46.7		
Devrek	3.4	2.8	1.0	-	-	-	-	-	-	-	0.3	0.9	8.4		

IV.1.2 Geological Characteristics

(1) Topography

a) Vicinity of the Project Area

The topography in Turkey is characterized by the structural topography of approximately the east west direction while reflecting its geological structure as a whole. They can be roughly classified into 3 zones, namely the Pontos Mountain Range expanding in the east west along the Black Sea, the Anatolia Plateau Region on its south side and the Taurus Mountain Range Region on the south side of Anatolia Plateau.

Devrek River is a branch of Filyos River flowing into the Black Sea, and is the river in the Pontos Mountain Range.

60 % of the Filyos River basin gradually increases in its altitude from north to south, and is covered by the Pontos Mountain Range directing to the east west. There exist many mountains also in the topography in the south areas, and the valleys and plains are distributed among the mountains. The Sariçiçek Mountain in Safranbolu District is the highest in this region and has the height of 1,637 m. The mountains in one of branch ranges of Bolu Mountain Lump topographically divides Bolu Province from Zonguldak Province, and passes through the center of Filyos water system.

b) Project Area

The Devrek River inside the project area is classified into the block which flows to the geological structure and into the block which crosses with it, and these blocks are repeated at the respective locations, but

generally speaking, the latter portion builds up a V-shape valley. In addition, the mountains having their crests at latitude being from about 1,000 m to about 2,000 m indicated the layout of south west to north west direction on both the banks of river. These mountain postures have a comparatively round profile.

The slope degree at the project area, which is facing the Devrek River is sharp by the lower area carving action of Devrek River. The reservoir and the dam site are planned on this sharp topography while the facilities of raceway and the like are planned to be installed at the area of mountain bodies having a comparatively round profile.

No large scale landslide nor a collapse of land can be recognized at the project area. In addition, any scientifically excellent topography or any other topography excellent in the landscape view point can be found.

The left bank of dam site is an approximately uniform slope surface from 30 to 40°, but the right bank is a ridge elongating slenderly to the south direction, and the dam is placed on the tip of this ridge (Figure V-1).

(2) Geology

a) Vicinity of the Project Area

The geological structure in Turkey has an east west directionality, generally can be classified into the Pontides Zone which elongates the Anatolia Landmass approximately into the east west direction and into the Anatolides on its south side, and can also be classified into the western Taurides and the eastern bend zone on the Mediterranean Sea side. The western

area of Pontides Region can be further classified into the Istanbul Region and the Sakarya Region.

The Istanbul Region entails the metamorphic bedrock of Precambrian era while the Sakarya Region doesn't include the layer of the Paleozoic era as the initially generated layer. The entire region including the project area belongs to the west area of Istanbul District of Pontides Region, wherein the gneiss and schist of the Paleozoic era, the granite and granodiorite (diorine granites) of the Mesozoic era and the marl, mudstone, sandstone and limestone (Gökçesu layer) of the Tertiary period are distributed.

b) Project Area

The bed rock consisting of granite rock and the granodiorite and the surface layer precipitated substances covering the said areas are distributed on the periphery of dam site.

The bed rocks are of the weathered portion down to several meters in depth, and even the further lower portion becomes brownish because of the crack surfaces which are oxidized down to a considerably deep position depending on the locations. The precipitated substances of surface layer prove to be the surface soil of about 50 cm thickness and also the river bed sand and gravel as well as the terrace precipitated substance of about 10 cm covering or being distributed on the slope of both the banks.

The majority of granite rocks being distributed in this spot entail unseparated hair cracks even in their fresh areas, and the Mylonite looking granite rocks can be partially recognized.

The underground water level rises to the mountain side along the topography on both the banks.

The granite, gneiss, schist and limestone of the Paleozoic era, and the limestone, sandstone and mudstone of the Tertiary period are distributed on the peripheral areas of reservoir (Figure IV-2, Figure IV-3).

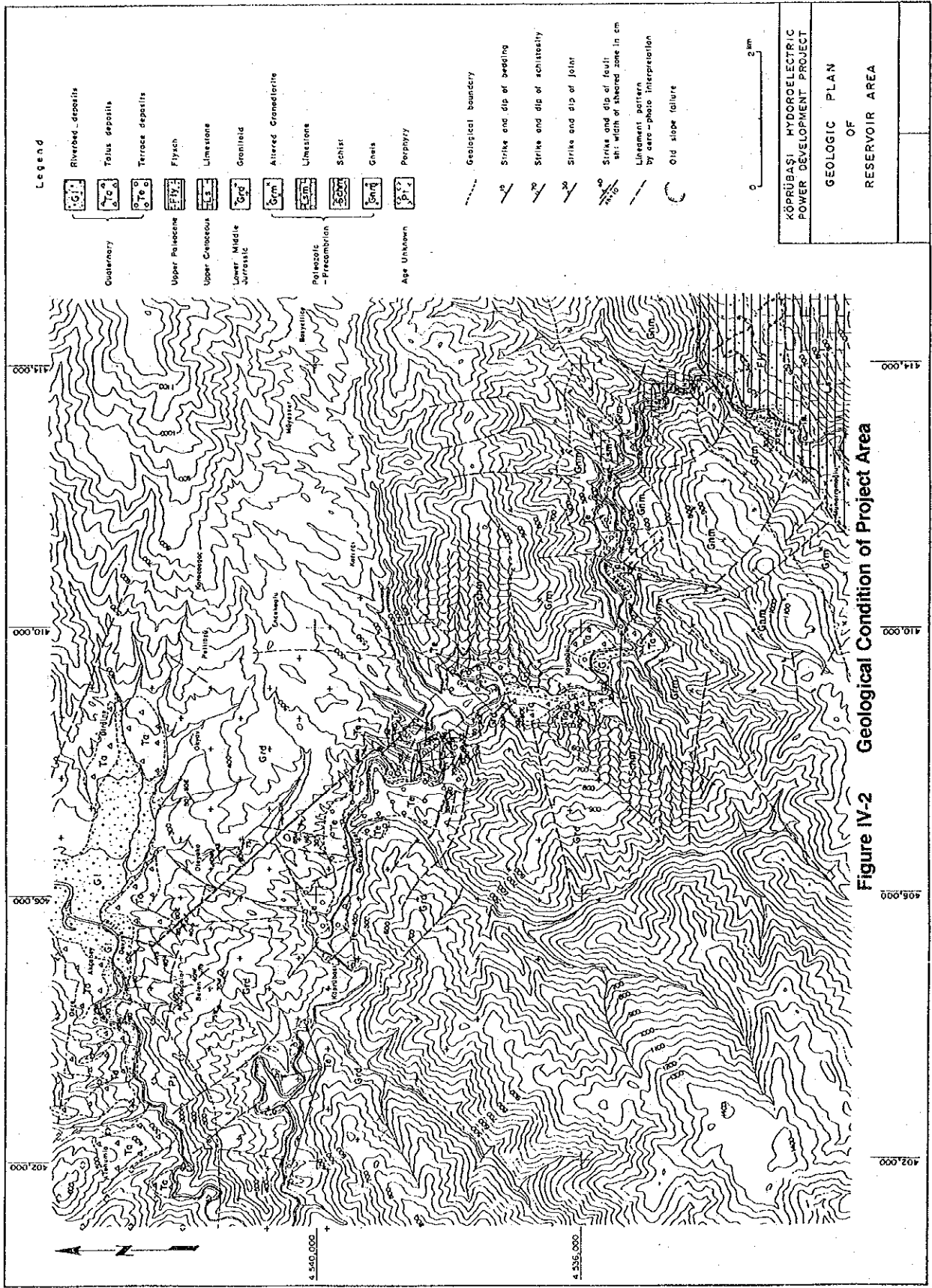
The raceway passing-through land is structured of granite rock and granodiorite, its surface is weathered to the decomposed state and its topography is gentle.

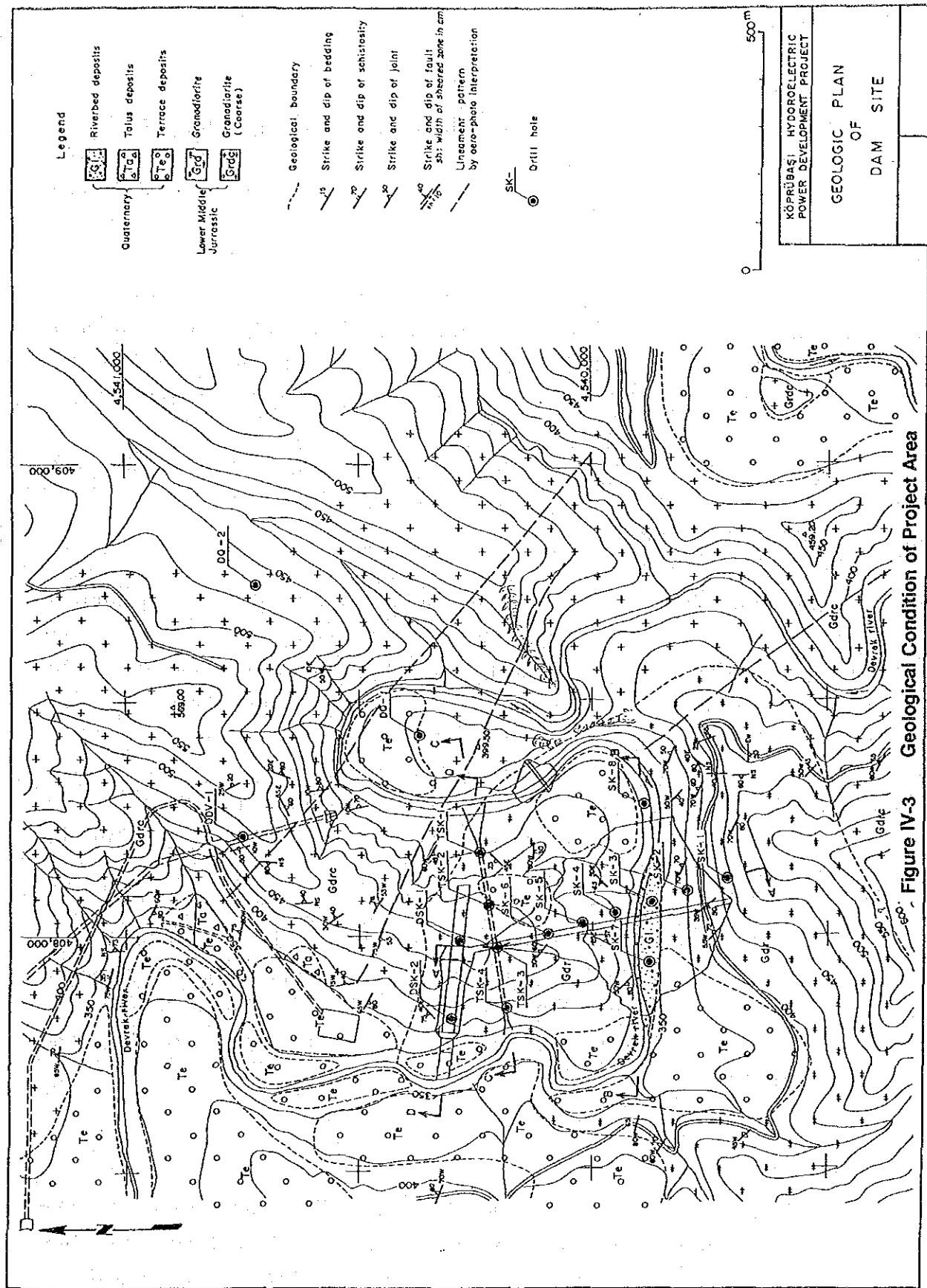
This area is of a general geology in the Istanbul Region, and especially the scientific geology and the geology excellent in the landscape are not distributed therein.

(3) Earthquakes

Turkey has two transform faults forming the plate boundary called the North Anatolia Fault and the East Anatolia Fault.

The North Anatolia Fault passes through the vicinities of Gerede City and Bolu City to the south southwest direction from the north northeast and extends to the south, 24 to 30 km from this project spot. For this reason, the project spot is located at Second Degree of Seismic Zone.





KÖPRÜBAŞI HYDROELECTRIC
POWER DEVELOPMENT PROJECT

GEOLOGIC PLAN
OF
DAM SITE

Figure IV-3 Geological Condition of Project Area

IV.1.3 Hydrogeological Characteristics

(1) Vicinity of the Project Area

According to the relationships between geology and the quantity of groundwater¹⁾ in the vicinity of project area, it is reported that the peripheral geology (Figure IV-4) can be divided into 3 types.

One of the groups consists of Crystalline schists (pk1), Grantothoids (mg2) and Granites (mg5), and in this area a slight quantity of groundwater can be observed along the fractures and fissures in the stratum having no porosity.

The second group is the Flysch of Mesozoic era and the Cenozoic era, which are Clay, Claystone, Sandstone, Pebblestone, Marl and Limestone system.

They show the negative characteristics from the viewpoint of groundwater, but the Limestone, Pebblestone and Sandstone strata relate to the granted existence of groundwater depending on the position of stratum.

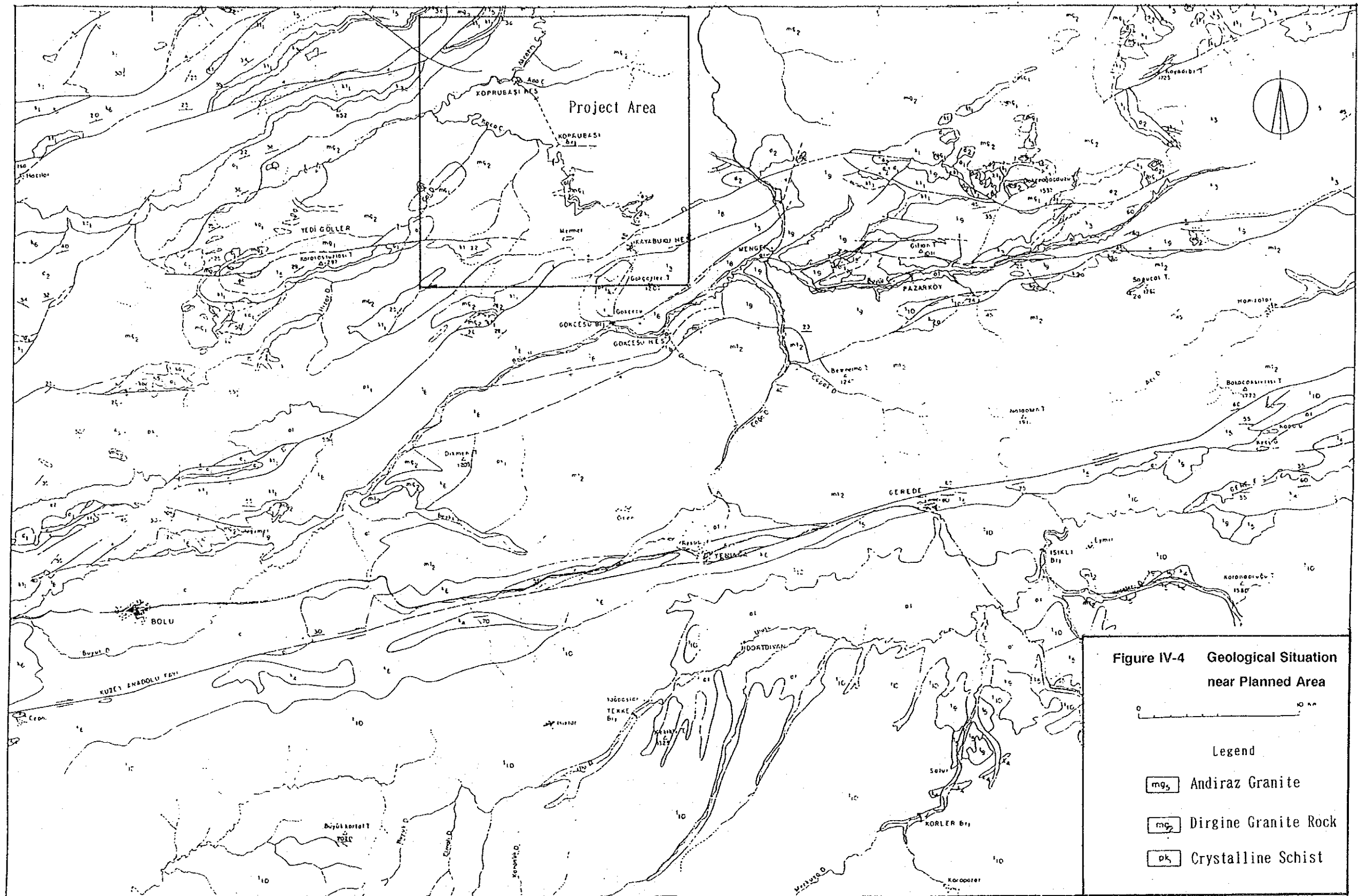
The third group is the Inalti stratum (Tor) to which the Safranbolu Lime stone and Soğanli Limestone relate, but differs from the foregoing group from the viewpoint of groundwater.

A great amount of groundwater springs up at the location of Karastic stratum formed along the fissures and fractures generated inside the Limestone by Tectonism, and its typical locations are Safranbolu, Karabük, Yenice and Çaycuma.

(2) Project Area

The stratum of project area is Grantothoids (mg2) in the first group, and the groundwater is slight and is less than 10 Lt/sec³⁾ as compared with the standard flow out water

volume in object of the development of ground water.
For information, there is no project for utilizing the
groundwater at the project area, and there exists no
permitted groundwater well except for that in Mengen and
Çaycuma Plain.



IV.1.4. Soil Characteristics and Usage Conditions

(1) Vicinity of the Project Area

The kinds of soil⁴⁾ being distributed in the peripheral areas are Alluvial Soil, Hydromorphic Alluvial Soil, Grey-brown Padsolic Soil, Red-yellow Padsolic Soil and Non-calcareous Brown Forest Soil (Figure IV-5, Figure IV-6) and no distribution of organic rich soil can be seen in the area.

The Non-calcareous brown forest soil is distributed in the range from Gökçesu village to Ericek settlement, that is located on the opposite bank.

The distributions of Non-calcareous brown forest soil and Arburn soil can be observed in the area toward Bolu city located in the upper stream area.

The Grey-brown soil is distributed in the east-west direction in the peripheral area of project area but its kind changes in the south-north direction near Köprübaşı village as its boundary, and the Red-yellow padsolic soil and the Hydromorphic alluvial soil are distributed respectively in the downstream area of that north side and furthermore in the north area.

The degree of Erosion⁴⁾ of soil in the vicinity of project area (Figure IV-7, Figure IV-8) is included in a high class.

But the northern part near reservoir area is included in the medium class.

The thickness of major soils is to be from 0 to 90 cm in the area from Gökçesu village to the Ericek village (Figure IV-9, Figure IV-10)

Between Gökçesu village to köprübaşı village, the thickness of soil is from 20 to 50 cm and the same situation can also

be found in the northern area from Köprübaşı village.

The pH⁵⁾ of soil in Bolu province varies to some extent with the soil layers, but most parts of soil show the pH in the range from 7.5 to 8.0, though the range in Bolu is from 6 to 8.5.

Soils in Mengen district show a slightly higher pH which ranges from 7 to 8.5 in comparison with that of Bolu province.

The content of lime⁵⁾ in the soil ranges from 1 to 5% in many areas in Bolu province, which is in the same range as in Mengen district, but Mengen district has a large area and shows slightly higher value than other districts.

Vicinity of project area shows the organic content in the range from 1 to 3%. This value is the general value of soils.

According to the soil utilization map⁴⁾ (Figure IV-11, Figure IV-12), the vicinity of project area is included in the area and can be utilized only as a pasture and a forest by the limitation of slope condition, rock content and erosion degree.

(2) Project Area

The kinds of soil distributed at the project area⁴⁾ are Grey-brown pedsolic soil, Red-yellow pedsolic soil, Alluvial soil, Hydromorphic soil and Colluvial soil.

Alluvial soil is distributed to the agricultural area in the valley from the vicinity to dam site to Köprübaşı village whereas the Grey-brown pedsolic soil is distributed to the reservoir area in the upstream side from Kesebükü and Kayabükü villages.

The thickness of these soils⁴⁾ is more than 90 cm. Degree of soil erosion is divided into two parts near Kesebükü village in the future reservoir area.

The soil erosion degree in the north area including the dam site enters the medium range while that in the south area enters the high range.

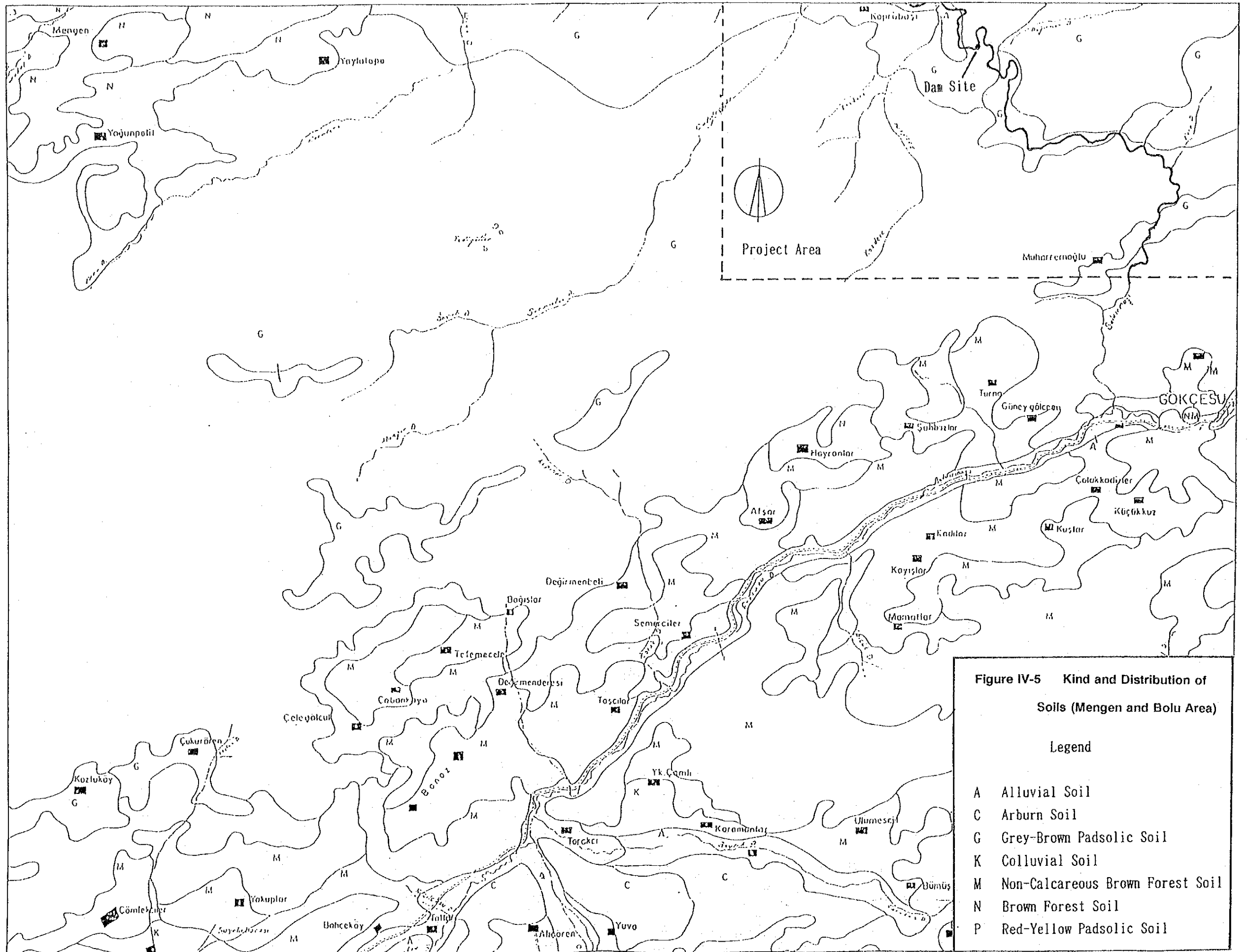
Reservoir area is included in the area limited to agricultural activity as well as its vicinity from the viewpoint of soil utilization.⁴⁾

Soils on the river side from dam site to Köprübaşı village are suitable for any agriculture, because these soils are thick in depth.

The fields near Akçabey village on the downstream from Köprübaşı village are also suitable for agriculture and this area is specified as first class agricultural fields.⁴⁾

The third class agricultural fields are distributed to the south-east area from this first class fields.

Moreover, other first class agricultural fields⁴⁾ are distributed along the river side from Özbaşı village to Devrek city.⁴⁾



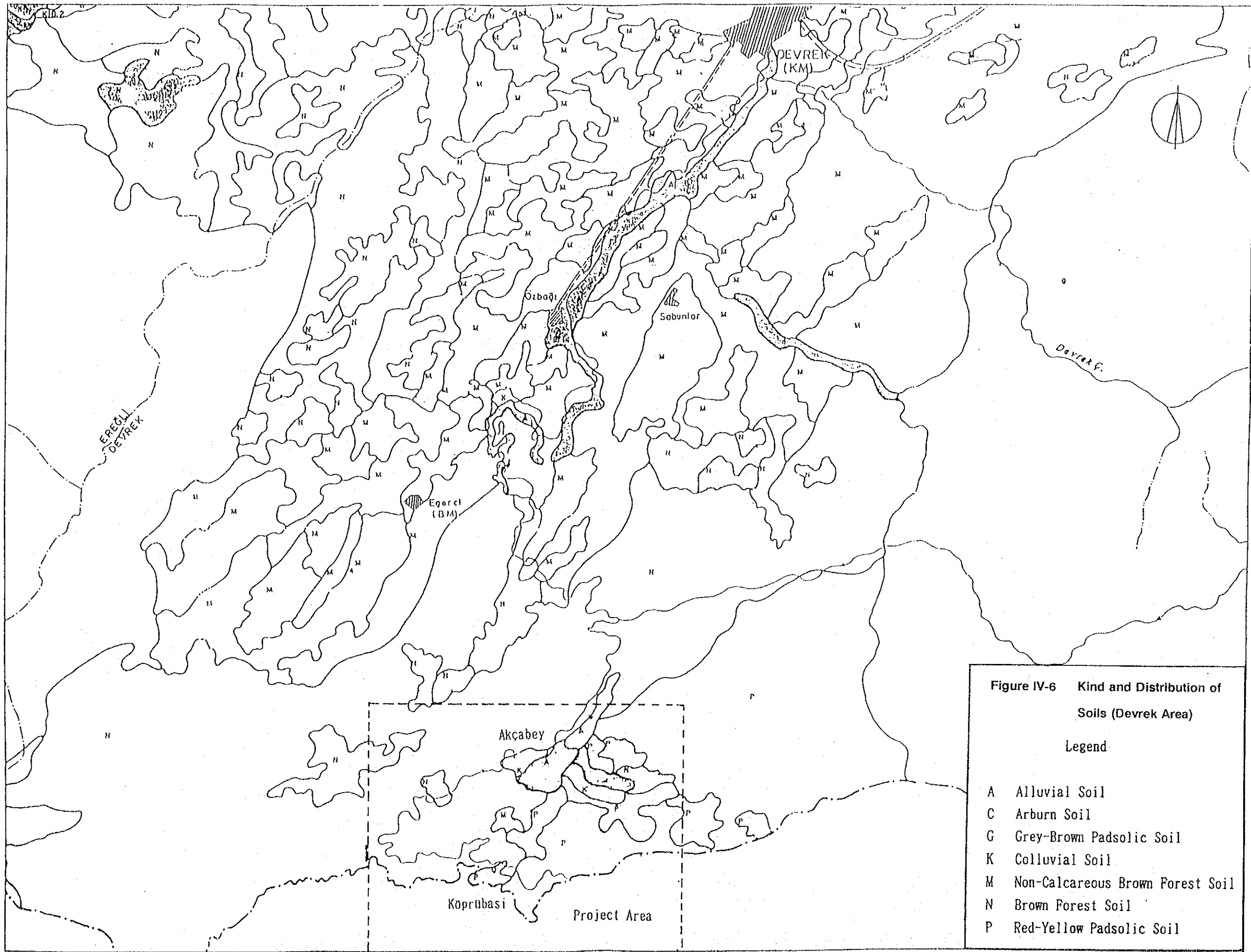
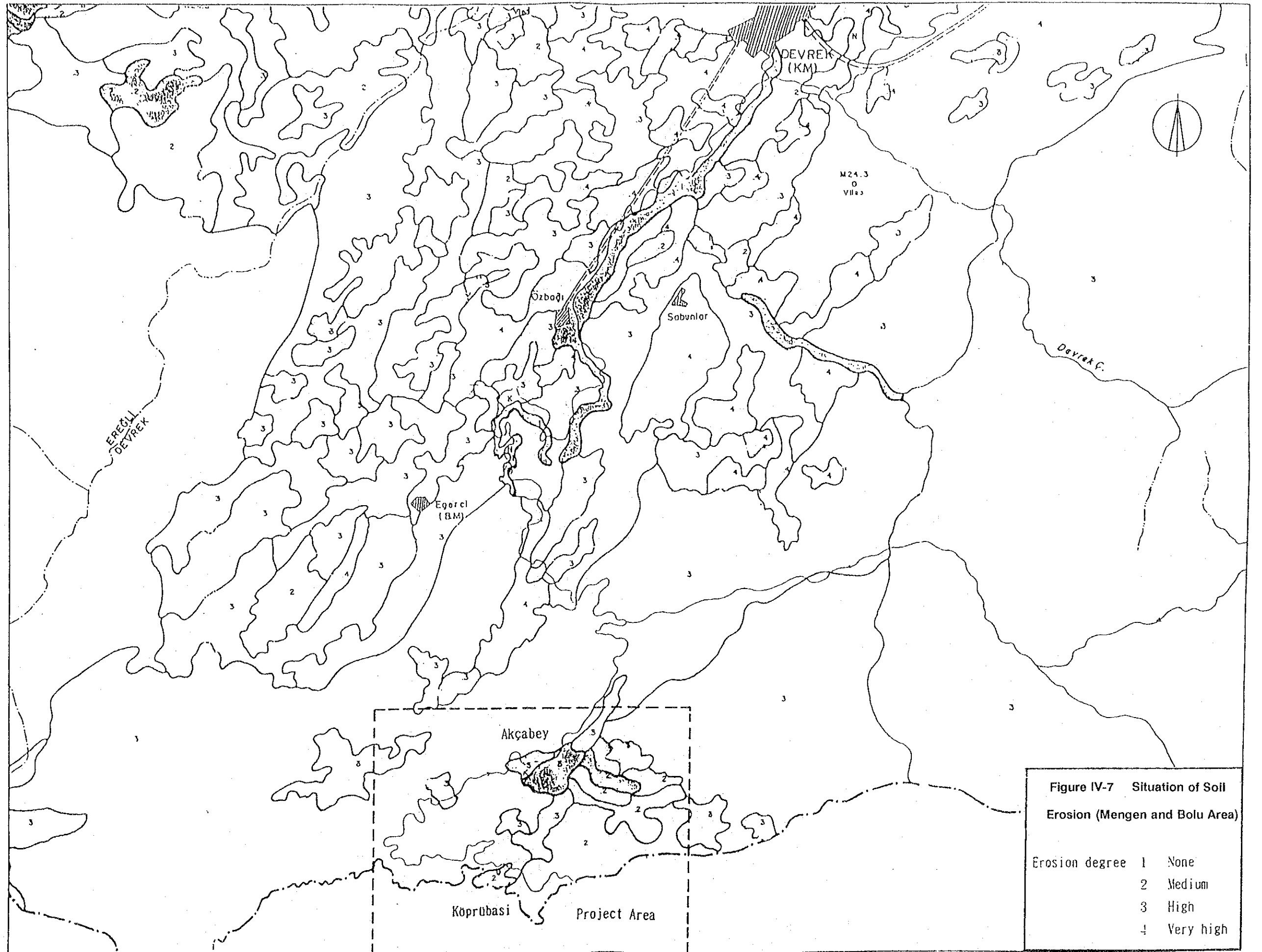
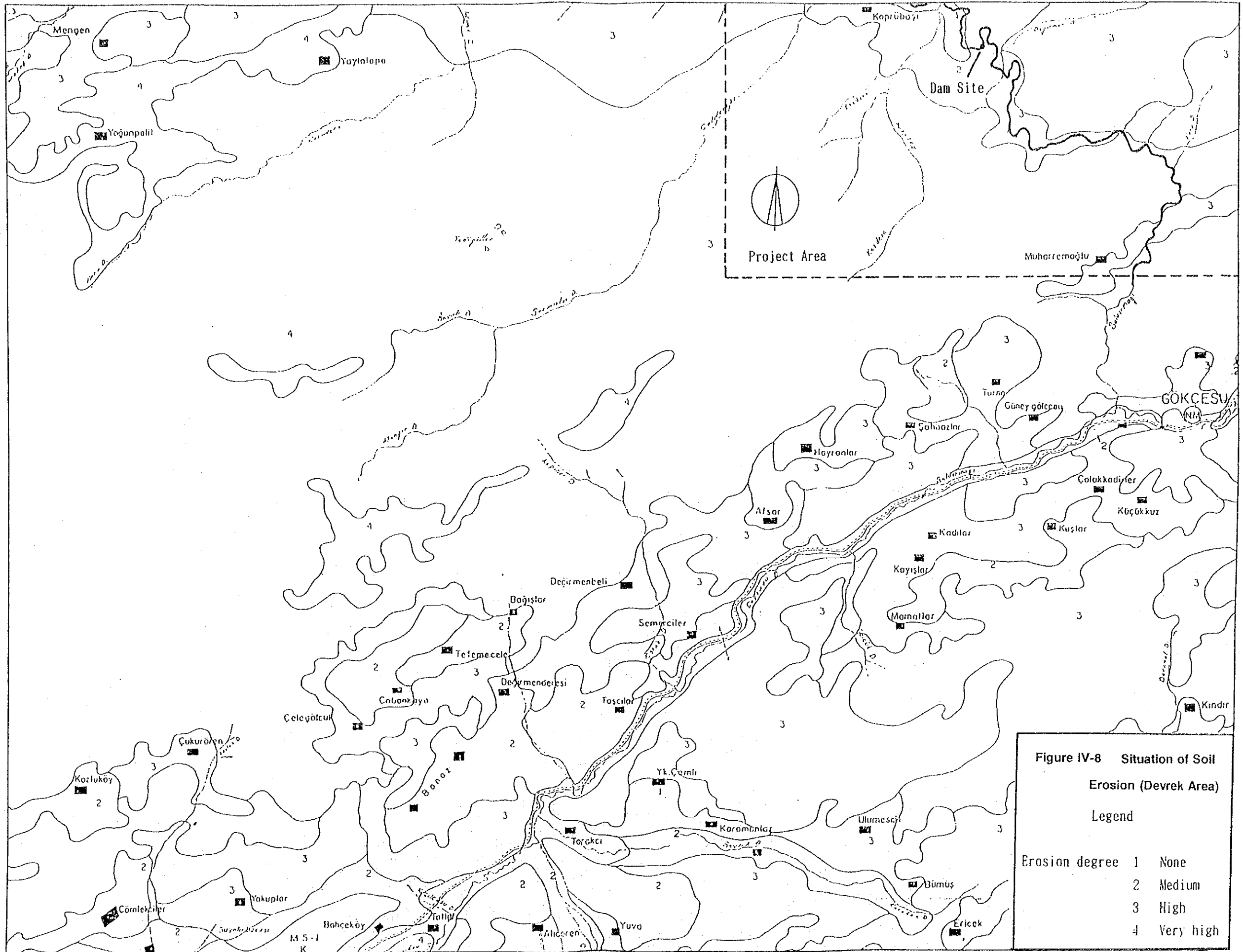


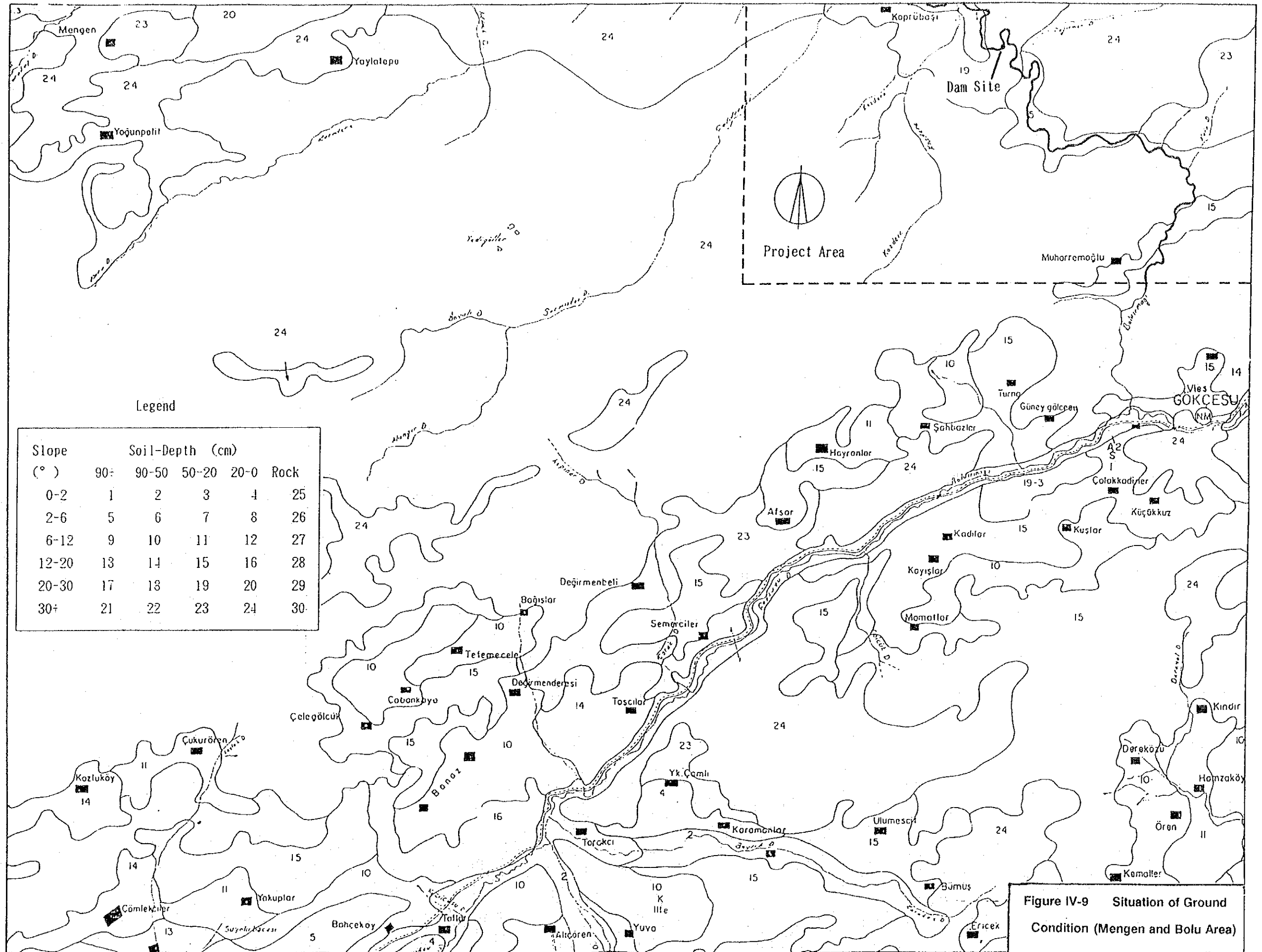
Figure IV-6 Kind and Distribution of Soils (Devrek Area)

Legend

- A Alluvial Soil
- C Arburn Soil
- G Grey-Brown Padsolic Soil
- K Colluvial Soil
- M Non-Calcareous Brown Forest Soil
- N Brown Forest Soil
- P Red-Yellow Padsolic Soil



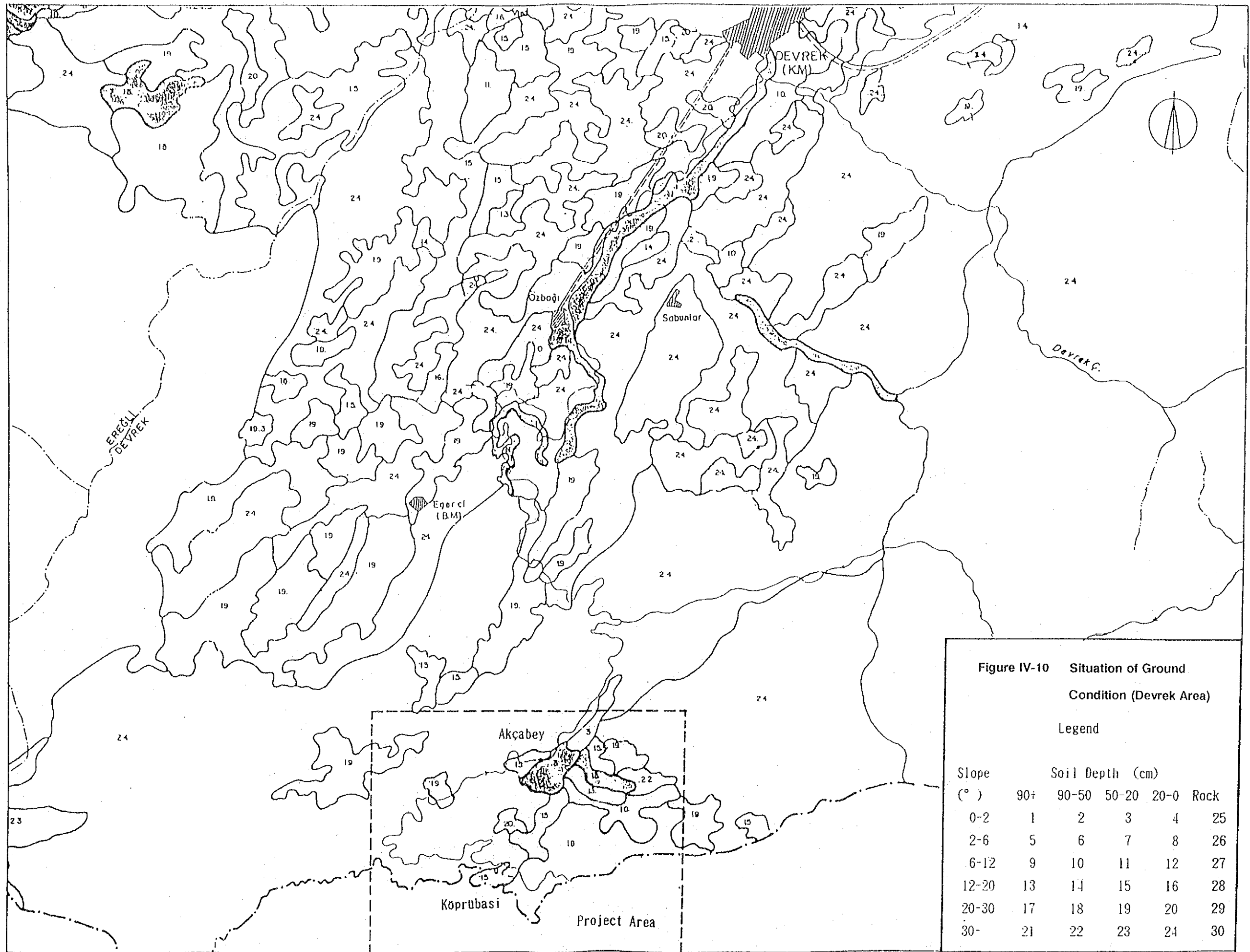


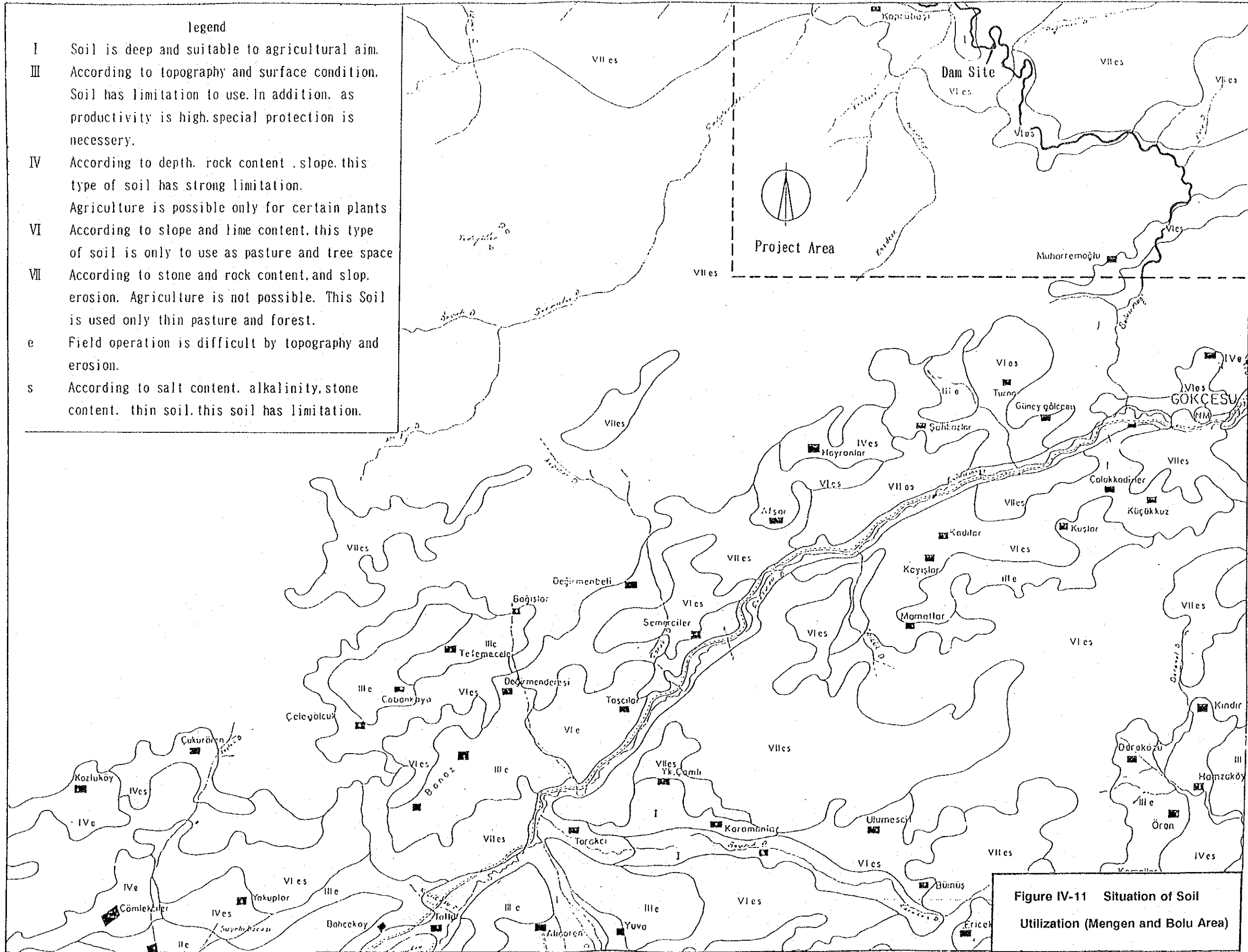


Legend

Slope (°)	Soil-Depth (cm)				Rock
	90+	90-50	50-20	20-0	
0-2	1	2	3	4	25
2-6	5	6	7	8	26
6-12	9	10	11	12	27
12-20	13	14	15	16	28
20-30	17	18	19	20	29
30+	21	22	23	24	30

Figure IV-9 Situation of Ground Condition (Mungen and Bolu Area)





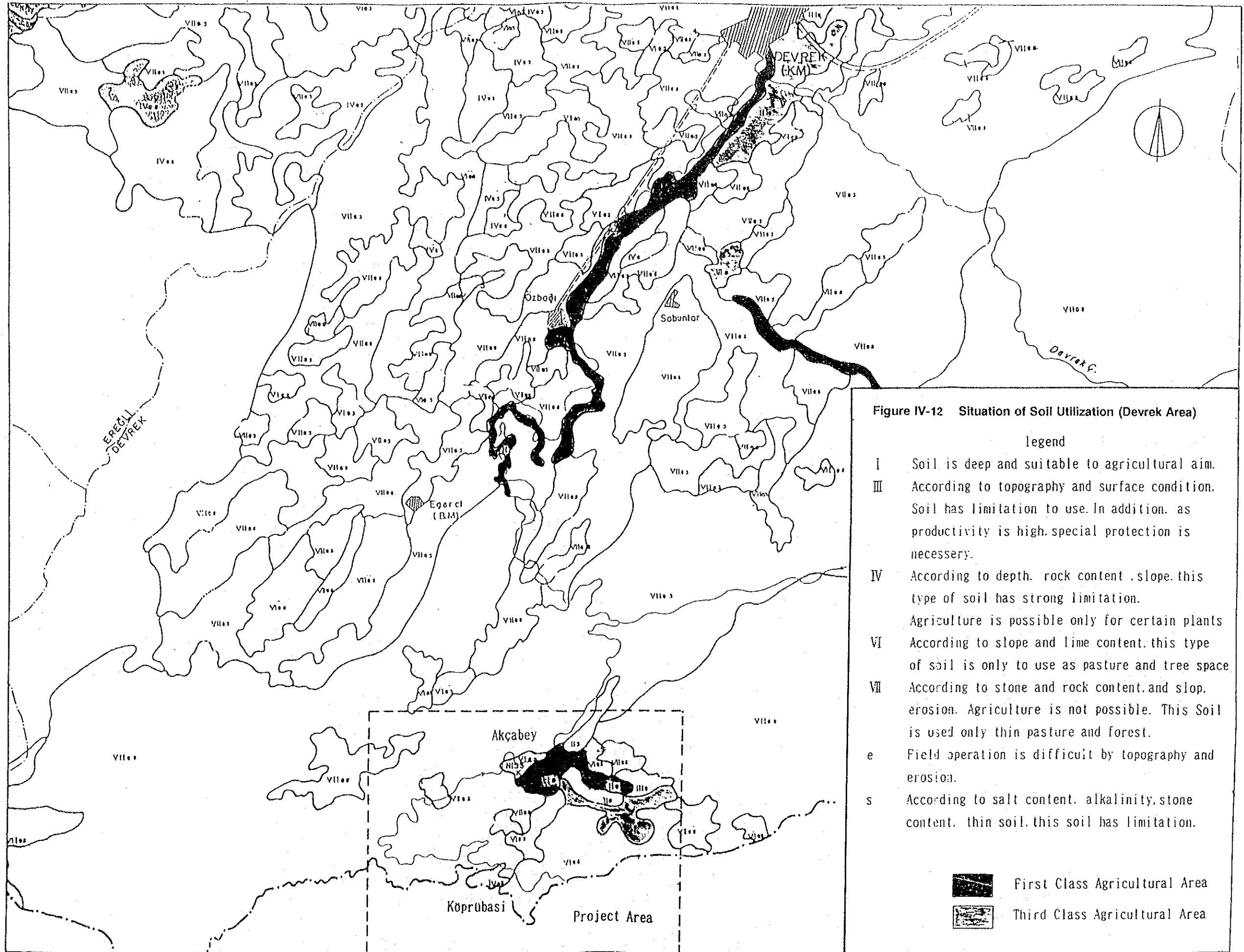




Figure IV-12 Situation of Soil Utilization (Devrek Area)

Legend

- I Soil is deep and suitable to agricultural aim.
- III According to topography and surface condition. Soil has limitation to use. In addition, as productivity is high, special protection is necessary.
- IV According to depth, rock content, slope, this type of soil has strong limitation. Agriculture is possible only for certain plants.
- VI According to slope and lime content, this type of soil is only to use as pasture and tree space.
- VII According to stone and rock content, and slope, erosion. Agriculture is not possible. This Soil is used only thin pasture and forest.
- e Field operation is difficult by topography and erosion.
- s According to salt content, alkalinity, stone content, thin soil, this soil has limitation.

-  First Class Agricultural Area
-  Third Class Agricultural Area

IV.1.5 Agricultural Fields

(1) Vicinity of the Project Area

According to the statistical data of land utilization in Bolu and Zonguldak provinces⁶⁾ (Table IV-6), forest and agricultural area in Bolu, Mengen and Devrek districts covers about 42%, 76% and 86% respectively.

In Bolu district, about 72% of this area consists of forest, and in both Mengen and Devrek districts forest area covers about 80% in both.

The agricultural areas⁶⁾ (Table IV-6) in Bolu, Mengen and Devrek district are 707,418 ha., 66,501 ha., and 101,369 ha., respectively, and the total area of agricultural land in these 3 districts is 875,288 ha.

The irrigated agricultural fields occupy about 3.5% of total agricultural area in Bolu district.

In Mengen and Devrek district, they occupy below 0.1% and 2.2%, respectively.

The area used as orchards is about 3.5%, less than 0.1 % and less than 0.1% for Bolu, Mengen and Devrek, respectively. Moreover, area used as vineyards is also extremely small.

According to the kind and annual production⁶⁾ of agricultural products in each of areas (Table IV-7), 37 kinds of products are being produced.

Main products in Bolu district are wheat, barley, maize and potato, while the wheat and barley and potato are mainly produced in Mengen district.

Table IV-7 shows these 3 districts have almost the same products in dry farming and irrigated agriculture.

In Devrek district, wheat and maize are main products.

Looking at the productivity of products⁶⁾, Bolu district has a high productivity on maize and potato while this district has a trend of slightly higher productivity on wheat and barley too.

As regards the cultivation of tree fruits and nuts, 15 kinds of tree fruits⁶⁾ are cultured, and the most high production is placed on hazel nuts, being followed by apples (Table IV-8).

Comparing the amount of annual production⁶⁾ and the number of kinds of crops, Bolu district shows the high productivity on agricultural fields.

According to the amount of fertilizer used in Bolu district⁷⁾, it is reported 346 tons of the ammonium system fertilizer was used in one year, in addition to 152 tons of urine system fertilizer, 59 tons of TSP, 27 tons of DAP, 392 tons of compost.

(2) Project Area

Location of project area is in the boundary between Mengen district of Bolu province and Devrek district of Zonguldak province.

In the north side of project area, the dry farming area is expanded widely⁴⁾ to Devrek city.

The vicinity of project area is covered by forest, but the agricultural cultivated area⁴⁾ is spread from Köprübaşı village to Akçabey village (Figure IV-13, Figure IV-14).

A part of this cultivated area is specified as the first class agricultural fields⁴⁾, according to the map of land classification (Figure IV-11, Figure-12).

In the upstream side of Köprübaşı village, Kayabükü and

Kesebükü village are distributed along the Bolu river, and small agricultural fields exist in the bottom of valley where the dry farming and the small irrigation farming are being managed.

Another farming area is expanded in the east/west direction with the Bolu river being crossed over also in the vicinity of Muharremoğlu village further in the upstream. In this region, agricultural fields are mainly utilized as dry farming.

The irrigation agricultural fields⁴⁾ utilizing the river water exist along the Devrek river up to the join point with the Filyos river in the downstream side of project area.

The area of irrigation agricultural field and dry farming field in the submerged area (Figure IV-15) come up to 426 da and 2,330 da, respectively. The kinds of major agricultural products are fresh bean, tomato, and pepper, and corn and spinach are secondary products, wheat and corn are produced in barren zones as feed for livestock⁸⁾.

The surplus products other than the self consumed portion are sold out to Gökçesu village and Bolu city.

Apples, cherries and walnuts are growing in the future submerged area and it is reported that there are 595 apple trees, 748 cherry tries and 445 walnut trees.

According to the result of question answer study in the main villages in or near project area, amount of chemical fertilizer used excluding compost was reported as follows.

Village	Gökçesu	Kayabükü	Köprübaşı	Akçabey
N-P-K mixed fertilizer (Kg/da/Year)	30	30	25	25

(Compare above amount to the national average and describe the result)

Table IV-6

Land Use Situation of Related Districts

Use Type	Bolu	District Mengen	Devrek	Future Submerged Area including Dam Facility
Pasture and Meadow	50,488 (3.0)	2,111 (2.4)	6,450 (5.5)	
Forest and Brush Wood	459,848 (27.0)	51,988 (60.1)	73,482 (62.3)	303.8
Dry Agriculture with Fallow	18,724 (1.1)	729 (<0.1)	—	233.0
Dry Agriculture without Fallow	114,503 (6.7)	10,609 (12.2)	18,523 (15.7)	
Irrigated Field	3,708 (3.5)	469 (<0.1)	2,557 (2.2)	42.6
Orchard	59,561 (3.5)	595 (<0.1)	350 (<0.1)	a few
Vineyard	586 (<0.1)	—	7 (<0.1)	
Sub Total	707,418 (41.6)	66,501 (76.4)	101,369 (85.9)	
Housing land, Water Surface, River Bed, Swampy (Mersh), Rocky Uncultivated land	993,011 (58.4)	20,564 (23.6)	16,659 (14.1)	
Total	1,700,429	87,065	118,028	589.4

* Unit : Hectar

** () means percent(%).

*** [] means percent(%) on area of future submerged one to total area of related districts.

Table IV-7

Crops in Future Submerged Area and Surrounding Districts

Kind	Production(Tons)			Yields(Kg/Hectares)		
	B*	M *	D*	B	M	D
Wheat	203,270	8,470	23,817	2,808	2,200	2,350
Barley	68,769	2,172	1,100	2,507	2,400	2,200
Rye	1,923	21		2,345	1,400	
Oats	9,698	150	258	2,261	1,000	1,720
Spells	950			1,377		
Maize	99,230	706	23,994	5,882	3,299	2,580
Chick peas	370		10	1,423		2,000
Dry peas			6.6			2,200
Peas	271	7	45	5,646	7,000	4,500
Dry beans	3,258		80	2,387		2,000
Broad beans	430	85	48	7,544	6,333	5,800
Beans						
Rice	3,430			6,423		
Tabacco	270			1,901		
Sugar beet	522			934		
seed	62,180			36,363		
Sunflower	420		7.3	1,400		1,217
Cow vetch	14,480		3 350	5,934	3,000	35,000
Clover	14,000	2,200	900	6,422	3,000	12,000
Wheat straw	234,844			3,369		
Barley straw	89,400			3,259		
Oats straw	12,607			2,939		
Okra	77		9	3,348		3,000
Calavence	965	12	37	7,910	6,000	4,111
Sweep pepper	1,050		60	13,462		6,000
Green pepper	1,900		117	13,194		9,000
Pepper		16			1,455	
Green beans	4,980	71	410	7,955	3,087	8,200
Potatos	301,690	3,450	1,350	26,949	12,000	13,500
Tomatos	5,800	20	1,050	22,481	2,000	35,000
Cucumbers	1,975	3.5	56	13,811	3,500	7,000
Pumpkins	1,960		100	14,962		20,000
Squash	1,910	46	140	15,656	3,539	14,000
Spinash	2,190	38	160	10,330	2,000	4,000
Cabbage	2,900	150	42	22,308	15,000	14,000
Black cabbage	6,900		700	21,767		14,000
Head lettuce	170		24	14,167		3,429
Leaf lettuce	1,380		27	10,534		3,375
Lettuce		45			11,250	
Eggplant	735		300	21,000		20,000
Warden orach	130			18,571		
Leek	6,515	20	400	21,153	20,000	20,000
Garlic			40			8,000
Green garlic	138			6,273		
Dry garlic	75	1.6		3,216	800	
Green onions	2,410	45		11,531	3,000	
Dry onions	6,310	200		11,685	5,000	
Onions			170			8,500
Hourse radishes	540			22,500		
Red radishes	105			17,500		
Radishes		25			5,000	
Watermelons	1,100			21,154		
Melons	380			20,000		
Carrot			8			8,000
Parsley			5			5,000

* B: Bolu, M: Mengen district, D: Devrek District.

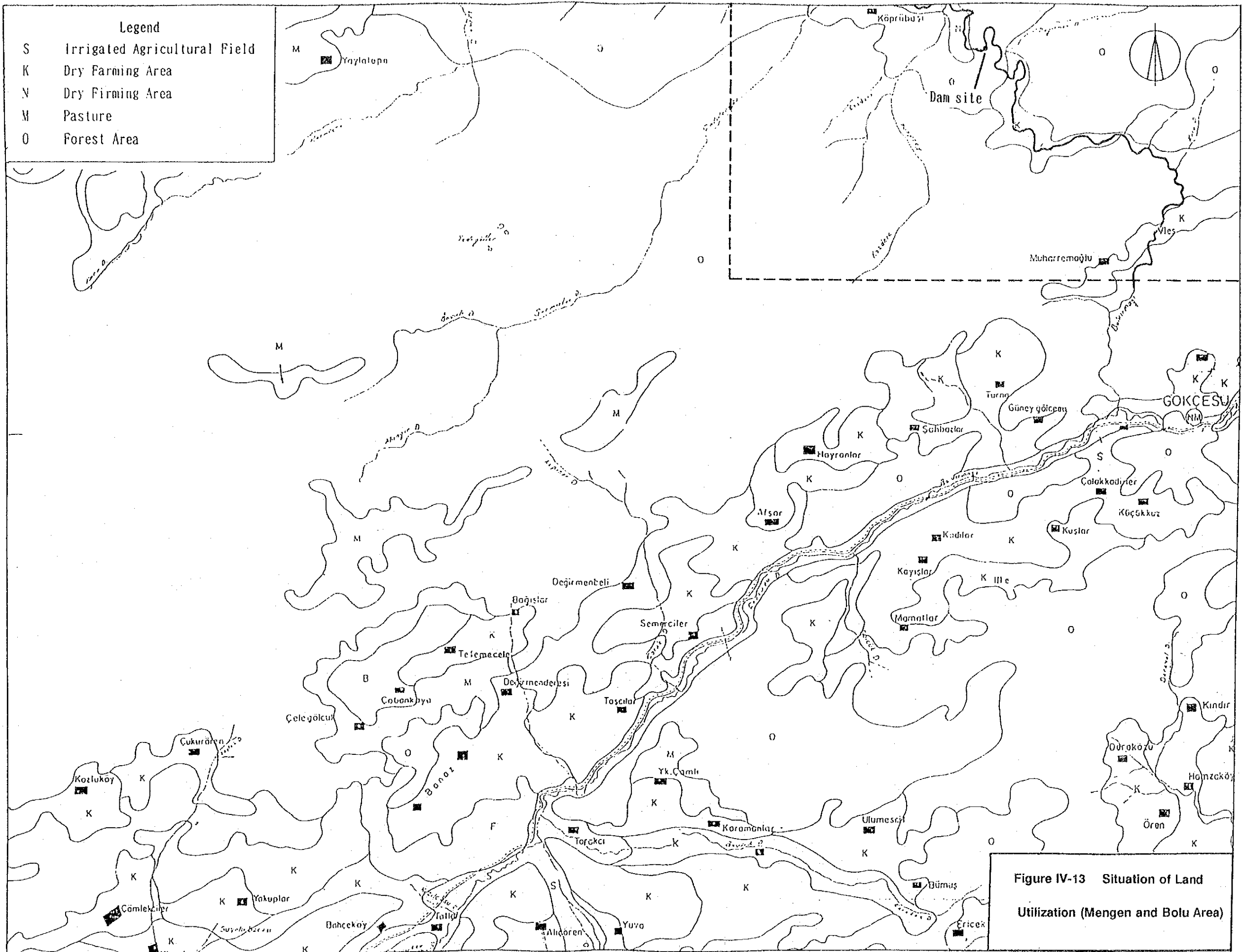
Table IV-8 Fruits Production in Future Submerged Area and Surrounding Area

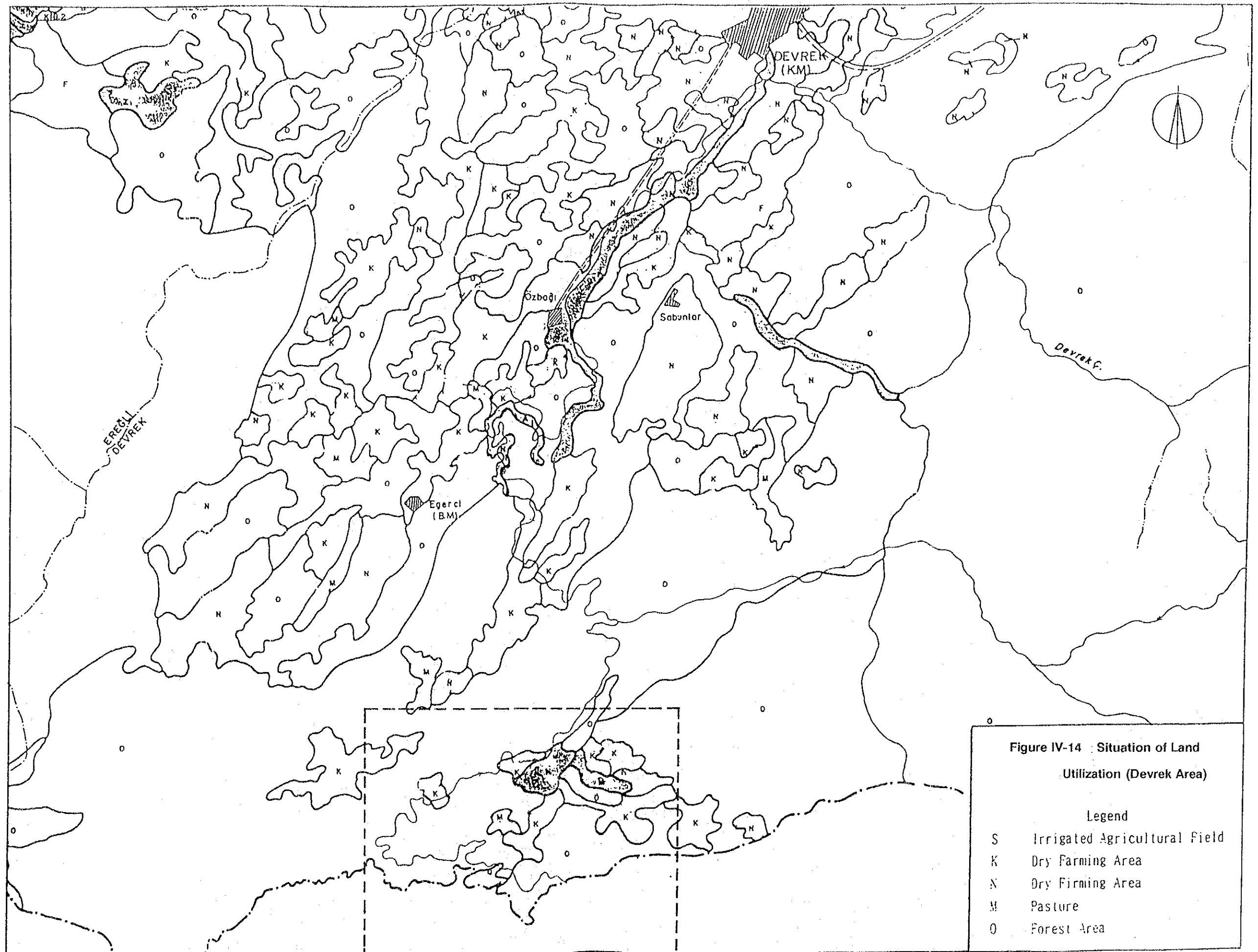
Kind of Fruits	Production(Tons)				Number of Trees			
	B*	M *	D*	S *	B	M	D	S
Pears	8,875	375	1,960		177,600	15,100	6,500	
Quinces	1,930	20			37,130	1,000		
Apples	41,199	665	2,032	38.6	613,200	35,000	14,850	595
				(<0.01)**				(<0.01)**
Cormels	1,576	75			205,950	20,000		
Cherries	2,160	94	1,281	29.9	55,500	9,000	1,800	748
				(<0.01)**				(<0.01)**
Peaches	1,408		284		44,330		480	
Sour cherries	521	8	234		11,725	1,800	2,700	
Apricots	116				2,200			
Mulberries	1,688	12			39,725	3,000		
Figs	111				4,970			
Almonds	257				13,000			
Walnuts	2,868	15	716	21.8	60,902	3,000	400	545
				(<0.01)**				(<0.01)**
Hazelnuts	57,074	11	158		20,970,000	8,000	59,220	
Chestnuts	1,014				21,950			
Grapes	11,475				-			
Total	139,325	1,325	7,266	88.5	22,471,682	105,200	90,395	1,888
				(<0.01)***				(<0.01)***

* B :Bolu District, M:Mengen District, D:Devrek District, S:Future Submerged Area.

** ()means Percent(%) to Fruits Trees.

*** ()means Percent(%) to Total Number of Fruits,Trees.





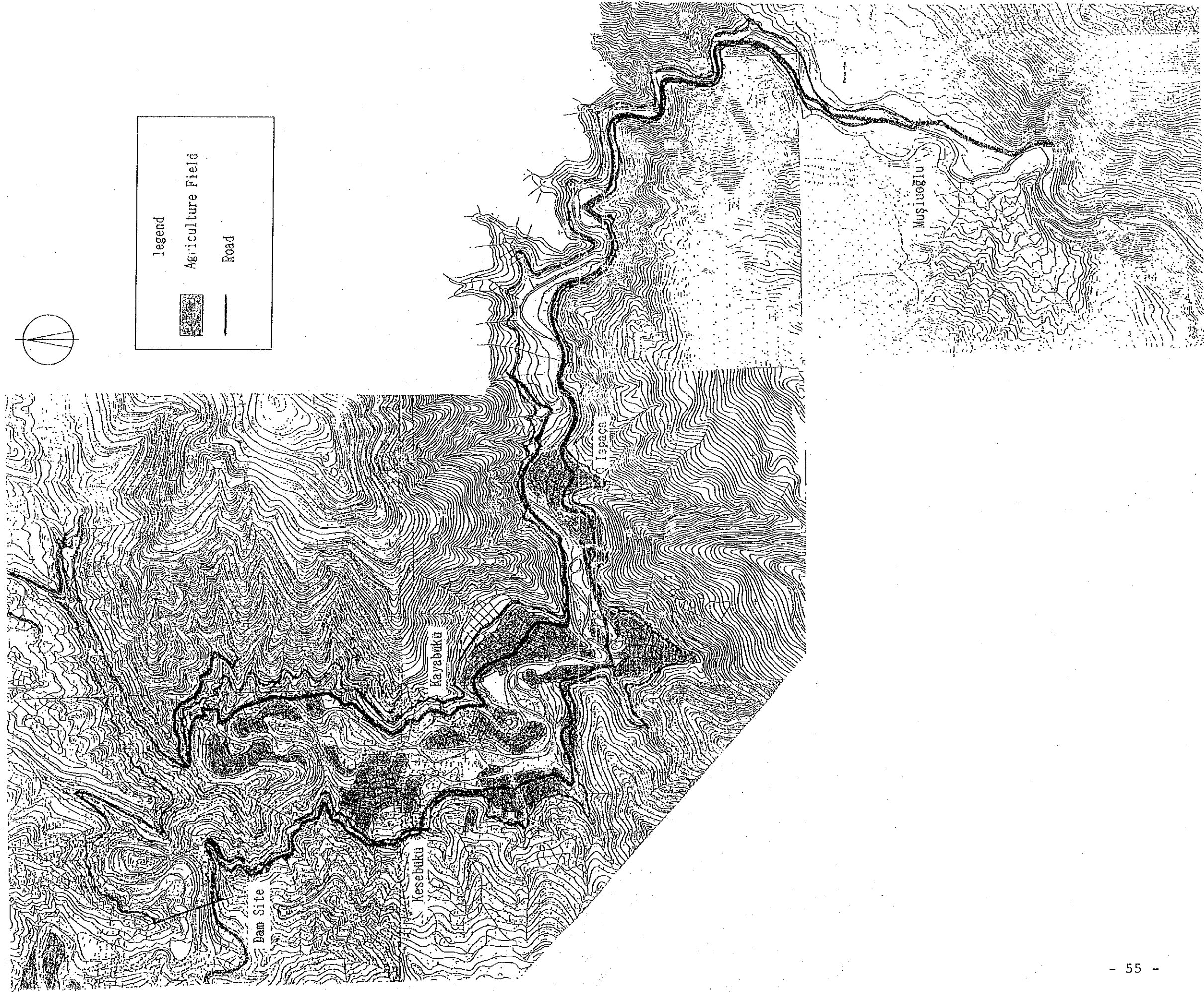


Figure IV-15 Submerged Area on Köprübaşı Project

IV.1.6 Hydrological Characteristics

(1) Vicinity of the Project Area

Köprübaşı Project Area is located at the middle basin of Devrek River which is one branch of Filyos River flowing in the north west area of Turkey. The Filyos River has its origin in Köroğlu Mountain (its latitude being 2,378 m) located at the location in the north west direction by some 100 km part from Ankara, whose name changes as Gerede River, Soğanlı River and Yenice River from the upstream side. The Yenice River joins with the Devrek River, which is a branch, on the upstream side by some 30 km from the river mouth, becomes the Filyos River and pours into the Black Sea.

The elongation of Filyos River is about 350 km, its basin area is some 13,300 km², and the annual mean flow rate is 104.6 m³/s¹⁾ at Devercikviran (No. 1335 Water Measuring Station) near the river mouth.

Devrek River located at this project area originates from Abant Lake which is located at the area in the south west direction of about 30 km apart from Bolu City. The river flowing out of Abant Lake is called Büyüksu River (Bolu River), then joins with Mengen River in the vicinity of Gökçesu Village and its name is changed to Devrek River Figure IV-1.

Devrek River is the largest branch in the Filyos River basin with its total length being some 150 km, and it is reported⁹⁾ that its basin area is around 3,130 km² and its annual average flow rate is 22.9 m³/s (No. 13-44 Gauging Station) in the vicinity of Devrek town.

(2) Project Area

a) Flow Rate

Out of the mean flow rate by month for the past 35 years in the dam area in project, the monthly maximum flow rate is $82.8 \text{ m}^3/\text{sec}$ (Mar) with its minimum being $10.69 \text{ m}^3/\text{sec}$ (Sep), and the annual average flow rate is $14.4 \text{ m}^3/\text{s}$, and the specific flow rate at this time is 7.2 L/s/km^2 (Table IV-9).

Looking at the seasonal special features, it can be noticed that there is much flow rate in March and April and the flow rate decreases from the summer season to the autumn season. According to the spectrum analysis of rain fall volumes, the periodical cycles of some 12 years and 4 years are recognized.

Table IV-16 and thereafter show the observation results of inflow rates from the branches in the block from the dam site to the outlet point (Figure IV-10) during the dry season. According to these tables, the percentage of total water volume of 3 branches occupied in the flow rate near Akçabey Village of the main stream is estimated to be around 30 %.

b) Suspended Sediment

The annual suspended sediment volume at the dam site is estimated to be 313,060 tons/year.

c) Water Quality

The water quality (Table IV-13) from the spring season to the summer season of Devrek River which is the river in object of the project covers the following contents.

(The survey is conducted once every month and its

result is to be described. For information, the water temperature, turbidity, T-P, T-N, heavy metals, coliforms shall be added to the survey items).

i) pH

The values of pH of Bolu River and Mengen River are around 8, and the values of pH at the confluence and dam site as well as the outlet point also show similar values.

ii) SS

The concentration of SS conspicuously changes and corresponds approximately to the change of flow rate (Table IV-12), and the increase of flow rate brings about the change in the SS concentration.

iii) DO

The DO concentration at the dam site ranges from 7.4 through 9.8 mg/l, and is almost similar even at outlet point. In addition, Bolu River and Mengen River are also within this range.

iv) COD

The COD at the dam site is 3 mg/l and outlet point shows a low value at 2.6 mg/l. On the other hand, the value of Bolu River proves to be 6.8 mg/l, and the concentration at the confluence of Gökçesu Village also proves to be a similar value.

v) BOD

The BOD shows a low value in general. The BOD at the dam site ranges from 1.3 to 3.8 mg/l, and its

value falls down during the period of much flow rate. The value at outlet point of this downstream side is in the range from 0.6 to 2.6 mg/l, and its value is slightly lower than that at the dam site.

vi) $\text{NH}_4\text{-N}$

The concentration of $\text{NH}_4\text{-N}$ shows a high value. The concentration at the dam site ranges from 0.050 to 0.54 mg/l, which is in the reverse relationship with the flow rate. That at the outlet point is from nd to 0.54 mg/l, which is approximately similar to the dam site. The concentration of Bolu River is extremely high at 0.06 to 0.975 mg/l, but the Megen River also shows a high concentration at 0.045 to 0.675 mg/l.

vii) $\text{NO}_3\text{-N}$

The concentration of $\text{NO}_3\text{-N}$ is very high. The concentration at the dam site ranges from 0.6 to 1.2 mg/l, and that at the outlet point ranges from 0.2 to 1.0 mg/l, and is lower than the concentration at the dam site. The concentration of Bolu River is extremely high at 0.8 to 2.4 mg/l, and the concentration is high during the period when the flow rate is less similar to the confluence point. The concentration of Megen River is in the order of around 1/10 when compared with that of Bolu River.

viii) $\text{PO}_4\text{-P}$

The concentration at the dam site ranges from 0.02 to 0.13 mg/l, but isn't proportionate with the increase/decrease of flow rate. The

concentration at the outlet point is in the range from 0.01 to 0.1 mg/l. The concentration of Bolu River is extremely high at 0.05 to 0.45 mg/l. The concentration of Mengen River on the contrary is extremely low.

ix) T-N

(The T-N shall be measured and described.)

x) T-P

(The T-P shall be measured and described.)

According to the flow rate measured results (Table IV-12) when the water quality was measured, the water volume is much in March to April, and decreases from early in the summer. In the measurement taken in July which is the water decreasing period, the water volume proved to be some 3 m³/sec at the dam site but changed to some 7 m³/sec at the outlet point in the vicinity of Akçabey Village.

(Measure the flow rate during the water quality survey every month, and grasp its relationship with the water quality).

According to the classification¹⁰⁾ (Table IV-13) of inland water resources, the water quality at the dam site proves to be first class in terms of the pH, DO, BOD, COD and NO₃-N, second class in terms of the NH₄-N and PO₄-P, and third class in terms of the NO₂-N.

Table IV-9 Monthly Natural Inflow at Köprübaşı Dam Site

Year	Period: 1956-91												C.A. =	1994 km ²	Unit: MCM	Total
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.				
1956	18.41	27.04	48.07	66.16	97.72	104.70	121.16	64.19	31.23	12.95	8.09	9.13	608.84			
1957	10.57	17.09	19.48	22.43	48.31	50.21	27.41	44.82	21.86	7.83	8.21	8.89	285.12			
1958	7.76	8.73	20.44	24.39	41.57	82.73	96.42	42.96	48.97	22.49	10.68	10.63	417.76			
1959	10.89	11.32	12.81	21.52	19.79	131.95	119.34	45.82	32.78	19.86	9.52	8.51	444.11			
1960	10.29	11.81	10.81	25.45	55.15	59.98	83.36	35.65	29.06	15.33	12.77	9.36	339.03			
1961	10.10	9.54	18.53	20.49	44.76	76.17	68.13	28.84	20.77	24.33	7.49	7.52	336.72			
1962	7.61	12.62	22.52	21.78	37.82	104.41	77.48	29.64	13.18	7.83	6.72	8.76	348.39			
1963	9.85	8.85	33.01	59.98	67.38	79.25	82.02	89.05	58.66	21.97	11.23	12.37	513.62			
1964	15.88	17.01	54.60	25.70	68.89	127.10	71.82	69.49	51.80	20.50	11.99	15.09	549.87			
1965	13.75	18.60	55.11	40.44	52.29	118.81	148.26	94.56	30.79	28.36	10.77	9.53	521.27			
1966	10.12	14.87	34.56	53.12	36.30	62.82	90.45	51.55	24.56	9.96	8.43	9.05	406.19			
1967	9.49	8.26	12.25	17.17	16.94	74.00	97.19	71.04	31.47	13.84	7.36	8.65	367.66			
1968	10.69	12.80	62.24	80.65	111.17	166.48	148.87	54.29	35.03	15.36	14.21	20.95	742.74			
1969	17.74	15.33	25.68	32.75	54.95	74.45	96.32	74.09	27.46	17.13	9.04	9.08	454.02			
1970	9.10	11.50	19.44	21.47	55.51	65.75	72.80	42.48	33.72	11.15	8.44	8.35	353.71			
1971	9.75	10.71	22.93	52.03	40.08	86.56	108.67	102.74	77.99	24.97	14.93	13.84	575.20			
1972	13.51	13.67	38.15	40.38	46.07	91.72	82.46	57.51	67.31	46.27	25.15	22.56	544.79			
1973	45.94	46.30	31.08	32.34	63.51	83.85	73.82	48.35	35.34	21.84	13.39	8.84	504.58			
1974	12.33	25.74	42.17	19.79	48.53	65.53	58.85	89.17	35.05	17.77	14.63	13.32	441.85			
1975	11.09	11.64	17.55	19.01	29.64	66.85	51.10	141.62	41.91	20.07	18.04	11.44	439.95			
1976	14.52	14.44	51.86	32.44	39.54	64.67	78.79	37.36	27.55	10.69	11.36	10.53	393.76			
1977	11.97	11.46	28.21	20.11	28.79	59.69	47.17	30.10	18.67	9.00	6.14	6.68	277.98			
1978	8.70	10.79	11.69	30.02	65.77	53.13	89.99	54.16	17.85	23.37	10.47	9.74	385.68			
1979	11.66	12.07	22.55	61.06	74.93	37.78	42.84	43.62	62.67	27.61	11.14	10.13	418.15			
1980	13.54	18.68	40.53	50.87	48.61	110.14	112.81	81.87	31.88	11.01	10.52	9.73	540.20			
1981	12.67	23.01	58.73	66.14	59.29	136.75	69.39	73.54	31.69	22.80	10.42	10.01	574.43			
1982	11.25	16.88	55.32	77.49	38.00	82.88	100.14	55.46	41.21	18.39	20.65	15.92	533.61			
1983	13.51	13.00	13.41	23.16	58.38	99.27	89.06	40.44	33.59	38.14	30.06	14.32	465.34			
1984	19.49	47.05	49.48	42.17	45.29	60.83	98.43	74.83	31.55	17.33	15.90	10.48	512.83			
1985	10.00	17.67	18.10	27.49	51.82	98.46	95.62	50.60	26.98	13.47	8.45	8.11	426.79			
1986	12.75	13.23	32.90	88.84	78.25	75.37	45.22	48.35	28.26	10.20	7.43	7.03	447.83			
1987	7.88	11.27	17.56	51.03	54.53	60.37	102.11	73.47	38.64	17.87	10.03	7.27	452.13			
1988	10.77	16.76	32.96	31.68	27.79	63.06	68.83	36.33	46.03	24.19	8.39	7.07	373.			
1989	11.21	34.88	46.41	29.04	52.22	99.86	35.41	25.35	23.30	11.27	7.36	6.55	382.			
1990	14.70	32.68	57.53	29.90	29.30	41.42	55.01	67.92	22.20	14.60	10.13	9.69	385.			
1991	14.54	19.54	23.13	22.34	55.04	63.44	45.09	41.39	79.29	65.32	19.45	17.57	466.			
Average	12.89	17.44	32.29	38.63	51.17	82.79	80.88	58.96	36.40	19.86	11.86	10.69	453.86			

Daily Ave. Runoff 14.392 m³/s
 Specific Discharge 7.218 l/s/km²

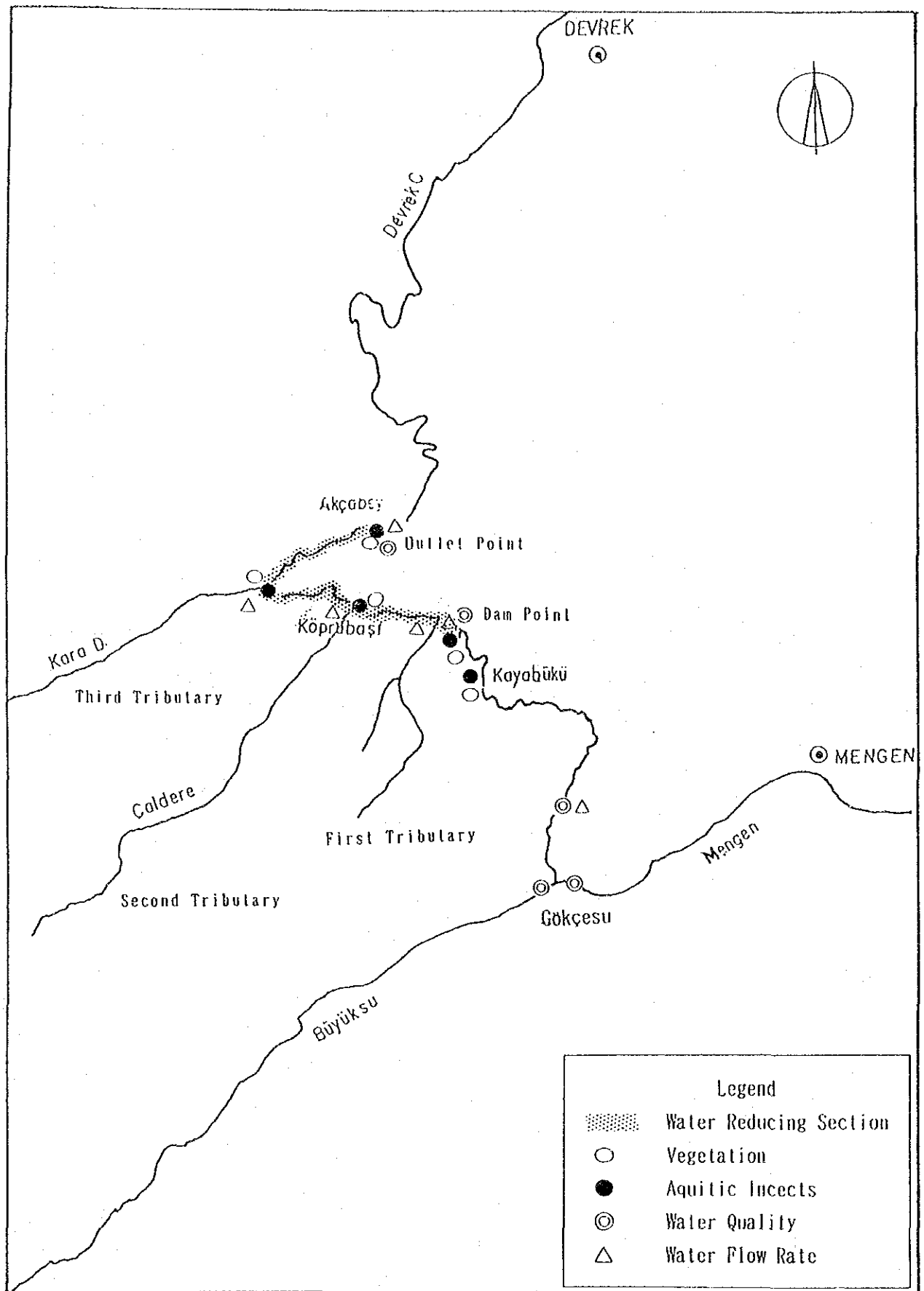


Figure IV-16 Location of Field Survey

Table IV-10 Water Flow Rate at 3 Tributaries (m³/s)

Date	Koz ⁽¹⁾	Cal ⁽²⁾	Karasu ⁽³⁾	Akcabey	1) + 2) + 3)
1993. 3. 10	1.04	1.13	3.92		
3. 18	0.63	1.22			
4. 8			1.08		
4. 15	0.98		5.71		
6. 9	0.43	1.01	1.12		
6. 16				17.97	
1993. 6. 25	0.33	0.86	0.99	9.06	2.18 (0.24)
7. 8	0.27	0.82	0.94	7.18	2.03 (0.28)
7. 9	0.26	0.77	0.85	7.27	1.88 (0.26)
7. 14	0.33	0.86	0.94	6.93	2.12 (0.31)
7. 29	0.22	0.67	0.56	4.79	1.45 (0.30)
8. 10	0.14	0.37	0.65	3.79	1.16 (0.31)
8. 11	0.21	0.38	0.55	5.15	1.14 (0.22)
Average	0.25	0.67	0.78	6.31	1.71 (0.27)
Area(Km ²)	40.37	94.4	164.47	2337.3	299.2 (12.8)

* () in the right column shows the ratio(%) of sum on 3 tributaries to the main course.

Table IV-11

River Water Quality near Dam Site

Item	Date	Upper Stream			Dam Site	Down Stream (Outlet point)
		Bolu River	Mengen River	Junction		
pH	3. 3	7.8	8.0	8.0	7.9	8.0
	(-) 4.28	7.9	7.8	7.8	7.9	7.9
	5.26	8.1	8.0	7.6	8.0	8.1
	6.30	8.0	7.8	7.6	7.8	8.0
	7.15	8.2	7.7	7.8	8.0	8.1
SS (mg/l)	3. 3	660	495	437	622	802
	4.28	70	35	45	70	50
	5.26	-	166	197	645	134
	6.30	54	21	49	48	52
	7.15	46	32	42	42	29
DO (mg/l)	3. 3	8.5	9.8	9.6	9.0	8.9
	4.28	9.9	10.4	9.8	9.8	9.7
	5.26	7.4	7.6	7.6	7.4	7.7
	6.30	8.0	7.9	8.3	7.8	7.8
	7.15	8.7	9.3	8.8	8.7	8.6
COD (mg/l)	9.15	6.8	2.8	6.7	3.0	2.6
BOD (mg/l)	3. 3	1.4	1.2	0.7	1.3	0.6
	4.28	2.8	2.0	2.6	2.4	1.9
	5.26	3.0	3.6	3.4	3.8	2.6
	6.30	3.1	1.8	3.5	2.6	2.5
	7.15	3.2	1.7	2.6	2.5	2.4
NH ₄ -N (mg/l)	3. 3	0.975	0.675	0.500	0.540	0.540
	4.28	0.475	0.058	0.175	0.270	0.110
	5.26	0.600	0.235	0.070	0.070	0.140
	6.30	0.740	0.150	0.440	0.075	0.200
	7.15	0.060	0.045	0.040	0.050	nd
NO ₂ -N (mg/l)	3. 3	0.055	0.026	0.026	0.042	0.032
	4.28	0.052	0.008	nd	0.032	0.021
	5.26	0.100	0.018	0.070	0.042	0.018
	6.30	0.260	0.013	0.200	0.075	0.022
	7.15	0.305	0.014	0.065	0.030	0.005
NO ₃ -N (mg/l)	3. 3	0.8	0.4	0.4	1.2	0.8
	4.28	1.7	0.7	1.0	1.1	0.6
	5.26	1.4	0.1	0.5	0.6	0.2
	6.30	1.9	0.2	1.0	1.0	0.8
	7.15	2.4	0.2	1.1	1.1	1.0
PO ₄ -P (mg/l)	3. 3	0.1	nd	nd	0.1	0.1
	4.28	0.13	nd	0.04	0.09	0.01
	5.26	0.05	nd	0.01	0.02	0.01
	6.30	0.29	nd	0.15	0.04	0.02
	7.15	0.45	0.03	0.26	0.13	0.06

Table IV-12 River Water Flow Rate at Water Quality Survey

Date (1993)	Upper Stream (Down Stream from Junction of Mengen and Bolu River)	Dam Site	Down Stream (Outlet Point)
3/3	18.1	25.6	
4/28	16.5	12.8	
5/26	10.4	12.2	
6/30	2.9	3.4	
7/15	2.9	2.8	7.1

* Unit : m³/sec

Table IV-13 Water Quality at Dam Point

Parameter	Water quality Class				Dam Point (Mean Value)
	I	II	III	IV	
pH	6.5-8.5	6.5-8.5	6.--9.0	Outside	7.9
DO	8	4	3	< 3	8.5
BOD	4	8	20	>20	2.5
COD	25	50	70	>70	3
NH ₄ -N	0.2	1	2	> 2	0.201
NO ₂ -N	0.002	0.01	0.05	>0.05	0.044
NO ₃ -N	5	10	20	>20	1.0
PO ₄ -P	0.02	0.16	0.65	>0.65	0.076

(Unit: mg/l)

(The maximum, minimum and mean values are shown in the said list on the basis of the results of every month, and the evaluation is added to the water quality.)

IV.1.7 Available and Planned Usage of Surface Water Resources

(1) Agriculture

a) Vicinity of the Project Area

Gölköy dam exists in the vicinity of Bolu city in the Büyüksu plain in the upstream area of Filyos river, and the dam water is used as the irrigation water of Büyüksu plain¹¹⁾.

Further, a water intake weir for utilizing Büyüksu river water exists in the vicinity of upstream near Bolu city.

No similar facilities exist at the Mengen river (Figure IV-17).

In the Devrek river where the Büyüksu river and the Mengen river join each other, public irrigation¹¹⁾ is being done in the farming of about 50 ha along the river from the dam site to Devrek city.

According to the result of question answer study for some villagers of Mahmutoğlu village, it is reported that fresh vegetables and fruits are cultivated by utilizing the mountain slope and narrow ground near valley by pumping up the river water when water is only required.

In addition, some 300 ha. public irrigation¹¹⁾ is being done in Filyos river bank from Devrek city to Çaycuma plain.

There is information about the water volume required for these irrigation systems being 5,500 m³/ha/year¹¹⁾. (Collect detailed data on the irrigation water. Investigate also the period during which the irrigation is carried out and the present daily irrigation requirement, including about the irrigation scheme in the future.)

b) Project Area

There is the irrigation farming area⁸⁾ of 426 da within the future reservoir.

Besides, groundwater from coal mine near Gökçesu village is discharging into Devrek river.

Several regional development plans¹⁾ (Figure IV-17) exist in the Filyos river system, and Filyos Irrigation Project (9,253 ha.) and Tekke Dam Irrigation Project (11,317 ha.) related to the agriculture.

(2) Fishery

Table IV-14 shows the record¹²⁾ of kinds and planned yields by the raising at Büyüksu river, Mengen river and Devrek river.

The fish kind at Büyüksu river in the upstream near project area is trout, and its annual amount is in the order of 12 tons¹²⁾.

Some 17 tons of trout are being raised similarly in Mengen river.

Information in Table IV-15 shows carp and trout also planned to be raised in the Devrek river.

On the other hand, the fish being raised at the natural ponds and dam reservoir is are mainly carp etc,. About 5 tons of fish of these kinds are being raising at the Gököy reservoir (131 ha).

But, this fish raising is not being done at the vicinity of the project area and down stream area near dam site at present.

Fishery for natural fish has been limited excluding line fishing in these rivers.

(3) Water for daily life

The drinking water and the water for daily life at the villages near and in the project area depend on the purified water being sold at stores and spring water from the mountain slope, respectively.

Especially, villagers utilize the water transported by the long pipeline from distant locations. The river water is not being utilized at all.

(4) Industrial Water

Several hydraulic electric power development plans¹⁾ (Figure IV-17) such as Kayabükü Hydro Power Project (12 MW) and Çay Hydro Power Project (25 MW) are proposed in the Devrek river.

The latter concerns with Köprübaşı project wherein a reservoir of Çay project is to be located in the vicinity of the down stream of outlet point of Köprübaşı project. Excluding above plans, no other large scale water utilization facilities are proposed in this area.

(5) Others

Devrek river is not being utilized for the transportation and river flow-down leisure due to its narrowness and shallowness.

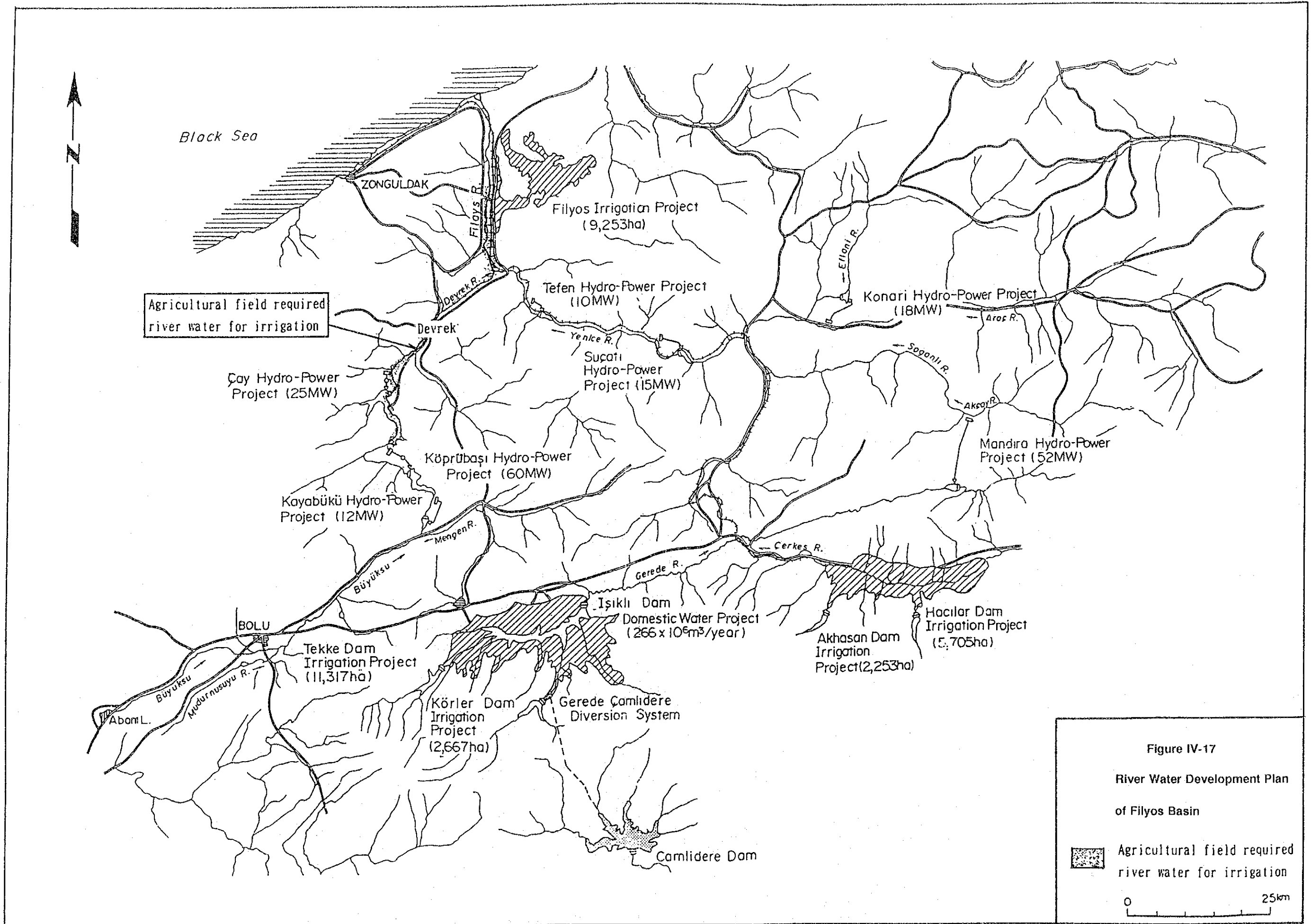



Figure IV-17
 River Water Development Plan
 of Filyos Basin

 Agricultural field required river water for irrigation

0 25km

Table IV-14

Fish Raising Activities near Planned Area

Place	Kind	Capacity in Plan	Real Raising Capa.
Bolu Province		(ton/year)	(ton/year)
Bolu Merkez	Trout	4	4
Bolu Merkez	Trout	10	8
Mengen Alibeyler	Trout	4	4
Mengen Kayislar	Trout	3	3
Mengen	Trout	6	3
Mudurnu Beydere	Trout	7.5	7
Düzce	Carp	6	4
Düzce	Carp	19	10
Düzce Fındıklı	Trout	60	20
Düzce Kavakbıçkı	Trout	30	0
Merkez Akçaoren	Trout	4.4	0
Akçakoca Koçar	Trout	13	0
Akçakoca Beyören	Carp	8.5	0
Zonguldak Province			
Devrek Yagmurca	Carp	80	0
Devrek Dorukan	Trout	5	0
Karabük Basköy	Trout	25	30
Oevrek Ayva Deresi	Trout	50	0
Alaplı Belen	Trout	150	0
Merkez Hörgücdere	Trout	150	0

Table IV-15

Fish Production by Utilizing Lakes and Reservoir

Place	Kind	Amount of Delivery
Bolu		(ton)
Yeniçag (Lake 270 ha)	Carp	1
Düzce Hasanlar (Reservoir 285 ha)	Carp, etc.	2
Mudurnu (Lake 5 ha)	Carp, etc.	5
Merkez Gököy (Reservoir 131 ha)	Carp, etc.	5

IV.1.8 Aquatic Organisms

IV.1.8.1 Aquatic Plants

(1) Vicinity of the Project Area

(Make a material survey and report on the existence of valuable aquatic plants in the peripheral region as well as on the aquatic plant aspect for Abant Lake, Gököy Dam, Seven Lakes, etc.)

(2) Project Area

The river beds of Büyüksu river and Mengen river of the upstream of project area are mainly composed of stone and gravel with a small quantity of silty sediment. It seems these bottom properties are not suitable for deep rooted plants.

According to the eye observation up to the dam site from the join point between Bolu and Mengen rivers, large scale aquatic plants excluding the epilithic diatoms could not be seen, but a very slight amount of weed named Fantinalis antipyretics be recognized on the rocks in the Bolu river side at the join point in the vicinity of Gökçesu village.

The river bed near the outlet is composed of gravel and stone. Nevertheless the epilithic diatom and green algae can be seen on the stone surface, any other types of plant such as water plant which has a root and floating leaves can not be found.

IV.1.8.2 Aquatic Insects

(1) Vicinity of the Project Area

(Make a material survey and report on the existence of valuable aquatic insects in the peripheral region.)

(2) Project Area

According to the field survey results (Table IV-16) of project area, 1 kind of Stone-flies, 4 kinds of Mayflies, 2 kinds of Caddis-flies, 1 kind of Freshwater shrimp, 1 kind of Midges, 1 kind of Horse fly, 2 kinds of Earthworms and larvae of Dragonflies were found.

The kinds which were confirmed in all the survey points are Perlodidae of Stone-flies, Baetidae, Hydropsychidae and Chironomidae.

No large differences can be seen in the composition of kind between the point of reservoir area and the outlet point.

Looking at seasonal differences at the same location, 1 kind of Leuctridae of Stone-flies, 1 kind of Caenidae of Mayflies and 1 kind of Simullidae of Midges appeared in the spring.

According to the composition of these species, trophic system of river is assumed qualitatively in Oligosaprob to Mesosaprob level, though the species of the insects obtained from the field survey are unknown.

IV.1.8.3 Fish

(1) Vicinity of the Project Area

According to the data showing the distribution^{13), 14)} of fish in Turkey, the inhabitation of 27 kinds of fish

Table IV-16 Kind of Aquatic Insects in Planned Area (June-July, 1933)

Speices	Loc.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
PLECOPTERA								
Leuctridae							2-5	
Perlodidae	1	6-20	2-5	6-20	6-20	21-100	21-100	
EPHEMEROPTERA								
Baetis sp.	100-500	21-100	2-5	21-100	6-20			6-20
Ecdyonurus sp.	6-20	2-5		1	1			2-5
Ephemerella sp.		1						
Caenidae								21-100
Potamanthidae		1						
TRICHOPTERA								
Rhyacophila sp.		1		1				
Hydropsychidae	6-20	6-20	2-5	6-20	6-20	2-5		
CRUSTACEA								
Gammarus sp.	2-5							
DIPTERA								
Chironomidae	6-20	2-5	2-5	2-5	2-5	1		
Simuliidae								2-5
Tabanidae	1							
OLIGO								
Lumbriculidae					2-5	2-5		
MISC								
Anisoptera		2-5	2-5					2-5
Hydracarina	1				1			

* Location (1):Kayabuku Point, (2):Dam Point , (3):Köprübaşı Point,
 (4):Akçabey Point, (5)Karadere Point, (6):Karadere Point-Spring,
 (7):Kayabuku Point-Spring.

** Unit: ind · s/100m²

(Table IV-17, Figure IV-18) are reported in the Filyos river system where Bolu and Zonguldak provinces are located.

The inhabitation of 19 kinds of Carp (Cyprinidae), 2 kinds of Trout (Salmo trutta macrostigm, Salmo trutta abantio), 2 kinds of Loach (Gobitidae), 1 kind of Pike (Esocidae), 1 kind of Catfish (Siluridae) and 1 kind of Perch (Percidae) are reported.

The inhabitation of 4 kinds of Sturgeon (Acipenseridae), 5 kinds of Mullet (Mugilidae), 1 kind of Eels (Anguillidae), 1 kind of Trout (Salmo trout lablax) and several kinds of Gogy (Gobidae) in a month at Filyos river are reported.

Of these kinds, Salmo trout lablax is called Black sea trout, and is included in the group of Anadromous fish¹⁵⁾, which lays eggs in the upstream of river.

(2) Project Area

According to a question study at the Abant lake, the inhabitation of carp and trout is well known, but there is a trend of decrease in recent years because of the water pollution due to waste water discharge from accommodation of hotels. Further, the existence of trout is also known at Seven Lake of Yedigöller National Park.

According to the question answer study in the reservoir area, amount of carps has been decreased in recent years.

The fish caught by some residents by using net casting at the vicinity of outlet showed the same pattern of one type of carp, Capoeta capoeta siedoldi.

Village name	Gökçesu	Köprübaşı	Akçabey	Places
Carp (Sazan)	o	o	o	River, Tribu.
Trout (Alabalık)	o	o	o	Tributary
Mullet (Kefal)	o			River
Loach (Kum balığı)		o	o	River

At above villages, it was reported trout are living in the tributaries of Devrek river. In addition, the names of Kefal and Kum balığı were reported at Gökçesu village and Akçabey, Köprübaşı village respectively.

Turkish name, Kefal means Mullet, and its species is Mugil saliens. Kum balığı means loach (Gobitidae).

(Make a research on the species and ecology of trout, and confirm the species of Kefal.)

Table IV-17

Main Species of Fish Living in Filyos Basin

Fresh water fish		Species
Salmoniformes	Esocidae	Esox lucius
	Salmonidae	Salmo trutta macrostigm
		Salmo trutta abantic
Cypriniformes	Cyprinidae	Cyprinus carpio
		Alburnoides bipunctatus
		Alburnus orontis
		Aspius aspius
		Barbus plebejus escherichi
		Goblo goblo
		Leuciscus squalicis cephalus
		Rhodeus sericeus amarus
		Scardinius erythrophthalmus
		Tinca tinca
		Capoeta capoeta sieboldi
		Capoeta tinca
		Vimba vimba tenella
	Gobitidae	Cobitis cardarensis
		Cobitis linea spp.
		Orthrias angorae
		Seminoemacheilis lendli
		Lculscus
		Cobitis taenla
		Cabitio simplicispinna
		Noemochoilus angarae
Siluriformes	Siluridae	Silurus glanis
Perciformes	Percidae	Perca fluviatilis
		Lucioperca lucioperca
(Coastal fish)		
Salmoniformes	Salmonidae	Salmo trutta labrax (Blak sea trout, Anadromous)
Acipenseriformes	Acipenseridae	Acipenser sturio
		Acipenser guldenstaedti
		Acipenser stellatus
		Huso huso
Anguilliformes	Anguillidae	Anguilla anguilla
Mugiliformes	Mugilidae	Mugil cephalus
		Mugil auratus
		Mugil labrossus labrossus
		Mugil ramada
		Mugil saliens
Perciformes	Gobiidae	

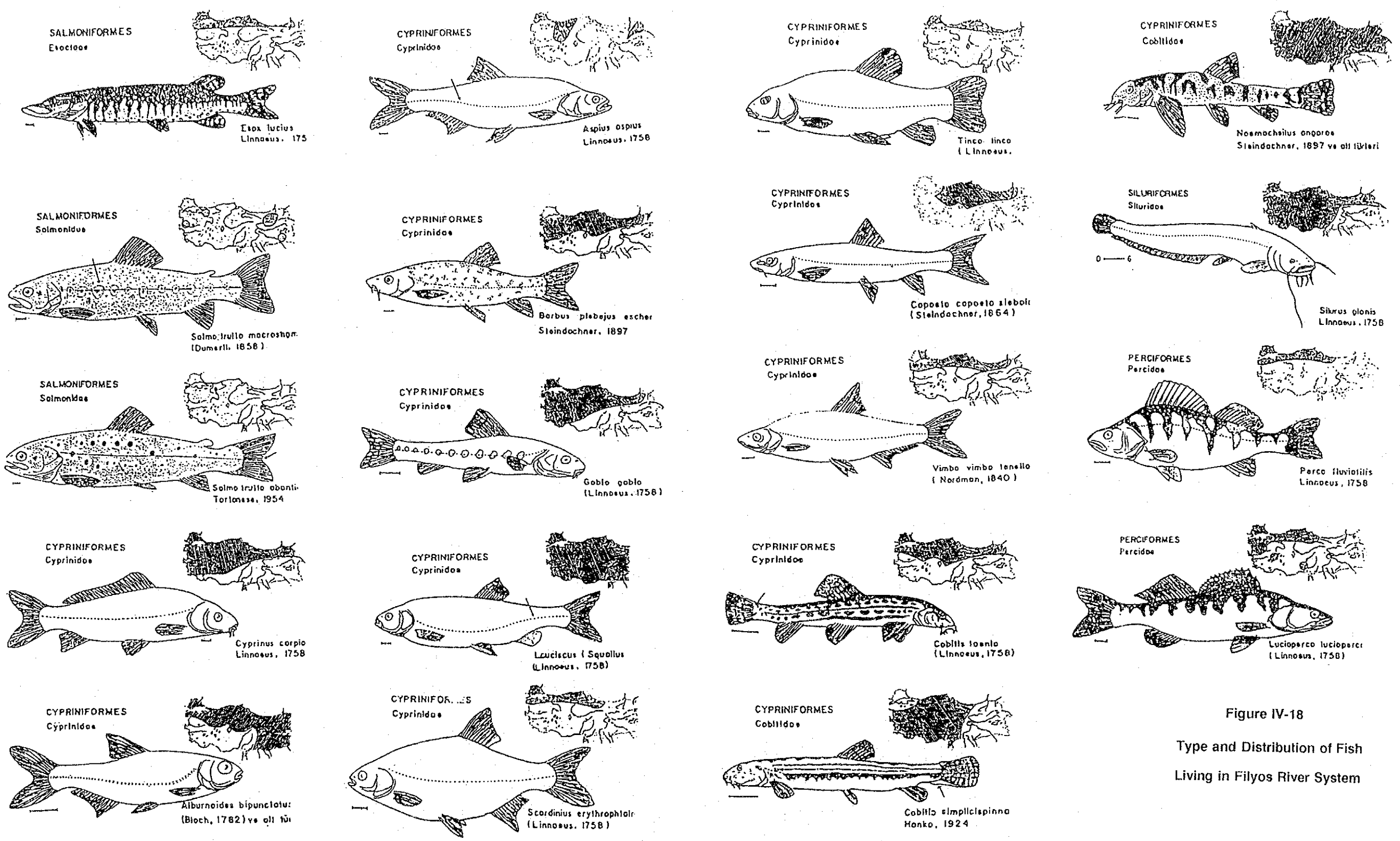


Figure IV-18
 Type and Distribution of Fish
 Living in Filyos River System

IV.1.9 Thermal and Geothermal Water Resources

5 locations¹⁶⁾ (Table IV-18, Figure IV-19) utilize the hot water at the Bolu area as a hot spring, but the thermal and geothermal water are not utilized at the project area.

Table IV-18 Sight-seeing and Recreation Area

Name	Regional Directorate	Characteristics
①Abant Nature Park	Bolu	Public Relaxation. Nature Conservation
②Yedigöller National Park	Bolu	Public Relaxation. Nature Conservation
③Gölcük Pasture	Bolu	Sight Seeing
④Aladag Pasture	Bolu	Sight seeing
⑤Gerede pasture	Bolu	Sight seeing
⑥Seben and Sarialan Pasture	Bolu	Sight seeing
⑦Akçakoca Ski Center	Bolu	Recreation
⑧Karataşkaya Ski Center	Bolu	Recreation
⑨Gölköy Dam	Bolu	Sight seeing
⑩Çubuk and Sünnet lake	Bolu	Sight seeing
⑪Bolu Thermal Springs	Bolu	Relaxation
⑫Mudurnu Thermal Springs	Bolu	Relaxation
⑬Sarat Thermal Springs	Bolu	Relaxation
⑭Badas Thermal Springs	Bolu	Relaxation
⑮Seven-Kesenözü Thermal Springs	Bolu	Relaxation

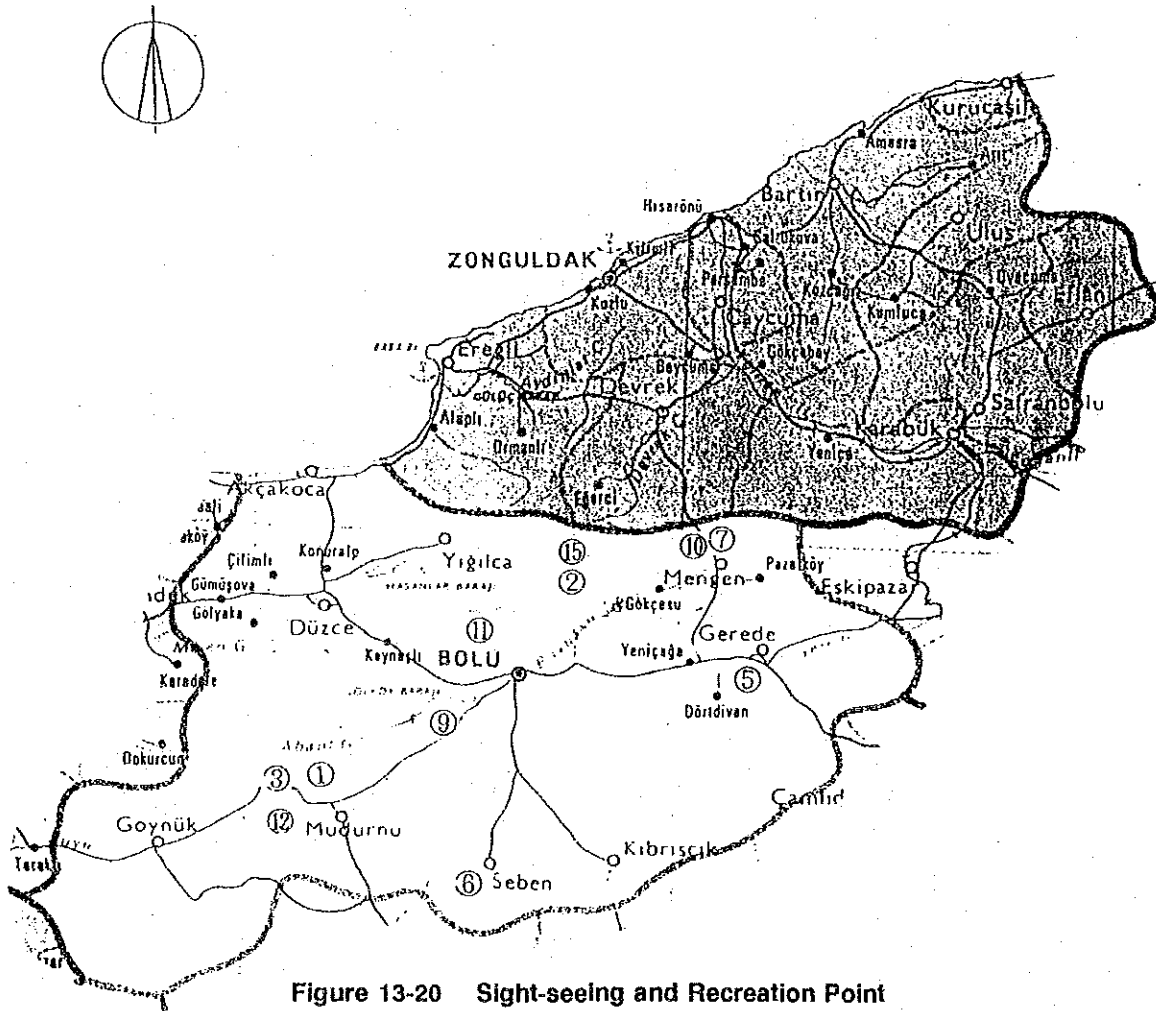


Figure 13-20 Sight-seeing and Recreation Point

Table IV-18 Sight-seeing and Recreation Area

Name	Regional Directorate	Characteristics
①Abant Nature Park	Bolu	Public Relaxation, Nature Conservation
②Yedigöller National Park	Bolu	Public Relaxation, Nature Conservation
③Golcük Pasture	Bolu	Sight Seeing
④Aladag Pasture	Bolu	Sight seeing
⑤Gerede pasture	Bolu	Sight seeing
⑥Seben and Sarialan Pasture	Bolu	Sight seeing
⑦Akçakoca Ski Center	Bolu	Recreation
⑧Karataşkaya Ski Center	Bolu	Recreation
⑨Gölköy Dam	Bolu	Sight seeing
⑩Çubuk and Sunnet lake	Bolu	Sight seeing
⑪Bolu Thermal Springs	Bolu	Relaxation
⑫Mudurnu Thermal Springs	Bolu	Relaxation
⑬Sarat Thermal Springs	Bolu	Relaxation
⑭Badas Thermal Springs	Bolu	Relaxation
⑮Seven Kesenözü Thermal Springs	Bolu	Relaxation

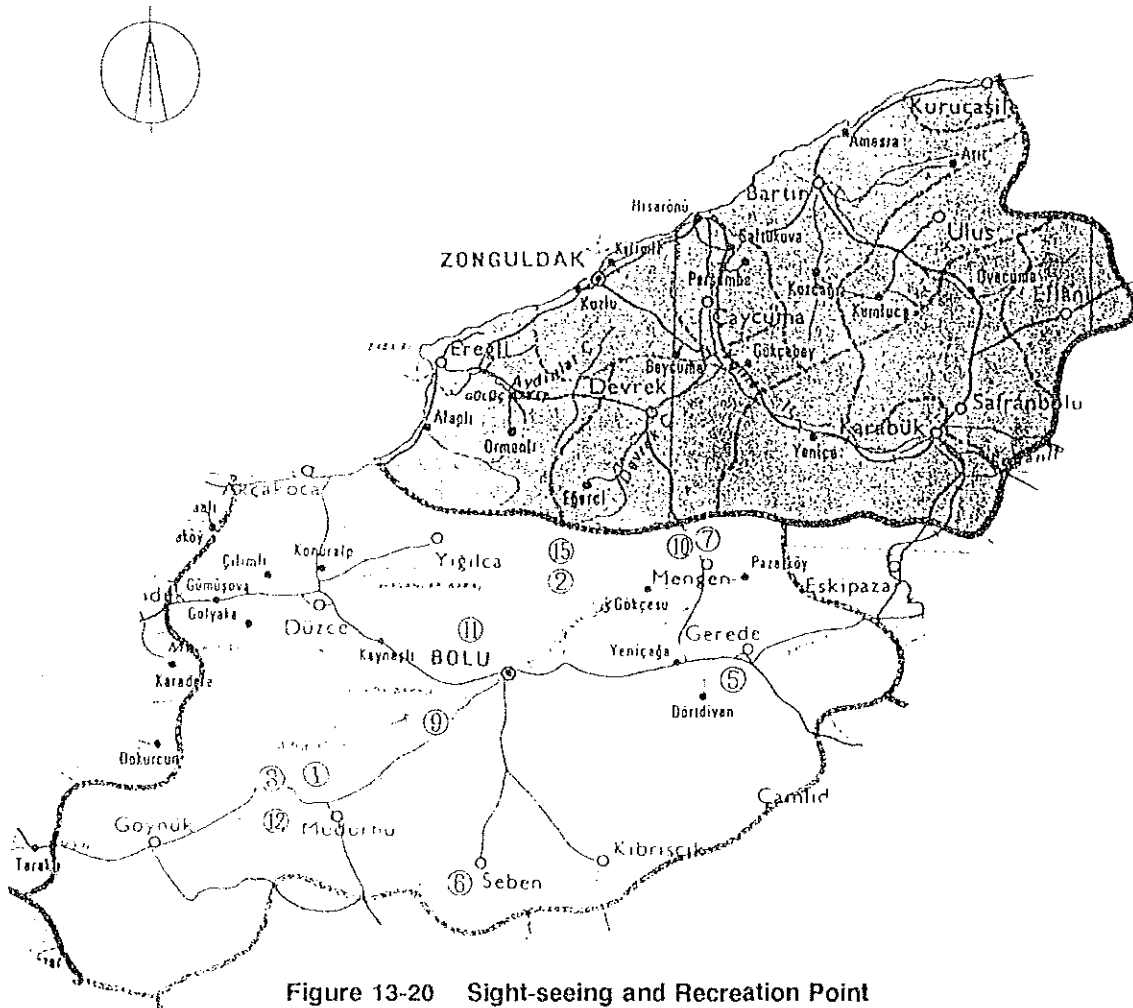


Figure 13-20 Sight-seeing and Recreation Point