V.2 Effect of Project on Physical and Biological Environment after Construction Stage and Countermeasure

V.2.1 Reservoir and Facilities

(1) Influential Factors

The occupation of land is the environmental influential factor of reservoir and facilities.

(2) Environmental Influence and Countermeasure

a) Reservoir

(i) Meteorological and Climate Conditions

The meteorological influence of reservoir becomes important against the thermal environment of forest, especially to the hydrological environment.

The function owned by the water surface and the forest[28] is such that the latent heat being used to the evaporation and transpiration of water reaches the level close to 70% of net radiation quantity and conspicuously alleviates the thermal environment of ground surface. In the naked land, almost all the net radiation quantity becomes a sensible heat and the ground surface temperature extremely goes up. The water surface and the forest consume much of solar energy to the transpiration, alleviate the thermal environment of ground surface and circulate the water in environment by the transpiration.

The solar radiation energy consists of short wave radiation, and when it has reached the ground surface through the atmosphere, the said energy

is comprised of the scattered radiation reaching the ground surface which is scattered by the direct radiation and the water steam as well as dusts in the atmosphere when it has reached the ground surface through the atmosphere. A part of short wave radiation is radiated by the ground surface. This is called a reflectance ratio or an albedo[29]. The smaller the albedo, the short wave radiation absorbs the energy and the latent heat becomes greater.

The albedo on the water surface is 0.03 to 0.10 if the sun altitude is high, 0.10 to 0.5 in case of a needle leaf trees, 0.15 to 0.20 in case of broad leaf trees and 0.08 to 0.45 in case of the soil, and its numerical value becomes greater[29] as its color becomes whitish and its moisture becomes less.
The annual evaporation quantity of reservoir surface at this project is 717 mm (Table V-5).

(ii) Geological Characteristics

Oyukkaya Cavern as a cultural asset exists at the height of 440 m on the left bank near Muharremeoglu Settlement located in the midway to the back water point of reservoir.

Because this cavern is submerged, a careful survey is to be conducted before the construction work as regards its value as a cultural asset, and the excavated products and the like are stored into a museum. Beside them, there are no scientifically precious topography and geology inside the reservoir.

Table V-5 Estimated Monthly Evaporation from Reservoir Surface

Unit: mm

Year	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1956	8.6	0.0	0.0	62.8	73.6	106.4	120.5	131.9	85.0	58.8	13.9	0.0	661.4
1957	0.0	14.6	20.0	58.2	78.9	113.8	132.5	135.2	114.4	81.6	40.7	8.6	798.5
1958	1.9	30.7	30.0	52.1	86.4	107.7	119.1	125.2	90.3	66.2	32.7	20.6	774.9
1959	7.9	0.0	3.9	54.1	80.3	101.0	125.2	120.5	78.9	50.1	34.0	30.0	686.0
1960	0.5	0.0	20.6	52.8	93.0	102.4	119.1	115.8	97.0	82.9	52.1	34.0	770.4
1961	0.0	0.0	19.3	70.9	87.6	108.4	122.5	123.8	87.0	66.9	40.1	15.3	741.7
1962	9.9	2.5	43.4	52.1	93.7	109.8	128.5	134.5	102.4	76.2	68.9	22.6	844.6
1963	1.9	30.7	13.9	45.4	78.3	109.8	125.8	132.5	105.7	72.2	42.1	13.3	771.6
1964	0.0	0.0	26.7	50.1	74.2	107.7	121.1	111.1	93.7	70.2	34.0	22.6	711.6
1965	2.5	0.0	28.7	47.4	85.0	115.1	119.1	114.4	102.4	47.4	41.4	30.7	734.2
1966	11.9	35.4	29.3	66.2	79.6	104.4	131.9	128.5	96.4	87.0	64.2	13.9	848.6
1967	0.0	0.0	13.9	55.5	80.9	98.4	119.8	123.2	97.0	73.6	24.7	16.6	703.5
1968	0.0	0.0	15.3	68.2	100.4	103.1	122.5	115.8	96.4	62.2	44.1	17.3	745.1
1969	0.0	9.2	21.3	38.1	95.0	117.8	110.4	130.5	104.4	60.8	40.7	32.0	760.3
1970	18.0	24.7	41.4	73.6	76.9	104.4	130.5	119.1	93.7	59.5	44.8	0.0	786.5
1971	28.7	7.2	33.4	52.8	87.0	103.1	121.1	119.8	101.7	52.8	39.4	0.0	746.9
1972	0.0	0.0	20.0	75.6	87.6	110.4	125.2	123.2	99.7	67.5	35.4	0.0	744.5
1973	0.0	24.7	17.3	53.5	85.6	100.4	124.5	113.1	103.7	71.6	9.2	5.9	709.4
1974	0.0	9.2	35.4	44.1	81.6	110.4	118.5	116.5	93.7	93.0	36.0	3.9	742.2
1975	0.0	0.0	41.4	71.6	85.6	113.8	129.9	122.5	98.4	66.9	31.4	0.0	761.3
1976	0.0	0.0	18.0	57.5	79.6	97.7	118.5	106.4	88.3	78.3	43.4	10.6	698.2
1977	0.0	36.0	24.7	54.1	86.3	105.7	121.8	117.8	96.4	50.1	53.5	0.0	746.4
1978	0.0	30.0	35.4	50.8	86.3	106.4	120.5	108.4	93.7	70.2	23.3	13.3	738.2
1979	5.9	22.0	39.4	52.1	85.6	112.4	112.4	121.1	100.4	67.5	40.7	12.6	772.3
1980	0.0	0.0	19.3	48.8	88.3	110.4	129.2	123.8	86.3	77.6	44.8	20.0	748.4
1981	12.6	7.2	34.7	50.8	70.9	117.1	123.2	120.5	103.1	87.6	26.7	39.4	793.7
1982	1.2	0.0	15.3	58.8	79.6	108.4	106.4	115.8	107.7	68.9	22.0	21.3	705.4
1983	0.0	0.0	29.3	66.2	89.0	100.4	119.8	109.1	99.0	58.8	30.0	18.0	719.6
1984	11.9	15.3	28.0	42.7	93.0	102.4	113.1	104.4	109.8	74.2	38.7	0.0	733.5
1985	14.6	0.0	14.6	60.2	96.4	103.7	109.8	130.5	91.0	52.8	54.8	7.2	735.5
1986	19.3	17.3	27.3	72.9	65.5	105.7	123.2	133.9	107.1	63.5	13.9	3.2	752.8
1987	2.5	18.0	0.0	41.4	83.6	105.7	131.9	117.1	103.1	63.5	37.4	10.6	714.8
1988	7.2	10.6	24.7	58.8	85.0	103.7	129.2	125.8	96.4	58.8	18.0	13.9	732.0
1989	0.0	0.0	42.7	89.0	83.6	105.1	121.8	131.2	97.0	62.8	31.4	1.9	766.5
1990	0.0	7.2	31.4	57.5	77.6	105.7	127.2	119.1	95.0	74.2	51.5	13.9	760.3
Average	4.8	10.1	24.6	57.3	84.4	106.8	122.2	121.2	97.6	67.9	37.1	13.5	747.5

(iii) Hydrogeological Characteristics

The underground water is not utilized in this area. In addition, also in view of the geology, since this area is included in the wide region showing a small quantity of underground water, it is said that the influence given on the underground water systems is expected to be small.

(iv) Soil Characteristics and Usage Conditions

The soil in reservoir is covered by Grey-Brown Padosolic Soil, the thickness of soil is from 20 to 50 cm and the erosion degree is in the middle to the high category. Further, category on the utilization suitability of soil in this area belongs to the pasture and forest lands.

The soil in the periphery area including the project area has no special high pH trend nor any special feature that the organic substances are particularly rich. The utilization suitability of soil in the peripheral area is not adequate for agriculture due to such characteristics that the percentage of stones and rocks covered slope and erosion degree. This land belongs in the area suited for forest usage.

(v) Agricultural Fields

There are the agricultural fields, which are evaluated to the first class, in the periphery of Belen village on the north side of dam site, but are not included inside the future reservoir.

Inside the reservoir, there are the agricultural field totalling 2,756 da which are combined with

small scale irrigated farming fields of 426 da along the river. The products of irrigated farming fields are vegetables. These farm products are produced mainly for the inhabitants' foodstuff.

Wheat, barley, corn and the like are being produced at the agricultural fields utilizing the barren soil of 2,330 da, but the products excluding the inhabitants' foodstuff are for the livestock.

The products of agricultural fields in this area including the peripheral area are for the purpose of self consumption, but other products than these are sold out to the nearby towns, which becomes one source of inhabitants' cash income.

A small scale of fruit cultivation is being conducted inside the reservoir, and some 1,890 trees in total including small trees are to be submerged, but the kinds of tree in object are apple, cherry, walnut, which are about 2%, 8% and 18% of product in Mengen District, respectively. These fruit trees shall to be preserved as much as possible by their transplantation to the area outside the reservoir area.

Because these agricultural products are common with those in peripheral areas and moreover there are no special products, the influence being exerted on the agriculture and foodstuff circumstances in the periphery areas can be estimated to be small.

As one policy of inhabitants' movement countermeasure, the loss of agricultural fields in the submerged area is compensated by the

calculation system based on the productivity of fields.

(vi) Hydrological Characteristics

There exist no other change in hydrological environment than that the reservoir is formed in the range shown in Figure V-1.

(vii) Available and Planned Usage to Surface Water

The river water is utilized in the irrigated agricultural fields inside the reservoir, but these irrigated agricultural fields are lost together with the submergence of agricultural fields into the water. The irrigated agricultural fields have the extent of 426 da, and the farm products are mainly vegetables for home consumption, and some part of these products are sold out to the villages near project area and become the source of their cash income.

The loss of these irrigated agricultural fields is to be compensated, but because the kinds of products don't especially differ from those in the area and their quantity is not so much, it can be understood that the said loss of land doesn't exert large influence on the agriculture and consumption in the area.

The potable water in this area does not depend on the river water, and moreover the surface water for the other purposes including fishery is not being utilized. The formation of reservoir is to give the space of new industries, such as the cultivation of fish to the regional inhabitants.

(viii) Aquatic Organisms

Proliferation of aquatic plants can not be seen in the river of reservoir area. The species of aquatic insects are general ones such as Stone-flies and Mayflies.

The fish in the river are mainly the carp and no trout are living in the river future submerged area.
The appearance of reservoir is to provide a new living environment to carp, etc.

(ix) Thermal and Geothermal Water Resources

There are no thermal and geothermal water resources and their utilization in the reservoir area.

(x) Area under Protection

There is no natural protection area inside the reservoir, but there are the three historical relics of Doruktepe Mound, Inistepe Necropole and Kayabaşi Antique Building Remains and also the two cultural assets of Kayabükü Village Mosque and Oyukkaya Cave.

According to the survey, the historical relics are recognized as first degree relics by Law No. 3386, 2863, 19660 and 20257 and need to be protected.

Therefore, the presence of relics is publicly announced to the regional residents on the basis of the instruction given by the Ministry of Culture and the fact to be announced about their existence and their documents sent to the

Ministry of Culture.

The Doruktepe Mound, İnistepe Necropole and Kayabaşi Antique Remains are to be excavated and protected by the cooperation of General Directorate of Monument and Museum. A detailed survey is needed for the Oyukkaya Cave, and these survey results are to be reported to the concerned organization for the evaluation. The Kayabükü Mosque is moved to another location following the movement of village.

The results of these countermeasures shall be reported to the Ministry of Culture.

(xi) Forest Resources

The trees in the area of 304 ha in total are to be submerged by the formation of reservoir. Its quantity is about 5% of the area in Mengen-Gökçesu Forest Management Area in which the reservoir is included.
The major kinds are black pines, firs, hornbeam, beach, etc. and don't differ from the kinds of trees inside the Forest Management Area and its periphery Management Areas in which the project area is included. Further, if the volume of wood should be assumed 150 m^3 per 1 ha, it will become some 50,000 m^3, whose volume equals 0.3% of the volume in Mengen District and 0.4% in Devrek District with small trees in object, and corresponds respectively to 17% and 17% of the annual increase volume of small trees. The influence on the forest resource is small if referring to the said figures.

Because the meteorological characteristics in this area are also suitable for the growth of

trees as the policy of environmental readjustment after the construction of dam and other facilities, the forestation can be made under the cooperation of the related organizations.

Losses of forest influence the contraction on living environment (Ambiences) of animals such as insects, birds and mammals, and forest hydrological environments, hydrological.
Concerning the reduction of forest resources, agreement and permission is to be obtained before construction.

In addition, the trees inside the reservoir shall be cut down for decreasing the eutrophication of reservoir and the trees in the submerged area also shall be cut down after discussion with the related organization.

(xii) Flora and Fauna

i) Flora

Almost all of the areas inside the reservoir consist of agricultural field.

With regard to the plant phase on the Black Sea coast, the broad leaf trees are distributed in the low and the middle land, and the needle leaf trees are distributed in the high land because the amount of precipitation is comparatively high. In addition, the region of the west from Ordo Province is also the area having the characteristics of Mediterranean Sea. The project area is located at this boundary.
The species peculiar to this area are two species of Udo of Dropwort family, and 2

species of Chrysanthemum family, 1 species of Wild pink family, and 1 species of Light house glass family.

47 species (9 species are unknown) could be identified in the field survey of herbaceous plant groups inside the reservoir, but the endemic species and the rare species as well as the species which are economically important have not yet been found.

The forest of 304 ha at the slope in the reservoir is to be lost. Present state to Ispaca village from Kayabükü Village is a barren agricultural field especially on the lower slope area. The appearance of reservoir contributes to the maintenance of forest hydrological environment such as alleviating the environment during the dry summer season.

ii) Fauna

It is reported that 17 species of mammals are living in the nature protection area located in the periphery of project area.

According to the question study, such animals as antler, bear, wild pig, wolf, marten, etc. are inhabiting the reservoir area including surrounding area. The wild pigs are in the area. The formation of reservoir may have a possibility for shrinking and partitioning the habitation environment of these animals, but it is judged that the influence on the animals is small when considering that these animals are protected from hunting, etc. and they

also have migration and wide distribution.

(xiii) Dairy Breeding Resources

There exist no pasture nor meadow which are wide enough to manage the breeding in the reservoir. The livestock animals are being bred mainly on the barren land or the land of narrow range such as the farming field. In addition, the number of animals is less, and the animal products are only being self-sufficing. Because the kinds of livestock products are milk, butter, yogurt and meat, and don't differ from the peripheral areas, it can be evaluated that the livestock resource have not a great influence on the dairy breeding resources and consumption of animal products in the surrounding area.

(xiv) Mineral and Fossil Fuel Resources

No mine exists inside the reservoir.

(xv) Locations High in Landscape Value and Recreation Area

No locations and areas exist inside the reservoir, which become the objects of high landscape.

Regarding the landscape, when the reservoir has been formed, the gray cultivated field will disappear and a new landscape of green and blue will be created (Figure V-6).

The water familiarizing space can be anticipated to become the place of regional recreation together with the nearby national park by arranging the traffic roads and lodging

facilities in the future.
According to the question study on some residents, regional vitalization is desired by the utilization of lake side as camping places and so forth.

b) Dam Main Body

(i) Geological Characteristics

Topography of the dam site, except for small collapses due to miner faults jointing immediately upstream of the left-bank abutment, indicates a stable state at both the slopes on both banks and the right-bank side ridge. Scientifically precious topography is not included at this point.
Geology of this site consists of granitic rocks and dia base intruded in them at parts. Scientifically precious geology is not included.

(ii) Soil Characteristics and Usage Conditions

According to the type of soil utilization, this site is concluded to be unsuitable land for agriculture.

(iii) Agricultural Fields

The agricultural fields is not included in the location where the dam body is placed.

(iv) Hydrological Characteristics

The river is divided by the dam body and the hydrological environments on the upstream side and the downstream side may change.

(v) Available and Planned Usage of Surface Water

The surface water is not being utilized at this spot.

(vi) Aquatic Organisms

The aquatic organisms at the place where the dam body is installed will become extinct and escape from there.

There are no aquatic plants at the dam site. The aquatic insects are Stone-fly group and Mayfly group, and these species are not ones limited to this site. The kind of living fish are mainly the carp group, and they widely inhabit the upstream and downstream sides of Devrek River. The living environment of these fish is to be partitioned by the dam, but the fish at the dam site prevented from dying out directly by their escaping behavior.

(vii) Area under Protection

The dam site isn't included in the protective area and there exist no relics and the like in object of the protection.

(viii) Forest Resources

No forest exists at the dam site.

(ix) Flora and Fauna

The natural vegetation at the dam site is extremely poor and no peculiar species can be found. The animals are also not living only at the dam site.

(x) Locations High is Landscape Value and Recreation

The dam site is almost naked land or land where low trees roughly exist sporadically and there exists no object of landscape.
The place where the dam body (Figure V-6) can be seen is only the vicinity of dam site, and can not be seen from the nearby national park.

(4) Raceway

Because the raceway is to be installed underground, it exerts no influence on the environment of ground surface area.

The construction work area for constructing the raceway is temporarily put under the object of compensation, but the topography and the vegetation on the ground surface area are to be restored together at the end of construction work.

(5) Power House and Switchyard

Since the power house is installed underground, it exerts no influence on the ground surface area environment.
The switchyard occupies an agricultural field of 5,000 m^2 of ground surface area and is not included in the protected area. The agricultural field is put under the object of compensation together with the setting of construction work area.

V.2.2 Operation

(1) Operation Plan

The operation plan for facilities are as follows.
Power plant is operated continuously under the condition of maximum discharge of 43.1m^3/sec. in the high-water season

Figure V-6 Future Scene of Dam and Reservoir

and the time of year when electric power is in demand, and in other seasons the times the facility is operated is according to the demand.

(2) *Environmental Influence Factors*

The environmental influential factors by the operation are storage and discharge of water, and the formation of water reducing section from dam site to outlet point. In addition, there are such factors concerned with the utilization of roads and lodgings to operate the facilities.

(3) Environmental Influence and Countermeasure

a) Storage and Discharge of Water

(i) Hydrological Characteristics

i) Storage of Water

• *Stratification of Water*

The flow of water and the vertical distribution of oxygen and nutrients in reservoir are greatly influenced by the existence of thermocline. The absence of oxygen at the bottom layer comes from the lack of vertical circulation due to the formation of temperature stratification and the excess nutrients.

As the indicator for knowing the situation of vertical circulation and the stratification of water, the following equation is conveniently used.[30)]

α = Total annual inflow volume of water into the reservoir / Total capacity of reservoir

Here, if the α is smaller than 10, it may result in a stable type on the stratification while if the α is more than 20, it may become a mixed type.

Because the total inflow volume is 451×10^6 (m^3) and the total reservoir capacity is 197.7×10^6 (m^3), it can be estimated that the α becomes 2 and becomes a stable type.

• Water Quality of Reservoir

The future water quality of reservoir can be obtained by the empirical equation (Vollenweider's equation)[36].

The nitrogen and phosphorus concentrations are to be calculated by use of this equation, but the T-N and the T-P are required as the parameters to be input.
Because the T-N and the T-P can not be measured in this study, substitutional calculation was performed by taking into consideration the relationship between the following inorganic state one and the total one.

According to the OECD report,[31] 60% in case of 500 mg/m^3 T-N or 70% in case of 5,000 mg/m^3 are inorganic state, and there is much inorganic state when the water is richer in nutrition. Additionally, there is such a knowledge that, in case of 10 mg/m^3 phosphorus, its 20% is in inorganic state and in case of 200 mg/m^3 phosphorus, its 45% is in inorganic state.
Equation (1) is used for calculating the

phosphorus.

Log (P) λ = 0.82 Log (X) + 0.19 .... (1)
where, X = L (P) / qs (1 + $\sqrt{\tau w}$) .... (2)
(P) λ = T-P concentration of reservoir (mg/m^3)
L (P) = Annual load of T-P (mg/m^2/year)
qs = Annual inflow volume of water (m^3/m^2/year)
τw = Residence time of water (year)

The unknown parameter is the phosphorus concentration (P) λ (mg/m^3) in reservoir.

First, the constant to be substituted into Equation (2) is calculated.

Annual load L (P) $=3.63\times10^{10}$(mgP/year)/$5.31\times10^{6}(m^2)=0.68\times10^{4}(mg/m^2/year)$
Annual inflow water volume qs $=4.51\times10^{8}$ $(m^3/year)/5.31\times10^{6}(m^2)=0.85\times10^{6}(m^3/m^2/year)$
Residence time of water τw = $197.7\times10^{8}(m^3)/4.51\times10^{8}(m^3/year)=0.43$ (year)

Therefore, the phosphorus concentration (P) λ of reservoir could be predicted as 37.1 mg/m^3 when the said numerical value was substituted into Equation (2) and moreover was calculated by Equation (1).

Similarly, Equation (2) is used for calculating the nitrogen (mg/m^3).

Log (N) λ = 0.78 Log (X) + 0.73 .... (2)
where, X = L (N) / qs (1 + $\sqrt{\tau w}$)

Annual load quantity L (N) $=5.63\times10^{11}$

$(mgN/year)/5.31\times10^{6}(m^{2})=1.0^{6}\times10^{5}(m^{3}/m^{2}/year)$

Therefore, the nitrogen concentration (N) λ of reservoir could be predicted to be 933 mg/m^{3}.

The annual average Chlorophyll-a concentration can be obtained by the following equation:

$$Log\ (Chl\text{-}a)=0.79\ Log\ \{L(P)/qs\ (1+\sqrt{\tau w}\}-0.435$$

The Chlorophyll-a concentration could be predicted to be 10 mg/m^{3}.

The annual average transparency (m) can be obtained by the following equation:

$$Log\ (Sec) = -0.39\ Log(X)+1.17$$

where, $X = L(P)/qs(1+\sqrt{\tau w})$

Since X stands for 37.1 mg/m^{3}, the annual average transparency becomes 3.2m.

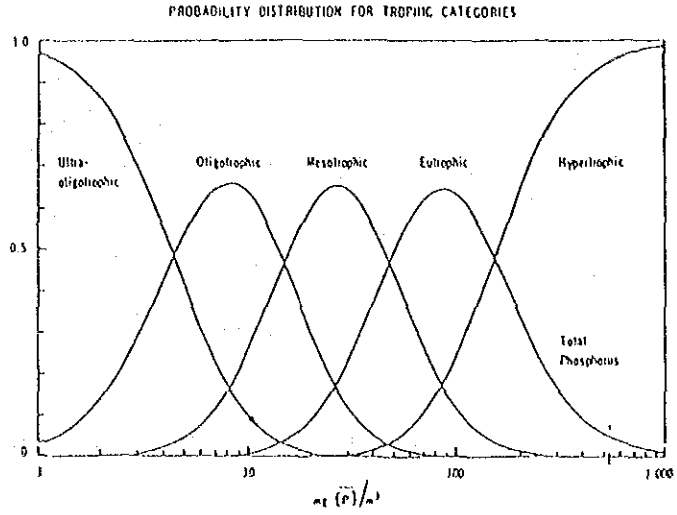
The oxygen consumption volume ($g \times O_2/m^2/day$) of bottom layer can be obtained by the following equation:

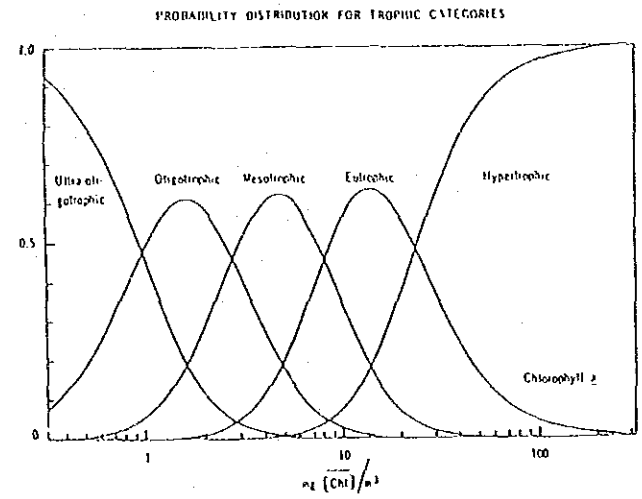
$$Log\ (HOD) = 0.467\ Log\ (X) - 1.07$$

where, $X = L(P) / qs\ (1 + \sqrt{\tau w})$

Since the X is 37.1 mg/m^{3}, the consumption volume became 3.2 $g \times O_2/m^2/day$. This equation is for only 18 lakes and the number of case studies is less and moreover the correlation coefficient (r) is 0.6 and also accuracy is low.

If Figure V-7 should be used for predicting the degree of eutrophication of reservoir





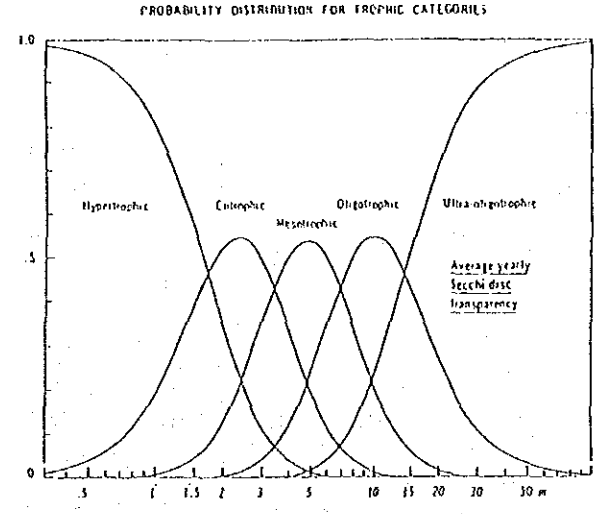


Figure V-7 **Probability Distribution for Trophic Category**

from reservoir from the study of OECD using the above mentioned calculation result, the probability becoming Mesotrophic in the case of inorganic phosphorus is about 60%, the probability becoming Oligotrophic is about 10% and the probability becoming Eutrophic is about 30%.

In case of the Chlorophyll, the probability becoming Oligotrophic is several percent, the probability becoming Mesotrophic is 35% and the probability becoming Europhic is about 55%.

A similar situation can be predicted from the annual average transparency.

Here, if it can be assumed that the amount of phosphorus state is accounted for 20% of T-P, T-P concentration will become about 380 mg/m^3.

Therefore, future trophic level can be predicted to become the state over Mesotrophic level.

(The prediction of eutrophication shall be conducted on the basis of the water quality survey for at least 2 years. In addition, the T-P and the T-N shall be used for predicting the phosphor and the nitrogen concentration in future reservoir.)

For the eutrophication problem in future reservoir, monitoring aimed to grasp the present conditions shall be planned and attempted to maintain the water quality by suitably removing the aquatic plants in

reservoir.

• Sedimentation

Amount of suspended sediment at the dam site was calculated to be 152 tons/year/km^2. The value of total water capacity/annual inflow volume and ratio of bed load to suspended load at the reservoir are 44.1% and 100% respectively, and if the sedimentation period is assumed to be 50 years, amount of sediment in the reservoir becomes 18.78×10^6 tons.

The average density after 50 years is calculated as 1.19 tons/m^3, and the sediment deposited in the reservoir after 50 years assuming the above ratio is calculated as 15.78×10^6 m^3.

ii) Discharge of Water and Water Quality

• Water Quality

The deterioration on water quality of reservoir exerts an influence on the aquatic organisms in the reservoir and the downstream and the river water utilization. In the OECD report[37], concentrations of phosphorus and nitrogen in the discharged water from the reservoir are assumed to be equal to the concentration of reservoir water predicted with the above equation.

The inflow of nutrients promotes the proliferation of phytoplankton and COD as the polluted substances are produced in the reservoir.

In the reservoir of this project, it can be estimated that the phosphorus becomes the limiting factor because the phosphorus concentration is less than nitrogen.
According to the reaction formula of photosyntheses and aspiration of phytoplankton, 22 mg of TOD (Total Oxygen Demand) can be produced if 1 mg of nitrogen is taken into the plankton, and 159.3 mg of TOD is produced[32] in case of the phosphorus.

The TOD was calculated in case of the phosphorus which is a limiting factor.

The average inorganic phosphorus concentration in the future reservoir is around 0.04 mg/l, it can be converted into 5.7 mg/l of TOD.

The relationship between the CODAcid and TOD is said to be within the following percentage:
CODAcid = TOD/1.78
Therefore, this means that 3.2 mg/l of CODAcid is to be internally produced.
The limit values of eutrophication preventing the standard of the lake, pond, marsh and dam reservoir are indicated as shown in Table V-6. If the inflow portion of organic matter should simply be added and compared with the calculated result, it can be supposed that the COD overs the standard value of 8 mg/l for other water usage.

Table V-6 Water Quality

	Nature Preservation	Other Usage
COD (mg/l)	3	8
T-N (mg/l)	0.1	1
T-P (mg/l)	0.005	0.1

According to the above results, trophic level in future reservoir is explained to become eutrophic state. However, as the depth of this reservoir is big and the annual water temperature is comparatively low, it can be estimated that the serious eutrophic state is not caused.

For this eutrophication problem, monitoring on water quality of reservoir shall be planned in order to catch the early changes on water environment. Moreover, if the deterioration on water quality occurs in future, discussion concern with the readjustment on the regional waste water treatment on urban and so on in the subject river basin shall be performed among the related organization to prevent becoming eutriphication.

• Water Temperature

There is the problem of influence of low temperature water drainaging during the summer season as the environmental influential factor in addition to the nutrients.

The discharge of cold water, stored during winter season gives an influence to the river organisms at the downstream side.

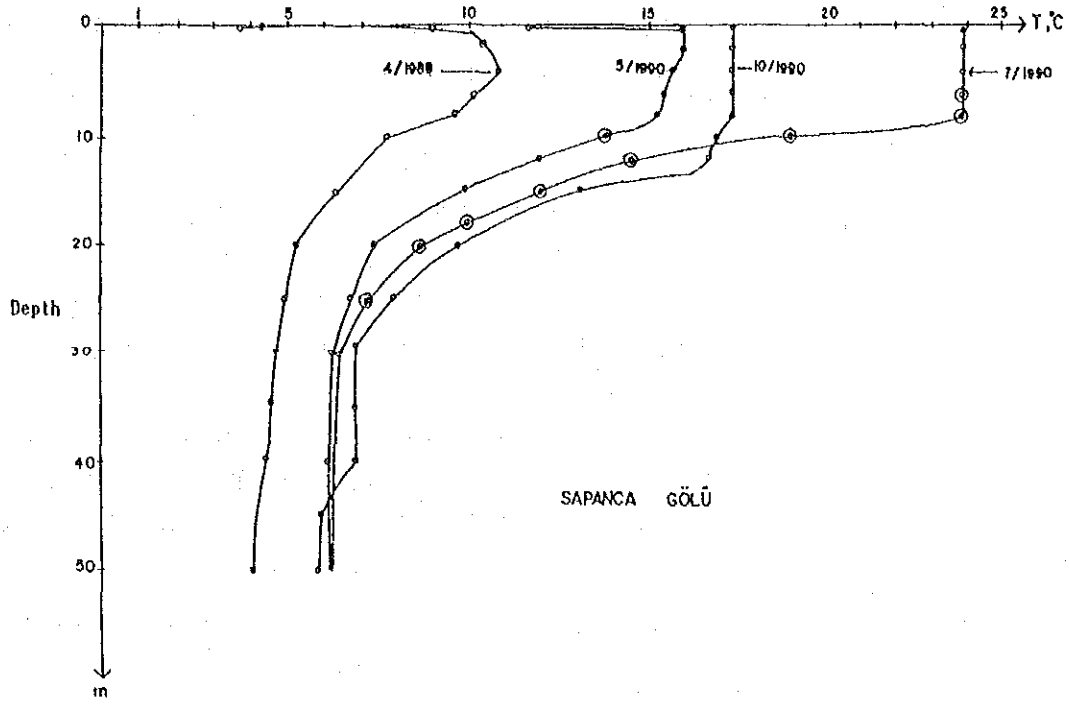
According to the instance on measurement[33] at Sapanca Lake which is a natural lake, the water temperature showed 24°C on the surface in July, but lower than 10°C at the 30 m depth (Figure V-8).

Concerning the influence to the organisms on the temperature fluctuations, there is the knowledge on Cyprinus carpio which is one species of carp[34].

The most suitable water temperature to the hatching of eggs is in the range from 14 to 30°C, and if the water temperature change is given from 20°C, no influence is given to the eggs at a fall lower than 7°C, and the hatching percentage is said to be 0 at a of fall more than 12°C.

In this project, the water is planned to be taken from the depth of 10m to 57m from the surface. In case the discharging volume is 10.1m^3/sec. and water temperature shows 6°C, the temperature becomes about 8°C by mixing between the discharge water and the river water (assuming that the water flow rate and water temperature are 1.5m^3/sec. and 20°C respectively).

Simply based on the above information, influence of cold water may occur on the ambience concern to the hatching of eggs. However, it can be thought serious influences for fish living in the Devrek River do not occur because they have a wide space for living in the river and the egg-laying site is not located at only the place near outlet point.



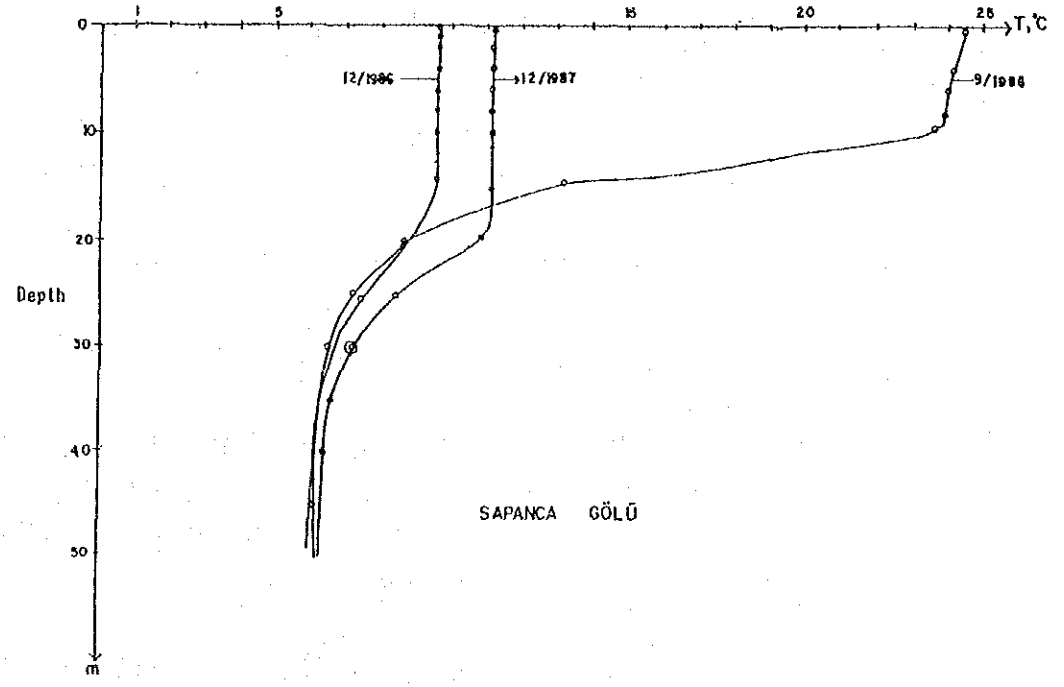


Figure V-8 Temperature Stratification Situation

Moreover, as the cold water problem becomes a subject of discussion only for the summer season, and in summer season fish have high activity on the migration in the river, it can be thought the direct impact for fish and influences on fish ambiences are comparatively small.
Çay project gives wide space for living fish. So, it can be considered the duration of this influence is short.

Moreover, although there is also the problem of turbid water from the reservoir for a longer term, the fish inhabiting this river are carp and loach, which are strong against turbidity, so it can be estimated that no serious problem is caused.

The change in volume of discharge water by the operation may change the depth of river. About this problem, as the shoal region alone changes and moreover the fish also have the moveability, it can be thought from this fact that the influence on the living fish is comparatively smaller than the influence by the water temperature.

(ii) Available and Planned Usage of Surface Water

About 50 ha of irrigated agricultural fields exist between Devrek Town and the dam site and there is the agricultural fields of about 300 ha further on the downstream side.

The water volume required for the irrigation of this agricultural fields is 5,500 m^3/ha/year in total. The area most directly relating to the quantity of discharge water can be seen in the

area from the dam site to Devrek Town, and the irrigation purpose of this district resides in vegetable and fruit tree cultivation.

As countermeasure against the utilization of river water, consideration is given to the operation plan so that the water can be supplied when the irrigation becomes necessary.

(iii) Aquatic Organisms

The deterioration of water quality in the reservoir is to be improved by promoting the waste water treatment in the upstream area. In addition, infringement of fish to the intake mouth is to be prevented by using a fence or net.

There is the problem on division of the living environment to the upstream and downstream side, especially for fish, concerning the influence on aquatic organisms by the appearance of dam and reservoir.

The same species of carp also inhabit the upstream and the downstream, and moreover, breeding in the reservoir can be expected, but it is estimated that no problem may be caused.

The trout in Abant Lake and the other trout in the upstream area of branch of the Devrek River can be expected to be the land locked type according to the reference literature, and the possibility for the extinction of such species by the dam is small.

The mode of life of these trout is to be surveyed at the stage of detailed design, and then protection plan prepared to correspond to the problem.

b) Water Reducing Section

(i) Hydrogeological Characteristics

The utilization of underground water can not be seen even in this area and its peripheral areas.

(ii) Hydrological Characteristics

The river water is turned in its stream by the dam, and the water is transported to the opposite bank of river near Akçabey Village by the underground tailrace tunnel.
Consequently, some 25 km water reducing section is formed in the area from the dam site to outlet point near Akçabey Village.

i) Change in Water Flow Rate

The water of three small rivers flows into the main stream in the water reducing section (Figure IV-16). According to the measurements from June to August during the period when the flow rate of main stream was small, the sum of water flow rate of three small tributaries in this section was from 1.1 to 2.2 m^3/sec. and the percentage being occupied by the water volume including the main stream was from 22 to 31%, and the contribution of the third small tributary having the water flow rate was 12% on average.

River water in the section about 2 km from the dam site to the first tributary, excluding the rain water flow into the river falling down the slope of valley, is stopped by the dam.

As the countermeasure against this section, another facility for discharging and maintaining the water volume required in the future is installed to the dam body, although it seems the formation of reducing section does not seriously influence the natural and social environment. The necessary water volume is to be estimated at the stage of detailed design.

ii) Water Quality

There is Köprübaşi Village of 356 persons on the downstream side of dam.
As the parameter of river water quality, the value of BOD is low as a whole and clean, and big contamination sources can not be seen. BOD at the dam site is 1.3 to 3.8 mg/l and 2.5 mg/l on average, and is 0.6 to 2.6 mg/l and 2.0 mg/l on average at the outlet point.

If the BOD balance between two points should be studied taking the result of field study conducted on July 15 as an example, the balance becomes as follows:

$2.8(m^3/S) \times 2.5(mg/l) + 4.3(m^3/S) \times X(mg/l)$
$= 7.1\ (m^3/S) \times 2.4\ (mg/l)$

Therefore, the BOD value of water totaled 3 branches and other inflow water was calculated to be 2.3 mg/l.
This value indicates that the future BOD value at the outlet point doesn't differ greatly from the present situation even if the water is quite reduced at this section.

After the start of operation, the water quality and the organism survey is conducted adequately to grasp the change of water quality in the water reducing section.

iii) Suspended Sediment

I is estimated that earth and sand of about 313,060 tons is to be accumulated in the reservoir during one year.
Therefore, the same amount of earth and sand is decreased at the downstream of dam. Because the amount of suspended sediment of Filyos River is estimated as the amount of 3,803,800 tons per year and the amount at the dam site is Devrek River is accounted for about 8% of it, it seems that this project doesn't give a great change for the present load on suspended sediment in the river.

There exist the irrigated farming fields along the river on the downstream area from dam site to the junction with Filyos River but it can be thought that, because they are not directly utilizing the river bed and located on the river terrace, these farming fields are not lost by only the decrease of suspended sediment.

(iii) Available and Planned Usage of Surface Water

Any facilities and industries utilizing the river water are not located in the area between dam site and outlet point.

(iv) Aquatic Organisms

Similarly to the reservoir area, the proliferation of aquatic plant can not be seen in this section.

The aquatic insects are similar to those at the other points, and are not those inhabiting only this section but are general species.

According to the question study at Köprübaşı Village located at the water reducing section, the carp and loach are mainly living in the main stream.

If the water volume between the dam and the first branch becomes zero, the living environment of these fish is lost. Further, because the water volume is less between the second branches, it can be thought that there appears such influence as escape in case of the carp.

There is information that the trout are inhabiting the upstream of branches in this section, and the trout can not be seen in the main stream. The inhabitation of trout depends on the water temperature and the quantity of oxygen, and because they can move even if the water depth becomes the body height of trout, it can be expected that no serious problem is caused even if the trout live in the first branch and contact is needed with other trout in the second branch.

Because the newly formed reservoir gives grand living environment to the aquatic organisms, it can be estimated that no serious influence is caused to the inhabitation and proliferation of fish in the object rivers.

(v) Area under Protection

This area is not included in the natural protection area.

(vi) Forest Resources

The forest exists on the right bank slope, and the bushes and agricultural fields exist on the right bank in the water reduction section.

The kinds of trees growing on the right bank slope are pines and beech etc. and are not the kinds growing by directly absorbing the river water. These kinds of trees are those growing dependent on the soil moisture coming from the precipitation, which is comparatively rich in this region.

Therefore, it can be supposed that no serious influence is given to the forest resources because the periphery forests are not lost by the formation of water reducing section.

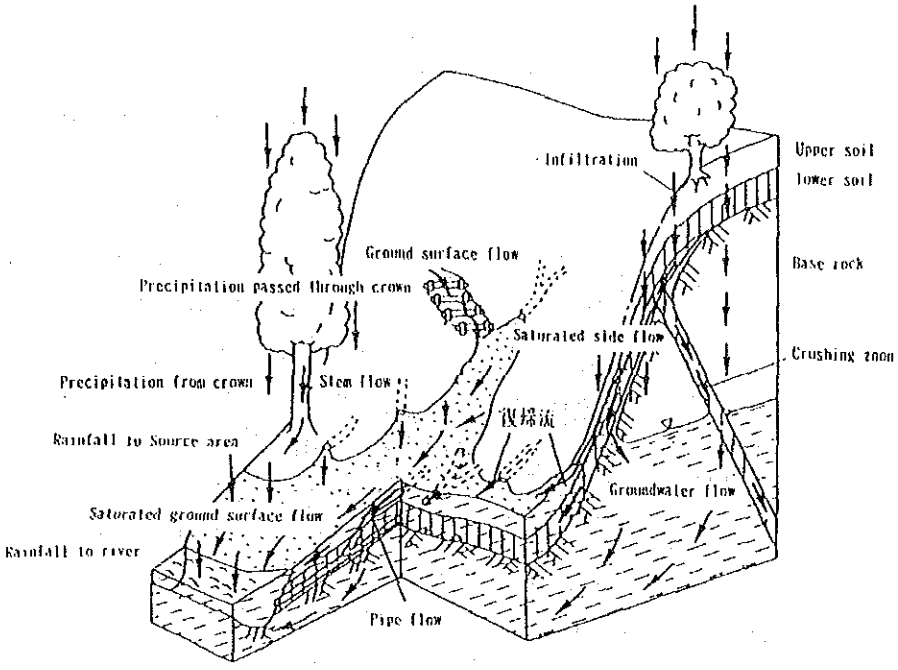
(vii) Flora and Fauna

i) Flora

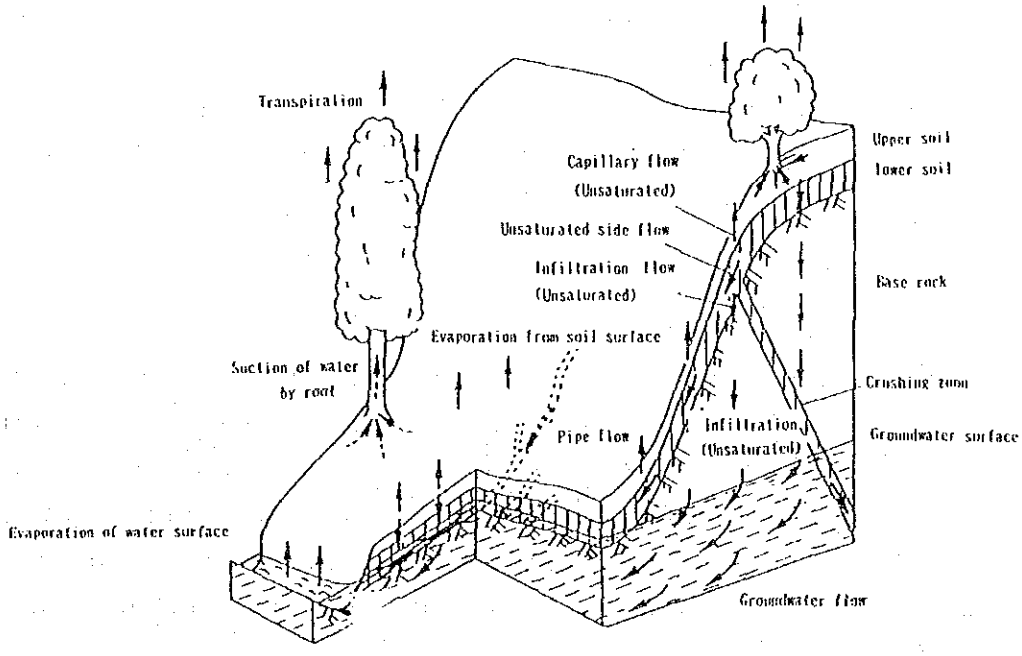
If the water volume discharged to the water reducing section from the dam is supposed zero, the river surface up to the first branch is lost. The vegitation in this section is not forest, and this section is occupied by the fairing field, settlement area and the bushes mainly composed pines.

Generally, the plants on the mountain slope are growing by adsorbing the necessary water for their growth depending on the water brought by the rainfall, which is flowing down from the slope (Figure V-9).

Because the plants in this section are not



(a) Case of heavy rainf Upper soil is suaturated by water)



(b) 1 week after heavy rain

Figure V-9 **Behavior of Rain Water at Forest Slope**

the kinds directly utilizing the river water and not the species dependent on the air humidity such as the orchid, it can be thought that no serious influence is caused to the vegetation.

The appearance of river bed may change the micrometeorological environment by the solar heat, because the section has a feature such as long and narrow and the structure has not a shape to prevent the circulation of atmosphere, though this section exists at the valley bottom, it can be expected that the humidity of air is prevented by the moisture from the soil and bushes.

Therefore, it can be thought that the ambience of plants is not greatly changed.

According to the plant survey at the water reducing section, no specific species have been found out.

ii) Fauna

The presence of comparatively deep and wider rivers and lakes/marshes limit the movement of land animals. The formation of water reduction section in the present project doesn't hinder or limit the place as the animals' goings/comings and water drinking place.

The wild goose/duck families and the cormorant of aquatic birds are living in the national park and the natural preservation area in Bolu Province and Zonguldak Province. For these birds, it can be expected that their living space is expanded

by the reservoir being newly formed.

(viii) Points and Area of High Landscape Value and Recreation

The water reducing section exists in the valley. The landscape in this section is structured by the slope of wood, and doesn't show any especially conspicuous landscape value. Excluding the visual range expanding point just below the dam site and the one part of Köprübaşı Village, there are no spots where this section can be seen by the residents.

c) Power House

(i) Noise and Vibrations

The noise and vibrations are generated when the power house is operated, but the influence to the inhabitants and the wild animals is extremely small because the facility exists underground.

(ii) Wastes

The wastes being generated by the maintenance control of power house and dam facility are to be disposed on the basis of the related legal rules.

d) Employees

(i) Wastes

The living waste water, refuse, etc. being caused by the employees are to be disposed adequately. The residual foods, etc. are to be appropriately disposed in order to lessen the influence on the wild animals.

(ii) Traffic

Concerning the employees' movement by vehicles, the enlightenment of traffic legal rules and so forth will be attempted to assure safety to the inhabitants.

V.3 Environmental Cost and Benefit

(1) Basic Concept

The basic formula for analyzing cost and benefit is as shown below.

NPV = Bd - Be - Cd - Cp - Cd

where,

NPV = Net present value,

Bd = Direct benefit from the project, such as;

- value of electric power to be generated and
- national land preservation value

Be = External benefit (including environmental benefits), such as;

- Positive effects including improvement of environmental amenity
- Economic value of secondary benefits

Cd = Direct costs related to the project

Cp = Costs related to environmental preservation

Ce = External costs (including environmental costs) such as;

- expenses for resettling the inhabitants, estimated value of damage suffered by people of whom opportunities for leisure are deprived

The values should be calculated in terms of relative ones compared with the basic year by removing influences of inflation. This calculation presumes the service life of the dam to be 50 years, and the influences will be estimated be comparing costs among the items of Be, Cd, Cp, and Ce. (Further estimation should be made in the future by checking the contents of the development program and confirming the costs.)

(2) Influences upon the Natural and Social Environments

The contents of the influences upon the natural and social environments are to be listed in Table V-7.

The table describes the contents of the influences and estimated influences if appropriate measures are taken. In compensating the inhabitants, their desires for resettlement should be fully respected.

(3) External Benefit (Be)

The external benefit is to be calculated based on the construction and work programs, blueprints of future local development, etc.

(4) Costs Related to Environmental Protection (Cp)

Costs for the contents of measures against the environmental impacts as stated above are estimated.

(a) During Construction

Environmental measures during the construction are not so particular when compared with those for other dams. Water turbidity and changes in its quality are to be surveyed from time to time in accordance with the construction program.

(b) After Construction

Water quality in the reservoir and reduction water area is to be monitored at monitoring points. Cultural heritage which should be protected is to be surveyed before filling the reservoir. Any items to be excavated will be stored in museums under the cooperation of the culture agency.

(5) External Costs (Ce, including environmental costs)

(a) Expenses for Resettlement

They are shown in Table XX.

(b) Estimated Value of Other Damage

Not particular

(6) Cost Benefit (C/B) of the Environment

Influences upon natural environment may sometimes modify the environment including topographic features. Hence. environmental protection measures are to be taken to lower and minimize such influence.

This project is to alleviate the influence by implementing sufficient environmental measures as listed in Table V-7. Regarding the socioeconomic environment, compensation for resettlement of inhabitants who are involved in the project area is to be handled with much respect to their desires. The benefit of the project includes securing power supply, offering economic effects to the construction points, and giving economic diffusion effects to the surrounding areas, as well as vitalization of the local technical groups, thereby securing infrastructure for regional development in the areas concerned.
(The scales of the benefits and costs should be compared and be estimated in terms of amounts from the macroeconomic viewpoints.)

(a) Environmental Cost and Benefit

<External Cost (Ce)>

External cost to be incurred during construction includes those of resettlement of the affected local

Table V-7 Environmental Impact, Benefit and Environmental Protection Measure

Classification	Physical and Biological Influences and Utilization of Natural Resources					Socioeconomic Influences				
	Positive factors		Negative Factors			Positive factors		Negative Factors		
Stage	Item	Contents	Item	Applicable Area	Measures to be taken (Cost)	Item	Contents	Item	Applicable Area	Measures to be Taken (Cost)
<During Construction> 1) Modification of Topographic Features			△ Modification of Agricultural Land for securing Construction Material	○Quarry for producing Stone Materials, other than Reservoir	*Slope Protection Work, Minimum modification, Restoration of Land, and Afforestation			Objectives to be Compensated	Forests, Agricultural Lands, Houses, Afforested Trees, Fruit Trees, Public Facilities, etc. to be included from the Dam Bottom (343m in Sea Level) to 440m in sea Level	
				○Water-discharging Points, Deforestation	*Minimum modification					
				[Points I, K, L, M,and N,] [555 da : Fig.V-10	[to be further reviewen in the D/D Stage.]	◎ Population	**Increase in Population	○ Fruit Trees		1,788 (TL 6,346,132,000)
			△ Generation of Noises and Vibration		*Restriction of work during night (Measurement)	◎ Income (Planned Area / Surrounding Area)	**Increase in Employment	○ Agricultural Lands Compensation Values to be Calculated Under the Income Capitalization Method.		Area to be Compensated : 3,311 da.
			△ Changes in Air Quality		*Control Program (Measurement)		**Increase in Social Capital			within the Reservoir (TL 32,318,820,000) outside the Reservoir (TL 852,480,000)
			× Generation of Turbid Water by Construction Work		*Sedimentation Basin (Monitoring)	◎ Economy	**Temporary Vitalization of Local Economy	○ House	55 houses, 302 persons	(TL 4,500,000,000)
			× Changes in Water Quality (pH)		*Regulating Pondage (Monitoring)		**Vitalization of Local Technical Groups	○ Afforested Trees	2,895 trees	(TL 284,842,000)
			△ Illumination for Construction Work		*Minimum Illumination			○ Compensation for Public Facilities to be inundated	Mosque (3) Elelmentary School (1) Teachers' Dormitory (2) Bridge (1) Power Line (2km) Telephone Line (2km) Road (7km)	(TL 6,879,000,000)
			× Passage of Construction Vehicles		*Administration Program		**Effect of Economic Diffusion to the Arease		[6 km of a Lakeside Road to be Newly Built]	
Costs of Countermeasures (to be estimated by DSI)										
2) Construction of Facilities			× Generation of Turbid Water by Construction Work		*Sedilmentation Basin (Monitoring)					
			× Changes in Water Wuality (pH)		*Regulating Pondage (Monitoring)			× Forests	1,979 da	(No Expenses Needed)
			△ Generation of Noises and Vibration		*Restriction of work during night (Measurement)			× Decreases in Forest Resources		[Inventory to be inundated is small. Influences upon Forestry is also small.]
			△ Changes in Air Quality		*Control Program (Measurement)			× Decreases in Agricultural Production		[Influences upon Local Economy is small because Self-sufficiency is Prevailing.]
			△ Illumination for Construction Work		*Minimum Illumination			○ Income to be Realized at Resettled Areas		[Inhabitants' Desires will be Respected in Resettlement Programs. Efforts will be to secure Jobs and Incomes which meet the Resettlers' Desires.]
			× Passage of Construction Vehicles		*Administration Program					
Costs of Countermeasures (to be estimated by DSI)										
<After Construction> 1) Possession of Land ① Reservoir ② Facilities	× Separation of Fish Species ○ Changes in landscape	** Expansion of Ne Habitats ** Creation of New Landscape over the Lake	△ Agricultural Land to be inundated	(Irrigated area: 426 da and Ordinary Area: 2 ,330 da) Fig. IV-5	[to be further reviewed in the D/D Stage]	○ Landscape utilizing Water	**Increases in Objectives and Income of Tourism **Bringing up Leisure Industry			
			× Separation of Fish Species (No Precious Species found)							
			× Protected Cultural Heritage to be inundated	(Figs.IV-21 and IV-22)	*Prior Excavation Survey and Removal [If agreed with the Culture Agency, and to be paid by DSI. Survey to be started before the Construction Work is started]					
			△ Forests to be inundated	(1,979 da)	[to be transferred from the Forest Agency]					
			× Disappearance of Vegetation (No Precious Species found)		Protection of Surrounding Vegetation [Adoption of Underground Power Plant and Water Conduits]					
Costs of Countermeasures (to be estimated by DSI)										
2) Operation of the Facilities ① Reservoir ② Water Discharge ③ Formation of Water Reduction Area			△ Changes in Water Quality and Eutrophication		*Valley Affluent Water Control Program	○ Income	**Securing Long-Term Employment though small in number of persons to be employed	× Influence upon Irrigated Agriculture in Downstream Areas		[To discharge Water when Needed]
			△ Sedimentation of Sand		*Operation Program					
			△ Discharge of Low-temperature Water		[Temporary Evasion of Fish]	○ Traffic	**Securing Traffic and Physical Distribution Routes	× Influence upon Potable Water		[No drinking use of River Water]
			× Influence Upon Irrigation in Downstream Areas		[to discharge a Necessary Amount of Water when needed]					
			× Salification of Water							
			× Reduction of Sand in Downstream Areas							
			△ Reduction of Water Valume		*Addition of Discharging Facilities [to be determined in D/D]					
Costs of Countermeasures (to be estimated by DSI)					*Optimization of Maintenance Water Volume					
3) Monitoring Costs of Countermeasures (to be estimated by DSI)			△ Changes in Water Quality and Eutrophication		*Periodic Measurement and Evaluation of Water Quality [BOD,COD,pH,T-N,T-P, Chlorophyll, and Other Wildlife Survey]			Comprehension of Living Environment of Peole to be resettled		
Key Points	Utilization of New Environmental Resources		Reduction of Environmental Influences by implementing Appropriate Conservation Measures			Improvement of Local Development Programs for Continued Local Vitality and Fusion with this Project				
Cost Benefits	External Benefit (Be)	(TL) to be estimated by DSI	Environment Conservation Expenses (Cp-1)		(TL)	Comprehensive External Benefits (Be)	(TL)	External Costs (Ce) Tl 51, 181, 274,000, at unit cost for 1992. TL 81,900,000,000 at unit cost for 1993		
			Historic Ruins Excavation Expenses (Cp-2)		(TL) [to be estimated by DSI]	(Including laborers' Income of TL)	To be estimated by DSI			

Notes : 1) Symbols used in the table have the following meanings.
◎ : substantial influence ○ : medium influence △ : small influence or small if appropriate countermeasure is taken × : ignorable influence or ignorable if appropriate countermeasure is taken
2) Underscored items in the table indicate external costs (Ce); asterisked (*) ones, environment conservation countermeasure (Cp); and double asterisks (**), external benefits (Be) which have economic value of secondary benefits.
3) Most of people to be resettled want to resettle in the adjacent town of Gökçesu and its surroundings. It is necessary to resettle them by sully respecting their desires. Inhabitants should be given priority in employing laborers for construction and dam control engineers after construction.
4) Necessary items in future environment impact assessment are indicated in parentheses in the report. Main items include field measurement of water quality and supplementing of basic data by effecting vegetation survey, and data survey for natural environment and evaluation of scale of costs and benefits in the socioeconomic environment. Total amounts of countermeasure expenses, external benefits, and environment countermeasure expenses will be determined based on the report and DSI will make their calculation thereafter.

inhabitants for construction of dam, reservoir area, aggregate collection and preparation of construction road, also those of economical losses due to the utilization of lands which have been used for agriculture, forestry and public facilities. In addition, the losses of income which have been gained through production activities by using these lands shall also be counted as a part of the environmental cost. All of these losses and costs have been estimated (Table V-9) by the Environmental Study Group and Agriculture Engineering Group of DSi, and the results have been summarized as a DSi report titled "The Expropriation Report for Köprübaşı Dam Reservoir (Planning Stage)".

For the case of using land up to 440 m (High Water Level EL 437 m + 3 m) altitude, there will be 55 private houses, three mosques, one primary school, two lodging houses, one 30 m long bridge, 13 km village road, 2 km power distribution cable and 2 km PTT (electricity and telecommunication) line to be submerged. The land area to be submerged will be 5,794 decar in total, which is composed of 3,038 da forestry land and 2,756 da agriculture land. In addition, there will be about 555 da aggregate collection and material storage field to be needed outside the submerged area. The number of the villagers to be resettled is 392 persons (1992 data).

The compensation amount to cover the losses of all of the above lands, properties and so forth in the area to be expropriated is estimated as a external cost in the monetary value of 1992 to be 50,328,940,000 TL including the income losses to be incurred. The compensation amount for the aggregate collection site is estimated to be 852,480,000 TL in the year 1992. Total sum of them becomes 51,181,274,000 TL. When the amount is counted in the monetary value of the year

1993, it is required to reflect the escalation factor of 1.6, and the total sum becomes 81,900,000,000 TL. Above these submerged road of about 5.6 km is caunted as relocation road. This is the external cost to be incurred during construction phase. This amount also becomes the basis of compensation to be made for the site expropriation. These values are summarized in attached Table V-8. For details, see the DSi Report cited above.

Table V-8 Compensation Values for Expropriation of Dam, Reservoir and Aggregate Collection Sites

Items	Values
• Elevation (m)	Upto 440
• Compensation Amount in '92 for Dam and Reservoir Sites (TL)	50,328,794,000
• Compensation Amount in '92 for Aggregate Collection Site (TL)	852,480,000
• Total Compensation Amount of the above in '92 (TL)	51,181,274,000
• Total Compensation Amount of the above in '93 (TL)	81,900,000,000

Note: For estimation of the total compensation amount for 1993, escalation factor of 1.6 is used.

Source: DSi Report "The Expropriation Report for Köprübaşı Dam Reservoir (Planning Stage)"

Table V-9 The Expropriation Values of Immovables between Spot Heights in Köprübaşi Reservoir Area in 1992

S. Heights	Type	Amount (Da-Unit)	Unit Price (TL)	Total (TL)
343-430	I.C.	426	31,225,000	13,301,850,000
	$B.Z_1$	2,130	5,850,000	12,450,500,000
	Forestry	1,360	-	-
	Poplar (1-5)	470	10,000	4,700,000
	Poplar (6-10)	735	3,724	2,737,140
	Poplar (11-20)	1,190	68,850	81,931,500
	Poplar (21-)	500	296,000	148,000,000
	Apple	595	1,671,429	994,500,255
	Cherry	748	2,742,857	12,051,675,036
	Nut	545	4,114,286	2,242,285,870
	Residence-1	20	100,000,000	2,000,000,000
	Residence-2	35	50,000,000	1,750,000,000
	Mosque-1	1	250,000,000	250,000,000
	Mosque-2	1	400,000,000	400,000,000
	Masjid	1	100,000,000	100,000,000
	School	1	250,000,000	250,000,000
	Lodging	2	100,000,000	200,000,000
	Bridge	1	750,000,000	750,000,000
	Road	13 km (7.44 km)	445,000,000	5,785,000,000
	Electricity Line	2 km	35,000,000	70,000,000
	PTT Line	2 km	200,000,000	400,000,000
	Total			43,243,161,801
	20% Security Factor			8,648,632,360
	Overall Total			51,891,794,161

(Continue)

430-440	B.Z_1	200	5,850,000	1,170,000,000
	Forestry	619	-	-
	Total	819		1,170,000,000
	20% Security Factor			234,000,000
	General Total			1,404,000,000
40-445	Forestry	567	-	-
445-450	Forestry	492	-	-
Material Storing	B.Z_2	555	1,280,000	710,400,000
	Total			710,400,000
	20% Security Factor			142,080,000
	General Total			852,480,000

<Environmental benefit>

One of external benefit obtainable during construction will be the increase of employment opportunity. This benefit can be calculated by the following methods.

- Brief estimation method

  Expenditure for Workers (V) = A X B

  where: A = total number of workers needed throughout whole construction period

  B = average wage of the workers per person

- Detailed estimation method

  $A_k = \Sigma (X_i \cdot Y_j)$

  $V = \Sigma A_k$

  where : X_i = the number of workers with same level of wage in a certain year of construction phase

Y_j = the amount of wage per person belonging to X_i

A_k = total employment expenditure required for a certain year of construction phase

V = total employment expenditure required for the whole period of construction phase

At present time, the detailed data required for the above calculations are not available. Therefore, it is desirable that DSi will calculate the values when various data become available in future.

The expected social and economic changes will be the following items:

- Resettlement of local inhabitants of the project site and its impact to the destination society where resettled

- The loss of production gained at the project site before the construction

- Positive impacts to be obtained through increase of employment opportunity and activation of the local social and economic activity

There will be positive or negative impact to the destination society depending on whether resettlement plan would be carefully made or not. If resettlement plan would have been well made, the resettled families could start their new livelihood smoothly and therefore would not bring any conflict to the destination society. In the opposite case, not only the resettled families would suffer unstable livelihood, but also the destination society would bear new issue for resolving possibly incurred social

problems. Therefore, it is desirable that the project planner will carefully deal with the resettlement issue.

(b) After Construction

<External Cost (Ce)>

In general, the environmental cost to be incurred due to existence of reservoir and facilities will be the negative impact of water reduction area generated in downstream side. Under the Köprübaşı project, the water reduction area will only be about 1 km long. Moreover, a discharge valve will be installed at the dam site which will serve to discharge water when needed. In addition, utilization of river water in the water reduction area is very limited. In the further downstream side after the 1 km point, there are three tributaries flowing into the main stream with enough flow rates. Therefore, negative social environmental impact will be little, and the environmental cost would be negligible.

On the other hand, the another external benefit will be the uses of the reservoir. For example, the reservoir may be used to cultivate fishes for fishery and recreation purposes. Create sight-seeing business would also be possible. These are all potential environmental benefits. It is desirable that the project operator would make positive use of the reservoir during plant operation.

As mentioned above, there will be positive social and economic changes expected to the society through positive use of reservoir as fishery and recreation resources.

<External Benefit (Be)>

As already mentioned, the issue of water reduction area will be little, and therefore potential environmental impact will be negligible. On the other hand, create additional employment opportunity are and secure transportation road in the area, etc. expected, and this will the benefit to be gained.

Creation of additional employment opportunity will activate the nearby society.

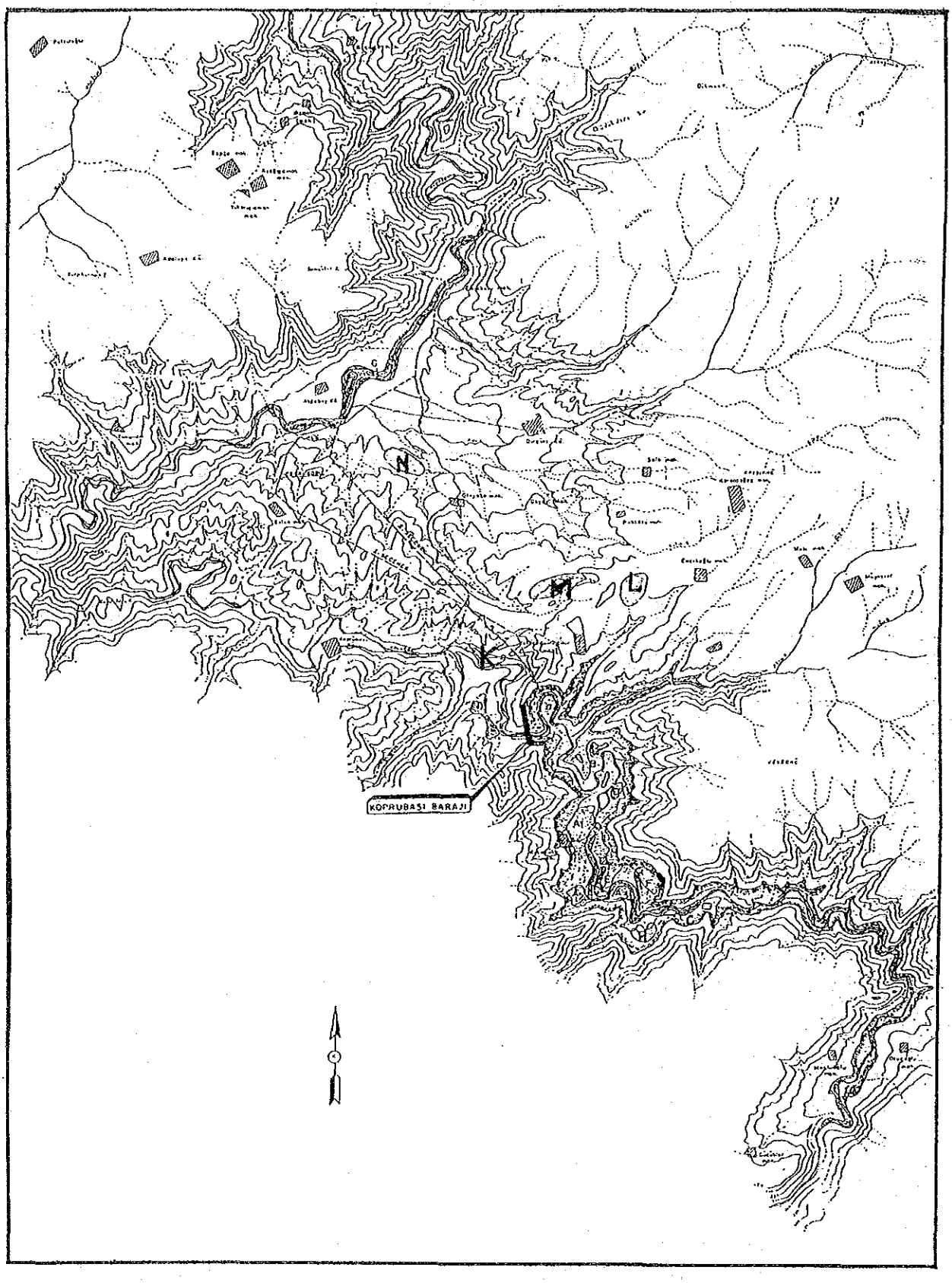


Figure V-10 Topography and Aggregate Collection Sites around Dam and Reservoir of Köprübaşi Project Site

Chapter VI Influences being Caused After Closing the Facilities and the Countermeasure

The dam and power station being installed by the present development project is based on the operation plan for about 50 years. However, actual operation of these facilities are continued over a long term of years.

VI.1 Influences on the Natural Environment and Countermeasure

The following influences and countermeasure can be imagined

(1) Accumulation of earth and sand due to the Soil Erosion at Upstream Area

Since the inflowing of the earth, sand and the water are continued, the dredging plan of reservoir bottom and the water quality management is planned.

(2) Accumulation of polluted Substances by developing the upstream area and near reservoir.
For maintaining the water quality of lakes as the environmental water and the living organisms, river water flowing into the lake and the waste water from hotels and lodging facilities at camping area are controlled as the countermeasure by discussing to the related organization.

(3) Influence to the River Water Utilization of Downstream in the Future

The river in the water reducing section formed during the enforcement of project is restored as the need arises. The necessary water is supplied on the basis of the request on the river water utilization in the downstream area.

VI.2 Influence Caused to Social and Economical Environments and Countermeasure

(1) Environmental cost and benefit

The way of treatment of the dam,reservoir and power plant facility after decommission will depend on the decommissioning plan of DSi. At this F/S stage, such plan has not yet been considered. This kind of plan will also be subject to overall policy or practice of the central government. Therefore, it is not realistic to talk on environmental cost and benefit in connection with the decommission of the project. The way of dealing with the full sediment and plant facility will be the key issue. It is recommended that DSi will perform study on the decommissioning issue in future.

(2) Potential social and economic changes

Potential social and economic changes which may have after decommission will certainly depend on the contents of decommissioning plan. Dsi will have to predict the potential changes based on its future plan for the decommission project.

No alternatives of this Project is available.

(1) Out of the project site and its periphery areas, the natural vegetation at the dam site is extremely poor as compared with that in the peripheral forest areas. The reservoir area is mainly of the farming field including a comparatively narrow irrigated agricultural land along the river. The upstream side of reservoir area is the valley covered by the forest, but because its tree species don't especially differ from those in the forest management area inclusive of its periphery areas and the volume of trees being immersed into water by the formation of reservoir, the influence given on the forestry industry in this area by the formation of reservoir is judged to be small.

Because the farm products available from the agricultural field such as the crops, vegetables, fruits, etc. don't differ from those at the peripheral villages, and moreover the farming pattern is in small scale and the said products are for the self-support, the influence being exerted on the agricultural industry in the area by the loss of agricultural field is judged to be small. And the influence given on the livestock industry is considered to be small.

(2) The project area isn't included inside the natural preservation areas such as the national park and the natural protection areas. No precious species of plant can not be found out at the project area. The wild animals found in this area are the same species as those inhabiting the national park and the natural protection areas. The formation of reservoir is destined to somewhat narrow their living space, but because these animal species are widely distributed, its influence can be judged to be small.

(3) On the other hand, because there are some relics and regional cultural assets inside the reservoir, the

protective countermeasures must be sufficiently be taken before enforcing the project based on the ample discussion to be held with the concerned agencies.

(4) Because both the nitrogen and phosphorus are in high trend as regards the water quality of Devrek River in object, together with the waste water disposal countermeasure in this basin, the water quality should be continuously monitored for decreasing the influence on the water quality of reservoir in the future.

The dam may bring about the partition of inhabiting areas especially against the fish out of the organisms in the river, but because the general carps are mainly the fish in this river and they are not the species especially inhabiting only the river in object and moreover because the reservoir is expanding a new proliferation and inhabiting space, the influence on the fish can be imagined to be small. On the other hand, the inhabitation of trouts are reported in the upstream basin of Büyüksu River. Because they are considered to be of land locked type, it can be thought that there is no influence, but their ecology is to be studied into details in the future.

(5) About 25 km of water reducing area will be generated by the enforcement of the present project. The natural vegetation in this section is rich, consisting of pines and oaks. Because these species are not those growing by directly absorbing the river water, because no precious species of plants can not be found out, because the rain falls comparatively much in this area, and because the inhabiting fish species of this river is the carps being widely distributed, the influence being exerted on the natural environment can be judged to be small. Further, because no inhabitants nor industries utilizing the river water exist in this section, and moreover the supply of water from the branch flowing into the water reducing section can be expected, the formation of water reduction block can be

judged to have no great influence on the natural and social environments in this area including its landscape.

However, the water discharge facilities shall be installed in order to sufficiently correspond to the requests for the sight-seeing development in the vicinity of reservoir area and for the water utilization in the regional agricultural industry in the future, or to the demands for the amenity pace involved in the sight-seeing development. For information, the water discharge volume from the facilities will be studied when boiling down the detailed design.

(6) The inhabitants and houses as sell as the mosques and schools need to be moved or relocated to another locations by the enforcement of project. The destinations will be decided and the compensation will be carried out in full consideration of the inhabitants' intentions.

For the case of using land up to 440 m (Reservoir high water level 437 m + 3 m) altitude, there will be 55 private hoses, three mosques, one primary school, two lodging houses, one 30 m long bridge, 13 km village road, 2 km power distribution cable and 2 km PTT (electricity and telecommunication) line to be submerged. The land area to be expropriated will be 5,794 decar in total, which is land. In addition, there will be about 555 da agriculture collection and material storage field to be needed outside the submerged area. The number of the villagers to be resettled is 392 persons (1992 data).

The compensation amount to cover the losses of all of the above lands, properties and so forth in the submerged area is estimated in the monetary value of 1992 to be 50,328,794,000 TL, including the income losses to be incurred. The compensation amount for the aggregate collection site is estimated to be 852,480,000 TL in the year 1992. Total sum of them becomes 51,181,274,000 TL. When the amount is counted in the monetary value of the

year 1993, it is required to reflect the escalation factor of 1.6, and the total sum becomes 81,900,000,000 TL. This is the external cost to be incurred during project implementation phase. This amount also becomes the basis of compensation to be made for the site expropriation.

(7) For construction works, it is needed regulations concern to the construction and the preservation of environment shall be respected by discussing to the related organizations.

Keeping the said results in mind, it can be thought that the present project can be enforced without no special influence on the natural and social environments.

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