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Cumulative Impact Assessment Baseline Monitoring Report for the Goksu-Seyhan Hydropower Cascade

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Cumulative Impact Assessment Baseline Monitoring Report for the Goksu-Seyhan Hydropower Cascade

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ABBREVIATIONS

AZE	Alliance for Zero Extinction
AKENERJI	AKENERJI Elektrik Uretim A.S.
BERN	Convention on International Trade in Endangered Species of Wild Fauna and Flora.
CITES	Convention on the Conservation of European Wildlife and Natural Habitats.
BOD	Biochemical Oxygen Demand
BOT	Built-Operate-Transfer
CIA	Cumulative Impact Assessment
COD	Chemical Oxygen Demand
dBA	A-Weighted deciBel
DOKAY	DOKAY Engineering and Consultancy Ltd. Co.
DSI	State Hydraulic Works
EC	European Commission
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EIEI	Electrical Power Resources Survey and Development Administration
EMMP	Environmental Management and Monitoring Plan
EMRA	Energy Market Regulatory Authority
EU	European Union
EUAS	Turkish Electricity Generation Corporation
FEOW	Freshwater Ecoregions of the World
GWh	Giga Watt Hour
h	Hour
ha	Hectare
HEPP	Hydroelectric Power Plant
IUCN	International Union for Conservation of Nature
km	Kilometer
kV	Kilo volt
L	Liter
m	Meter
MoEF	Ministry of Environment and Forestry
MW	Mega Watt
PIF	Project Information File
s	Second
SEA	Strategic Impact Assessment
TEIAS	Turkish Electricity Transmission Corporation
TEMELSU	TEMELSU International Engineering Services Inc.
WCD	World Commission on Dams
WFD	Water Framework Directive
WPCR	Water Pollution Control Regulation

VEC	Valued Ecosystem Components
%	Percent
º	Degree

EXECUTIVE SUMMARY

The aim of this Cumulative Impact Assessment (CIA) Report is to evaluate potential cumulative impacts of the HEPP projects in the CIA Study Area have been assessed in accordance with the three environmental features.

Construction of some of the projects planned by AKENERJI and other investors has been started within this period. Therefore, information about these additional projects has been included in this report while current status of other projects was updated. The identification and analysis of cumulative impacts associated with non-AKENERJI projects has been limited to information available in the public domain.

AKENERJI Elektrik Uretim A.S. (AKENERJI) is planning to construct and operate five Hydroelectric Power Plants (HEPP's) on Goksu River in the Seyhan River Basin of Turkey. The names of these HEPP projects are as follows:

- Feke I HEPP (30 MW)
- Feke II Dam and HEPP (70 MW)
- Yamanli III HEPP consists of
  - Himmetli HEPP (27 MW);
  - Saimbeyli HEPP (3 MW); and
  - Gokkaya Dam and HEPP (30 MW)

During the operation phase of the HEPPs, the most significant potential cumulative impacts will be observed in aquatic environment. These potential impacts include:

- Change of water flow regime from a river system to a series of lakes;
- Change of water quality; and
- Change of aquatic ecological characteristics of the Goksu River.

A field study, including flow measurements, surface water quality measurements and determination of aquatic ecological characteristics, was performed in order to set baseline conditions and assess potential impacts of the HEPPs accordingly.

Potential cumulative impacts of the HEPP Projects on water flow regime, water quality and aquatic ecological characteristics are assessed regarding results of these field studies and individual project features. A periodical monitoring schedule to identify and manage any significant adverse cumulative impact on Goksu River ecosystem resulting from the development of the subject hydropower cascades are established.

1. BACKGROUND AND PURPOSE

AKENERJI Elektrik Uretim A.S. (AKENERJI) is planning to construct and operate five Hydroelectric Power Plants (HEPP's) on Goksu River in the Seyhan River Basin of Turkey. The names of these HEPP projects are as follows:

- Feke I HEPP (30 MW)
- Feke II Dam and HEPP (70 MW)
- Yamanli III HEPP consists of
    - Himmetli HEPP (27 MW);
    - Saimbeyli HEPP (3 MW); and
    - Gokkaya Dam and HEPP (30 MW)

Seyhan River Basin is in East Mediterranean Region of Turkey. The location of Seyhan River Basin in Turkey is presented in Figure 1-1.

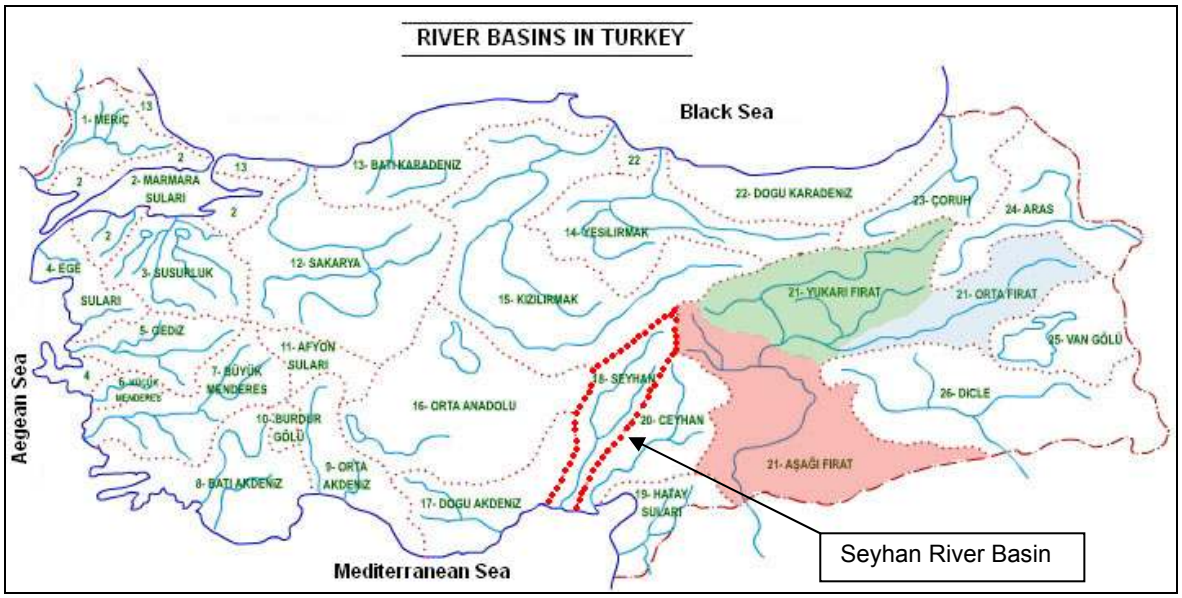


Figure 1-1. Location of Seyhan River Basin in Turkey
Source: URL 1, Official Website of EIEI, 2010

This report will mainly discuss the cumulative impacts of the HEPPs of AKENERJI listed above. Background information on these projects is given below and the locations of the HEPPs are presented in Figure 1-2:

- Feke I HEPP is a run-of-river type HEPP project on Goksu River, consisting of one weir and a powerhouse. Total installed capacity and the annual energy generation of the project are 30 MW and 117 GWh, respectively. Detailed information on the project will be presented in Section 2.1.1.

- Feke II Dam and HEPP is a project at the downstream of Feke I HEPP on Goksu River, with a powerhouse at the toe of the dam. The installed capacity of the power

plant is 70 MW and average annual energy generation is estimated to be 223,41 GWh. The surface area of the dam reservoir will be 3,730 km^2. Detailed information on the project will be presented in Section 2.1.2.

- Yamanli III HEPP includes Himmetli (27 MW) and Saimbeyli (30 MW) run-of-river type HEPPs and Gokkaya Dam and HEPP (3 MW) on Goksu River. The total installed capacity of the power plant is 60 MW and average annual energy generation is estimated to be 237.94 GWh. Detailed information on the project will be presented in Section 2.1.3.

1.1 Purpose and Requirements for Cumulative Impact Assessment

The HEPP projects of AKENERJI will be financed by the International Finance Corporation (IFC). As part of the due diligence process for these projects, the IFC have some requirements in addition to the Turkish legislation related to the environmental and socio-economic issues of the construction and operation of the HEPPs. Several studies have been carried out for compliance with environmental and social requirements of the Lender. “Cumulative Impact Assessment of HEPP Projects in Seyhan River” is prepared in accordance with the EU Directives on Strategic Environmental Assessment (SEA) and Water Framework Directives (WFD).

However, additional studies are requested from IFC including flow regime, water quality and ecology of Goksu River.

The purpose of this study is the assessment of the five HEPPs proposed by AKENERJI in the Goksu River for potential cumulative impacts that are not addressed in the former CIA study prepared for the total projects in the Seyhan Basin.

1.2 Scope of the Cumulative Impact Assessment

According to a series of discussions with both AKENERJI and IFC officials, the proposed CIA study will particularly emphasize the following topics:

- Elaboration of a more detailed understanding of the flow regime along the river section of interest;
- Determination of the existing water quality and aquatic ecosystem characteristics associated with the subject HEPP sites along two tributaries of Seyhan River namely Goksu and Dogancay streams; and
- Establishment of a regular/periodical monitoring schedule to identify and manage any significant adverse cumulative impact on Seyhan River ecosystem resulting from the development of the subject hydropower cascade.

1.2.1 Geographic Scope

Given the river-related nature of all the HEPPs proposed by AKENERJI, the most appropriate geographic boundary for the CIA study covering the area which will possibly be affected environmentally by the proposals has been taken to be the watershed boundary of the Seyhan Basin. The lower point of this can be defined as the Yedigoze Reservoir, since this currently acts as a barrier to potential impacts on the river below the proposed developments. Therefore, the location on the Yedigoze Reservoir which forms the maximum draw down elevation at the furthest point from the Yedigoze Dam axis has been determined and the catchment area boundaries of that location has been selected as the CIA study area. Such a boundary includes the locations of the material borrow sites, the service roads which will be improved during the project, and the possible corridors for the electricity transmission lines. AKENERJI projects and geographic boundaries are presented in Figure 1-2.

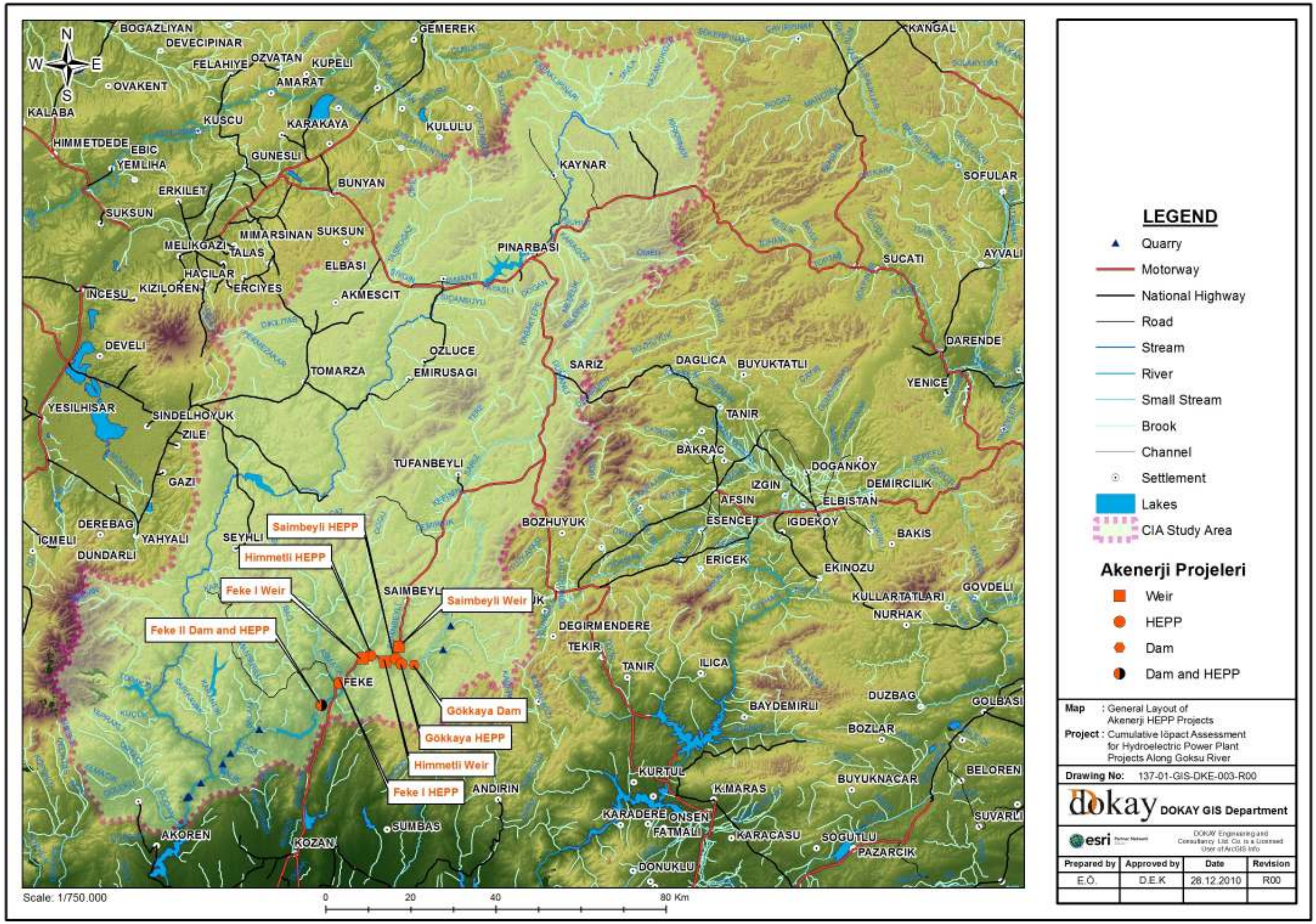


Figure 1-2 Map of General Layout of AKENERJI Projects

1.2.2 Temporal Scope

The temporal scope of the CIA study can be considered separately as the construction and operation phases. Although there is no definite information on the construction phase schedule of the projects, it is not expected that construction of all five projects will end at the same time. Regarding the operation phase, all HEPP projects of AKENERJI have obtained the Energy Generation Licenses from the Energy Market Regulatory Authority (EMRA) for 49 years. Cumulative impacts have been assessed accordingly.

1.2.3 Other Projects (Planned and Projected)

Beside the HEPPs that AKENERJI has proposed in the Seyhan Basin, there are some other projects or existing plants in the CIA study area defined above. Most of them are under construction and private companies are going to run these HEPPS. The most recent information on these projects is presented in Section 2.2.

1.3 Identification of Main Cumulative Impact Issues

In order to determine the cumulative impacts of the projects during construction, individual impacts stated in the EIA Reports were assessed whether they interact each other and overlap in the previous CIA Report. These issues to review for the assessment were:

- Dust and gas emissions
- Wastewater and solid waste generation
- Excavation and demolition wastes
- Noise and vibration
- Hazardous wastes
- Vegetation communities and flora
- Faunal elements
- Landscape
- Historic and cultural features
- Socio-economic factors

In the context of this CIA Report, during the operation phase of the HEPPs, the most significant potential cumulative impacts will be observed in aquatic environment. These potential impacts include:

- Change of water flow regime from a river system to a series of lakes;
- Change of water quality; and
- Change of aquatic ecological characteristics of the Goksu River.

These impacts are assessed due to results of field studies which are conducted one period. Field studies are conducted between;

- November 27th - 30th 2010 to measure current flow regime at selected locations;
- December 01st - 02nd to analyze existing water quality; and
- November 11th – 13th to determine characteristic of aquatic ecosystem.

The impacts expected during the operation phase in the aquatic environment and hydrology in the river will be different for run-of-river HEPPs and HEPPs with a dam. Detailed assessment of cumulative impacts that are listed above is presented in Chapter 5.

2. SUMMARY DESCRIPTION OF THE PROJECTS

2.1 Description and History of the AKENERJI Projects

The State Hydraulic Works (DSI), the main investing institution responsible for the utilization of water resources in Turkey, conducts planning studies in order to determine the most appropriate project formulations by using long-term data records. This CIA study focuses mainly on the HEPPs to be constructed and operated by AKENERJI. These five projects and most of the other projects listed in Section 1.3.3 were first proposed by DSI in "*Lower Seyhan Basin Master Plan Report (1980)*" and "*Upper Seyhan Basin Master Plan Report (1984)*" which were prepared by the Engineering Services Firm Group consisting of Verbund-Plan (Vienna-Austria), Romconsult (Bucharest-Romania) and Temelsu (Ankara-Turkey).

During the preparation of these master plans, Electrical Power Resources Survey and Development Administration (EIEI), a public organization carrying out engineering services related to the production of electrical energy, also contributed to the engineering studies conducted for the above master plans. These master plans give information on the utilization of water resources, flood control, irrigation and energy generation issues related to Seyhan Basin.

As a result of some legal arrangements related to the energy sector, the Built-Operate-Transfer (BOT) Model was introduced in 1984 with the enactment of Expropriation Law numbered 3096 and dated December 4, 1984. This model introduced the establishment and operation of a power plant by the private sector for a certain period of time. It is stipulated that the facility will be transferred to the State at the end of the period. Later, for the harmonization of energy legislation with the corresponding European Communities' legislation, the 'Electricity Market Law' numbered 4628 was enacted in 2001 to enable progress into a liberalized electricity market and to provide for fair and transparent market regulation.

Consequently, the projects determined by the DSI and EIEI were reassessed by the private sector in Turkey and new design alternatives were proposed for the HEPPs. Table 1-1 presents the most up-to-date status of the HEPPs within the CIA study area.

General layout of AKENERJI projects in Seyhan Basin are shown in Figure 2-1. Detailed information on these projects is presented in the following sections.

2.1.1 Feke I HEPP Project

Feke I is a “run-of-river” type HEPP project and will be located on Goksu River, main tributary of Seyhan River, in the Upper Seyhan Basin. Project lies in the borders of Feke District of Adana Province. The project is under construction phase. The Energy Generation License of the project was obtained from the EMRA in 2007 and will be valid for 49 years.

Feke I HEPP Project was firstly designed with 28.2 MW installed capacity and EIA is not necessary was assigned for this project in 2007. However, with final engineering design the installed capacity of the project is increased to 30 MW so the new EIA Report has been prepared due to EIA Regulation issued in the Official Gazette dated July 17, 2008 and 26939 numbered.

Feke I HEPP Project consists of Feke I Weir with a thalweg elevation of 606 m which is at 200 m away from downstream of Yesilvadi Village. Three quarries will be used to supply the material for the construction. Also, there are 5,188 m long three connected energy tunnels, forebay, surge tank, penstock, fish ladder and Feke I HEPP (installed capacity of 30 MW) with a tailwater elevation of 543 m. Due to the difficulty of construction of such a long energy tunnel, long investment period, energy production capacity and cost of the project, it is planned to construct horseshoe shaped energy tunnels in three steps. Tunnel 1 is 692 m long, which is connected to Tunnel 2. This tunnel is 2,577 m long and connected to Tunnel 3. Tunnel 3 is 1,919 m long and connected to surge tank.

The connection routes of the transmission lines of the project will be determined by the General Directorate of Turkish Electricity Transmission Corporation (TEIAS).

Full technical details of the Feke I HEPP Project are presented in Table 2-1.

Table 2-1 General Characteristics of the Feke I HEPP Project

Characteristics	Unit	Amount
Feke I Weir		
Drainage Area	km^2	2,731
Annual Average Flow	hm^3	973.13
Thalweg Elevation	m	606
Crest Elevation	m	613
Height from Ground	m	9
Height from Thalweg	m	5
Energy Tunnel 1		
Diameter	m	5.20
Length	m	696.925
Energy Tunnel 2		
Diameter	m	5.20
Length	m	2,577.798

Characteristics	Unit	Amount
Energy Tunnel 3		
Diameter	m	5.20
Length	m	1,919.378
Feke I HEPP		
Installed Capacity	MW	30
Turbine Axes Elevation	m	538
Turbine efficiency	-	0.93
Project Flow	m^3/s	55.8
Type	-	Half buried
Surge Tank		
Bottom Elevation	m	580
Top Elevation	m	636
Maximum Water Level	m	631.59
Minimum Water Level	m	582.16

Source: REF 1:Feke I Weir and HEPP PIF, 2009

The EIA Report was prepared in compliance with the EIA Regulation and was submitted to the Ministry of Environment and Forestry (MoEF) on March 6, 2008. Currently, the EIA Report has been accepted as the final EIA Report and the EIA Positive Certificate is issued.

2.1.2 Feke II Dam and HEPP Project

Feke II Dam and HEPP Project is located in Adana Province, Feke District on Goksu River. Construction phase of the project is almost finished and it will be used only for energy generation purpose and has an Energy Generation License for 49 years obtained from EMRA in 2007.

Feke Dam and HEPP Project is designed for the same area however most of the area of Feke District would be inundation due to dame reservoir area. So the project had been revised and dam and HEPP project divided into two different projects, which are called Feke I HEPP and Feke II Dam and HEPP projects.

Within the project, a dam body, derivation tunnel, water intake structure, penstock, powerhouse, service roads and a transmission line will be constructed. A quarry will be used to supply the material for the construction. The powerhouse will be constructed at the upstream of the Menge Dam and HEPP with an installed capacity of 70 MW and the average annual energy generation is estimated to be 223.41 GWh.

The electricity to be generated in the Feke II Dam and HEPP will be transmitted to gas insulated 154 kV switchyard and then to interconnected system.

General characteristics of the Feke II Dam and HEPP Project are presented in Table 2-2.

Table 2-2 General Characteristics of Feke II Dam and HEPP Project

Characteristics	Unit	Amount
Drainage Area	km^2	3,530
Annual Average Flow	hm^3	1,610.50
Derivation Tunnel 1		
Inner Diameter	m	6.0
Length	m	148.41
Derivation Tunnel 2		
Inner Diameter	m	6.0
Length	m	168.49
Dam		
Type	-	Roller Compacted Concrete (RCC)
Thalweg Elevation	m	485
Crest Elevation	m	545
Length of Crest	m	256.5
Bottom Elevation	m	474
Powerhouse		
Installed capacity	MW	70 (35 MW x 2)
Turbine Type		Francis-vertical axis
Tailwater Elevation	m	480
Gross Head	m	63
Project Flow Rate	m^3/s	127.50
Firm Energy	GWh	87.43
Secondary Energy	GWh	135.98
Total Energy	GWh	223.41

Source: REF 2: Feke II Dam and HEPP EIA Report, 2008

The Final EIA Report of the project is prepared in accordance with the EIA Regulation issued in the Official Gazette dated July 17, 2008 and numbered 26939.

2.1.3 Yamanli III HEPP and Quarries

Yamanli III HEPP and Quarries Project is located in Adana Province, Feke District on Goksu River. Construction phase of the project is almost finished and it will be used only for energy generation purpose and has an Energy Generation License for 49 years obtained from EMRA in 2008.

Yamanli III HEPP and Quarries has total 60 MW installed capacity with a combination of three projects called;

- Himmetli Weir and HEPP (27 MW)
- Gokkaya Dam and HEPP (30 MW)
- Saimbeyli Weir and HEPP (3 MW)

Yamanli III HEPP and Quarries Project was planned to be realized in two stages.

The two-stage Project is as follows:

Stage I: Gokkaya Dam and HEPP will supply water at 760 m thalweg elevation and it will be dropped to Gokkaya HEPP at 684 m tailwater elevation to produce electricity.

Stage II: Himmetli Weir with 677 m thalweg elevation will regulate the water to the Himmetli HEPP with 610 m tailwater elevation. In the mean time, Saimbeyli Weir and HEPP project is planned to benefit from potential hydropower of the Saimbeyli River. For this purpose, Saimbeyli Weir will regulate water at 733 m thalweg elevation and will transmit it the Saimbeyli HEPP with 677 m tailwater elevation.

Annual energy production of the Project will be 237.94 GWh including both stages. General characteristics of Yamanli III HEPP Project are given at Table 2-3.

Table 2-3 General Characteristics of Yamanli III HEPP Project

Characteristics	Unit	Amount
GOKKAYA Dam and HEPP		
Drainage Area	km^2	2,330
Annual Average Flow	hm^3	772.59
Derivation Conduit		
Type	-	Horseshoe shaped, Compacted Concrete
Inner Diameter	m	6.60
Length	m	253.75
Dam		
Type	-	Roller Compacted Concrete (RCC)
Thalweg Elevation	m	709.70
Crest Elevation	m	762
Minimum Water Elevation	m	755
Maximum Water Elevation	m	760
Reservoir Area (maximum)	km^2	0.812
Total Reservoir Volume	hm^3	22,297

Powerhouse		
Installed capacity	MW	30
Tailwater Elevation	m	684
Gross Head	m	71
Turbine Efficiency	%	93
Firm Energy	GWh	60.882
Secondary Energy	GWh	58.234
Total Energy	GWh	119.116
HIMMETLI Weir and HEPP		
Weir		
Drainage Area	km^2	2,604
Annual Average Flow	hm^3	870.79
Thalweg Elevation	m	657
Crest Elevation	m	667
Crest Length	m	42
Minimum Water Elevation	m	674
Maximum Water Elevation	m	675
Energy Tunnel		
Type	-	Horseshoe Shaped, Compacted Concrete
Inner Diameter	m	4
Length	m	122.23 m conduit + 3,617.82 m tunnel
Powerhouse		
Installed capacity	MW	27 MW (2 x 13.5 MW)
Turbine Type		Francis-vertical axis
Tailwater Elevation	m	610
Gross Head	m	65
Project Flow Rate	m^3/s	49
Firm Energy	GWh	53.160
Secondary Energy	GWh	52.999
Total Energy	GWh	106.159
SAIMBEYLI Weir and HEPP		
Weir		
Thalweg Elevation	m	734
Crest Elevation	m	740
Crest Length	m	30
Height from Ground	m	7.5
Height from Thalweg	m	6
Energy Tunnel		
Type	-	2.7 x 2.3 Box Shaped
Length	m	4,101.31
Powerhouse		

Installed capacity	MW	3 (1.46 MW x 2)
Turbine Type		Francis-horizontal axis
Tailwater Elevation	m	675
Gross Head	m	61.23
Project Flow Rate	m^3/s	5.5
Total Energy Production of Yamanli III HEPP		
Firm Energy	GWh	119.289
Secondary Energy	GWh	118.651
Total Energy	GWh	237.940

Source: REF 3: Yamanli III HEPP EIA Report, 2008

The Final EIA Report of the project is prepared in accordance with the EIA Regulation issued in the Official Gazette dated July 17, 2008 and numbered 26939 and it is approved at February 13, 2009.

2.2 Existing and Other Proposed HEPPs in the Seyhan Basin

Beside HEPP projects proposed by ENERJISA, there are other projects proposed by other private companies and existing HEPPs in the CIA Study Area in Seyhan Basin. The general layout of all HEPPs in the CIA Study Area is presented in Figure 2-2.

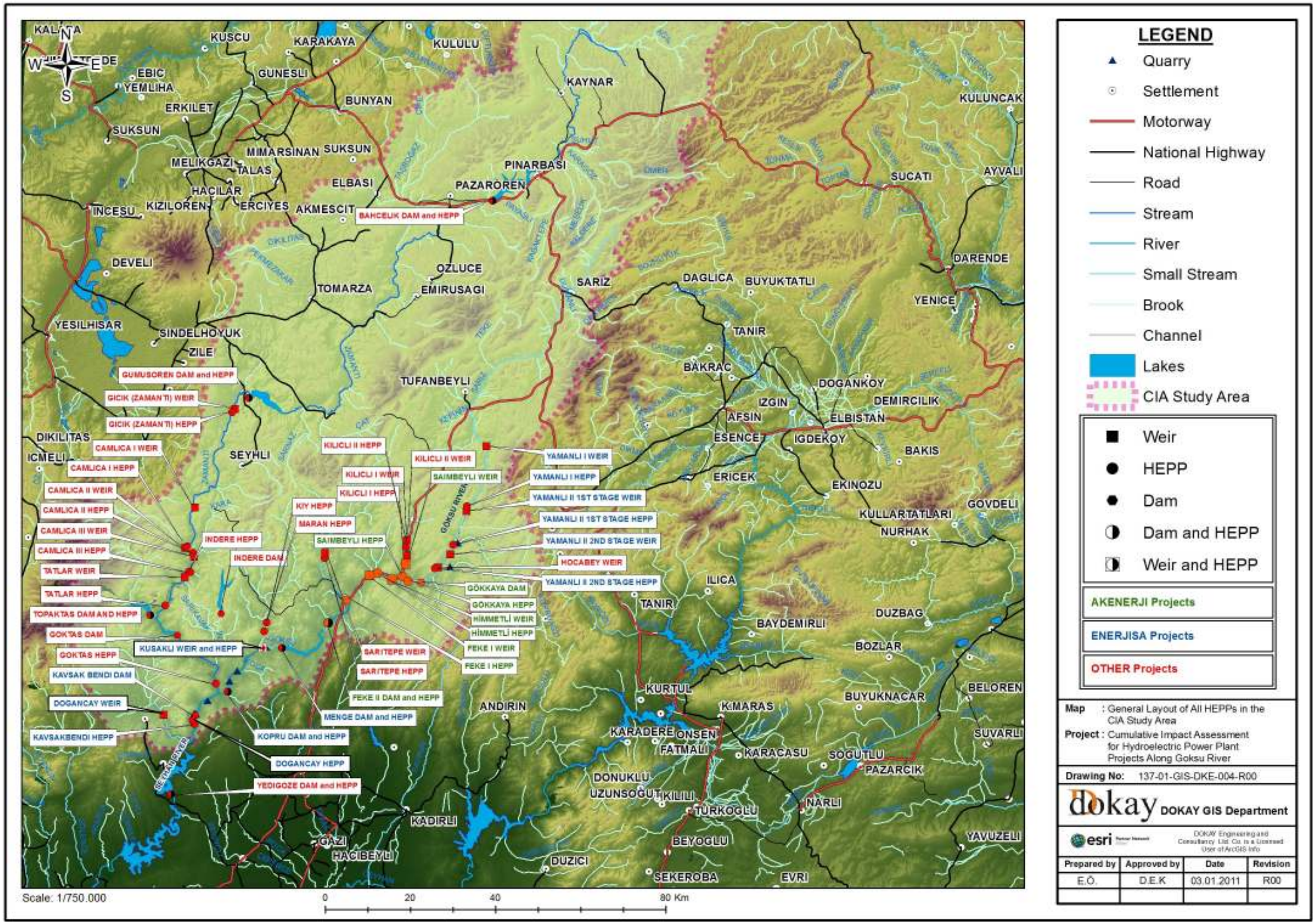


Figure 2-1 General Layout of All HEPPs in the CIA Study Area

For some existing HEPPs and projects under construction, the EIA procedure is not initiated. These projects are exempted from the EIA Regulation requirements according to the provisional Article 3 of EIA Regulation. Article 3 states that "*Provisions of this regulation do not apply to those projects; (i) whose final design was approved, or (ii) for which permission, license or approval was obtained pursuant to environment and other related legislation, or (iii) expropriation decision was taken, or (iv) site selection was made based on relevant legislation, or were (v) taken into investment programme, before February 7, 1993*".

Existing HEPPs

Bahcelik Dam and HEPP

Bahcelik Dam and HEPP is located on Zamanti River in Pinarbasi District of Kayseri Province. It began to operate in 2005. The HEPP which is being operated by a private company is used for irrigation and energy generation purposes. Since its permission procedures were finalized before February 7, 1993, the project is exempted from the EIA Regulation requirements. The installed capacity of the power plant is 4.71 MW and average annual energy generation is 27.84 GWh. The surface area and volume of the reservoir is 12.13 km^2 and 216.14 hm^3, respectively (URL 2, Official Website of DSI 12th Regional Directorate, 2008).

Camlica I HEPP

Camlica I HEPP which is a run-of-river type project is located on Zamanti River in Yahyali District of Kayseri Province. The construction of the HEPP started in 1995 and began to operate in 1998. The EIA procedure was finalized on May 26, 1997 with an EIA Positive Certificate. The installed capacity of the power plant is 84 MW and average annual energy generation is 429 GWh (URL 3, Website of Ayen Energy Co. Inc., 2008).

HEPPs under Construction

Kopru Dam and HEPP

Kopru Dam and HEPP Project having total installed capacity of 145 MW over the Goksu River, main tributary of Seyhan River, in the Upper Seyhan Basin within the boundaries of Kozan District of Adana Province.

Project is aimed to use the head of 92 m remaining between the Goksu River's elevations of 410 m and 318 m. Within the scope of the Project, it is planned to use present transportation roads to construct dam body, spillway, penstock pipe, and power house. The installed capacity of the Project is 145 MW and the annual power generation is planned to be 380,24 GWh as per the full development of the projects in the upstream.

Power to be generated in Kopru HEPP will be transferred to Akdam Substation through the transmission line of 380 kV at the length of 10 km and transferred to the national network from here. (REF 1: Kopru Dam and HEPP Final EIA Report, February 2009)

Menge Dam and HEPP

Menge Dam, HEPP Project and Quarries having total installed capacity of 85 MW over the Goksu main reach of the Seyhan River in the Upper Seyhan Basin within the boundaries of Kozan and Feke Districts of Adana Province.

Menge Dam and HEPP Project, it is aimed to assess the head of 57.5 m remaining between the Goksu River's elevations of 480 m and 422.5 m. Within the scope of the Project, it is planned to construct dam body, spillway, penstock pipe, power house and transportation roads. The installed capacity of the Project is 85 MW and the annual power generation is planned to be 201.93 GWh as per the full development of the projects in the upstream.

Power to be generated in Menge Dam and HEPP will be transferred to Kopru HEPP which is planned to be constructed in context of the 'Kopru Dam, HEPP and Quarries Project', form here together with the power produced in Kopru HEPP it will be transferred to Akdam Substation through the transmission line of 380 kV at the length of 10 km and transferred to the national network from here. The power transmission line and switching site will not be evaluated within the scope of this report, but separately within the scope of the EIA Regulation coming into effect by being published in the Official Gazette dated 17th July 2008 and no 26939. The EIA Report has been approved in January 2009 (REF 2: Menge Dam and HEPP Final EIA Report, February 2009).

Kusakli Weir and HEPP

Kusakli is a "run-of-river" type HEPP project and will be located on Goksu River, main tributary of Seyhan River. Project is located within the boundaries of Kozan District of Adana Province. EIA process for the project is ongoing, and the project is in its final design phase. The Energy Generation License of the project was obtained from the EMRA in 2008 and will be valid for 49 years.

Kusakli Weir and HEPP Project consists of Kusakli Weir with a thalweg elevation of 408.50 m and Kusakli HEPP with a tailwater elevation of 410.00 m which is on the right shore of Goksu River. As a result of feasibility studies carried out for the project, no transmission structure (i.e. transmission channel or tunnel) was proposed between the weir and powerhouse. The installed capacity and the annual energy generation of the project are 20.3 MWm/19.5 MWe and 46.657 GWh, respectively. The EIA procedure of

the project started on June 22, 2010, and still in progress (REF 3: Kusakli Weir and HEPP EIA Introduction Report, June 2010).

Kavsak Bendi Dam and HEPP

Kavsak Bendi Dam and HEPP in order to produce energy on 8 km downstream of joint of Zamanti and Goksu rivers two main creeks of Seyhan River within the borders of Kozan and Aladag Districts of Adana Province.

Project has been designed as Kavsak Bendi Dam and HEPP with 145.4 MW installed capacity in Kavsak Bendi Dam and 2 km downstream of dam. EIA has been prepared as per EIA Regulation coming into effect by being published in the Official Gazette dated 16.12.2003 and numbered 25318 and EIA Positive Certificate has been obtained from Ministry of Environment and Forestry (MoEF) on 15.10.2007.

After the EIA process, Project has been revised. In this context, detailed geological surveys carried out in locations of project units. Considering geological characteristics of the area, dam axle was located approximately 300 m to the upstream whereas powerhouse was located approximately 400 m to the downstream with respect to their original locations. As a result of this, length of the transmission tunnel increased from 1,950 to 2,593 m. It was also decided that excavation material to be obtained from dam axle and transmission tunnel would be adequate for construction, and hence, quarries have been excluded from the scope of the project.

Besides these, optimization studies for energy generation were repeated, and corrections have been made in the installed capacity and electricity generation amount of the project. According to optimization studies, an installed capacity of 178.89 MW was computed for Kavsak Bendi HEPP.

According to last revisions, installed capacity of Project has been revised as a total of 181.81 MW with slope type plant. Thus installed capacity of project has reached to 181.81 MW from 145.4 MW with the increase of 36.41 MW. Maximum operation water level cited in Final EIA Report dated September 2007 has not changed, installed capacity of turbines and nominal capacity of generators have been increased.

In the Final EIA Report, Project Owner committed that 5 m^3/sec of environmental flow would be released from the dam location in order to sustain the aquatic life in the river section between dam and powerhouse. This environmental flow was also taken into consideration in optimization studies, and an additional powerhouse at the toe of the dam was proposed. Environmental flow which should be provided for sustain of life in river, 9.42 m^3/s compensation water will be left to downstream of dam. Fish ladder will not be established within the scope of Project due to technical reasons.

Since installed capacity of Project is planned to increase from 145 MW to 181.81 MW, it is indicated that “In case of capacity increase and/or expansion about projects which are within or outside the scope of this Regulation, preparation of EIA Report is obligatory for projects whose total capacity increase is on or over threshold value cited in ANNEX-I of this Regulation. For this purpose, a new EIA process has began for Kavsak Bendi HEPP Capacity Increase Project, this EIA Report has been prepared and the EIA Report has been approved in November 2009 (REF 4: Kavsak Bendi HEPP Capacity Increase Final EIA Report, November 2009).

Dogancay Weir and HEPP

Dogancay is a “run-of-river” type HEPP project. Dogancay Weir will be located on Dogan Creek, a tributary of Seyhan River, while Dogancay HEPP will be located on Seyhan River. A transmission tunnel will be opened in the mountain between valleys of Dogan Creek and Seyhan River to connect weir and HEPP. Entire project is located within the boundaries of Aladag District of Adana Province. EIA process for the project was completed, and the project is in construction phase. The Energy Generation License of the project was obtained from the EMRA in 2008 and will be valid for 49 years.

Dogancay Weir and HEPP Project consists of Dogancay Weir with a thalweg elevation of 555 m and Dogancay HEPP with a tailwater elevation of 244 m. Length of the transmission tunnel between the weir and the powerhouse is 6,210 m. The installed capacity and the annual energy generation of the project are 49.17 MW and 190.15 GWh, respectively. The EIA Positive Certificate for the project was issued by the MoEF on August 25, 2009. Construction of the project is ongoing (REF 5: Dogancay Weir and HEPP Final EIA Report, 2009).

Yamanli II Weir, HEPP and Quarries

Yamanli II Weir, HEPP and Quarries Project will be located on Goksu River in Upper Seyhan Basin located in the east of Mediterranean Region. The major part of the Project Site lies within the boundaries of Saimbeyli, Adana, and a small part of it lies within Goksun, Kahramanmaras.

The Project is composed of two stages: the first stage includes Yamanli II Stage I Weir and Yamanli II Stage I HPP with an installed capacity of 49.70 MW, and the second stage includes Yamanli II Stage II Weir, Hocabey Weir and Yamanli II Stage II HPP with an installed capacity of 27.96 MW. Total installed capacity of the Project is 77.66 MW.

The first formulation proposed in the “Upper Seyhan Basin Master Plan Report” published in 1984 by the State Hydraulic Works (SHW) is composed of Yamanli II Weir at thalweg elevation of 1,153 m, an energy tunnel with a length of 16,090 m, a surge tank, a penstock and Yamanli II HEPP at downstream elevation of 760 m at the right shore of

Goksu River. However, due to long energy tunnel, difficult construction and cost of the Project, it was planned to be realized in two stages.

The two-stage Project is as follows:

Stage I: Yamanli II Stage I Weir at thalweg elevation of 1,153.50 m, an energy tunnel with a length of 8,212 m, a surge tank, a penstock and Yamanli II HPP.

Stage II: Yamanli II Stage II Weir, a transmission channel with a length of 4,180 m, an energy tunnel with a length of 1,000 m (discharging into the water inlet structure of Hocabey Weir), Hocabey Weir on Hocabey Creek, a transmission channel with a length of 1,900 m, a forebay, a penstock and Yamanli II Stage II HPP. EIA Report has been approved in February 13, 2009 (REF 6: Yamanli II HEPP and Quarries Final EIA Report, January 2009).

Gicik (Zamanti) Weir and HEPP

Gicik (Zamanti) Weir is a part of Develi Phase II Irrigation Project which was initiated 30 years ago. The construction of the project is expected to finish in 2008. An area of 52,000 ha in the Develi Lowland will be irrigated with an 11 km long tunnel. At the exit part of the tunnel a power plant will be constructed with an installed capacity of 6.7 MW. Since the permission procedures for the project were finalized before February 7, 1993, the project is exempted from the EIA Regulation requirements.

Saritepe Weir and HEPP

Saritepe Weir and HEPP which is a run-of-river type project is located on Asmaca Creek, a tributary of Goksu River, in Feke District of Adana Province. The HEPP which is a private company project will be used only for energy generation purpose. The construction of the HEPP is expected to finish at the end of 2008. Within the project, a weir with a height of 10 m and a 2 km long transmission channel will be constructed. The installed capacity of the power plant is 5 MW and average annual energy generation is estimated to be 20 GWh. The project is exempted from the EIA Regulation requirements. (URL 4: Official Website of Feke District Governorship, 2008).

Yedigoze Sani Bey Dam and HEPP

Yedigoze Sani Bey Dam and HEPP is located on Seyhan River within the boundaries of Imamoglu, Kozan and Aladag Districts of Adana Province. The HEPP is a project of a private company and will be used for irrigation and energy generation purposes. The construction of the HEPP is completed and dam is started to impound. The installed capacity of the power plant is 300 MW and average annual energy generation is estimated to be 969 GWh. The surface area and volume of the reservoir will be 14.9 km^2

and 642.8 hm^3, respectively. The EIA procedure of the project was carried out by DOKAY and EIA Report was approved on June 6, 2007 (REF 7: Yedigoze Dam, HEPP and Quarries Project Final EIA Report, 2007).

Proposed HEPPs

In addition to HEPPs under construction and existing HEPPs, there are also projects in feasibility and final design phases proposed by other private companies than AKENERJI. General information related to all projects in CIA Study Area is presented in Table 2-4 below.

The most recent information about these projects have been obtained mainly from official websites of EMRA, DSI and General Directorate of EIA and Planning, announcements appeared in local news portals related to the projects and EIA reports if available.

Table 2-4. General Information on the HEPP Projects Proposed in the CIA Study Area

Name of the Project	Location (Province - District)	Installed Capacity (MW)	Average Annual Energy Production (GWh)	Information	EIA Procedure
UPPER SEYHAN BASIN					
Zamanti River					
Bahcelik Dam and HEPP	Kayseri - Pinarbasi	4.71	27.84	- Operation (Private Company) - Irrigation and energy generation purposes - Reservoir area and volume: 12.13 km^2 and 216.140 hm^3	The project is exempted from the EIA Regulation requirements
Gumusoren Dam and HEPP	Kayseri - Develi	5	12	- Final Design (DSI) - Irrigation and energy generation purposes - Reservoir volume: 216.9 hm^3	EIA Report was approved on November 14, 1997
Gicik (Zamanti) Weir and HEPP	Kayseri - Develi	6.7	25	- Construction (DSI) - Irrigation and energy generation purposes - 52,000 ha area will be irrigated	The project is exempted from the EIA Regulation requirements
Camlica I Weir and HEPP	Kayseri - Yahyalı	84	429	- Operation (Private Company) - Run-of-river type HEPP - Energy generation purpose	EIA Report was approved on May 26, 1997
Camlica II Weir and HEPP	Kayseri - Yahyalı	15.9	90.7	- Feasibility (Private Company) - Run-of-river type HEPP	-
Camlica III Weir and HEPP	Kayseri - Yahyalı	28.5	42.6	- Final Design (Private Company) - Run-of-river type HEPP	EIA process has been completed
Tatlar Weir and HEPP	Kayseri - Yahyalı	58	214	- Feasibility (Private Company) - Run-of-river type HEPP	-
Indere Dam and HEPP	Adana - Feke / Kayseri - Yahyali	32.6	100.5	- Final Design (Private Company) - Energy generation purpose - Reservoir volume: 60.34 hm^3	EIA process has been completed
Topaktas Dam and HEPP	Kayseri - Yahyalı	7	34	- Feasibility (Private Company) - Reservoir volume: 1.47 hm^3	-
Goksu River					
Yamanli I Weir and HEPP	Adana - Saimbeyli	22	100	- Feasibility (Private Company) - Run-of-river type HEPP	-

Name of the Project	Location (Province - District)	Installed Capacity (MW)	Average Annual Energy Production (GWh)	Information	EIA Procedure
Yamanli II Weir and HEPP	Adana - Saimbeyli	78	308	- Construction (Private Company) - Run-of-river type HEPP	EIA Report was approved on February 13, 2009
Yamanli III Weir and HEPP	Adana - Saimbeyli	60	237.94	- Final Design **(AKENERJI)** - Run-of-river type HEPP Includes; • Gokkaya Dam and HEPP (30 MW) • Himmetli Weir and HEPP (27 MW) • Saimbeyli Weir and HEPP (3 MW)	EIA Report was approved on August 20, 2009
Feke I Weir and HEPP	Adana - Feke	30	117	- Construction **(AKENERJI)** - Run-of-river type HEPP	Project Information File was submitted on May 2009
Feke II Dam and HEPP	Adana - Feke	70	223	- Construction is almost finished **(AKENERJI)** - Energy generation purpose - Reservoir volume: 3,730 km^2	EIA Report was approved on January 31, 2008
Asmaca Creek (Goksu River)					
Saritepe Weir and HEPP	Adana - Feke	5	20	- Construction (Private Company) - Run-of-river type HEPP - Energy generation purpose	The project is exempted from the EIA Regulation requirements
Taslik Creek (Goksu River)					
Kilicli-I Weir and HEPP	Adana - Saimbeyli	2.7	9.85	- Construction (Private Company) - Energy generation purpose	EIA process has been completed
Kilicli-II Weir and HEPP	Adana - Saimbeyli	2.4	9.49	- Construction (Private Company) - Energy generation purpose	EIA process has been completed
Salam Creek (Goksu River)					
Maran HEPP	Adana - Feke	12.58	35.85	- Construction (Private Company) - Energy generation purpose	EIA process has been completed
Kiy HEPP	Adana - Feke	16.98	67.48	- Construction (Private Company) - Energy generation purpose	EIA process has been completed
LOWER SEYHAN BASIN					
Zamanti River					

Name of the Project	Location (Province - District)	Installed Capacity (MW)	Average Annual Energy Production (GWh)	Information	EIA Procedure
Goktas Energy Project (Goktas Dam and I-II HEPP)	Adana - Kozan and Aladag	290	1,160	- Construction (Private Company) - Reservoir volume: 133.34 hm^3	EIA Report was approved on December 25, 2008
Goksu River					
Menge Dam and HEPP	Adana - Kozan and Feke	33	120	- Construction (Private Company) - Energy generation purpose - Reservoir area and volume: 2,67 km^2 and 50.8 hm^3	EIA Report was approved on February 18, 2009
Kusakli Weir and HEPP	Adana – Kozan	20.3	46.66	- Final Design (Private Company) - Energy generation purpose	EIA process is ongoing
Kopru Dam and HEPP	Adana - Kozan	120	377	- Construction (Private Company) - Energy generation purpose - Reservoir area and volume: 2,93 km^2 and 93.2 hm^3	EIA Report was approved on February 18, 2009
Seyhan River					
Kavsakbendi Dam and HEPP	Adana - Kozan and Aladag	181.81	715	- Construction (Private Company) - Energy generation purpose - Reservoir area and volume: 2 km^2 and 51.05 hm^3	EIA Report was approved on October 5, 2007 Revised Project EIA Report was approved on February 23, 2009
Dogancay Weir and HEPP	Adana – Aladag	49.17	190.15	- Construction (Private Company) - Energy generation purpose	EIA Report was approved on August 25, 2009
Yedigoze Sani Bey Dam and HEPP	Adana - Imamoglu, Kozan and Aladag	300	949	- Impound phase (Private Company) - Irrigation and energy generation purposes - Reservoir area and volume: 14.9 km^2 and 642.8 hm^3	EIA Report was approved on June 6, 2007

Source: *Revised Kavsakbendi HEPP Project Feasibility Report, 2008*; Feke *I HEPP EIA Report, 2009; Feke II Dam and HEPP EIA Report, 2008*; *Yamanli III HEPP EIA Report, 2009*; official website of EMRA; and announcements appeared in local news portals related to the projects

3. LEGAL FRAMEWORK OVERVIEW

In this chapter, Turkish and European legislation related to the environmental impacts of construction and operation of the HEPPs has been reviewed and summarized.

3.1 National Legal and Institutional Situation

Turkish EIA process includes the steps of screening, public participation, scoping, EIA study, examination and evaluation of the EIA report. According to this regulation, projects are classified into two categories: projects listed in Annex I with significant potential impacts requiring an EIA report and projects listed in Annex II which may have significant potential impacts and require further environmental analyses. For these projects, a Project Introduction File is prepared in order to decide on whether an EIA report is required or not. These procedures are mostly in conformity with the EU EIA Directive.

Although the latest revision of EIA Regulation was published on July 17, 2008, the Feke II HEPP Project of AKENERJİ is subject to the requirements of the revision published in the Official Gazette dated December 16, 2003 and numbered 25318 according to the provisional Article 2 of the latest revision. An EIA Report is prepared.

On the other hand, the installed capacity of Yamanli III HEPP Project of AKENERJİ is greater than 50 MW, the project is in the scope of Annex I which covers the projects requiring EIA Report according to the EIA Regulation published on July 17, 2008 dated Official Gazette. Since the threshold for installed capacity in Annex I was decreased to 25 MW in the EIA Regulation dated July 17, 2008, an EIA Report was prepared for Feke I Weir and HEPP Project. A Project Information File (PIF) is prepared.

Water Pollution Control Regulation (Official Gazette dated December 31, 2004 and numbered 25687) (amended by the regulation issued in the Official Gazette dated February 13, 2008 and numbered 26786)

Water Pollution Control Regulation (WPCR) provides legal and technical foundations required for the determination of water pollution control in order to protect the surface and groundwater resources of the country and to ensure their optimum use within the best manner. Article 5 of this regulation particularly gives information on river basin plans and basin protection plans.

*"**Article 5** – Basin plans are prepared by DSI with related institutions in order to determine whether the existing water quality of inland waters are appropriate for intended water utilization. A basin protection plan is required to be prepared for protection, pollution prevention and remediation of inland waters quality considering the characteristics of the basin as well. As a result of the basin protection plan, a long term protection program and*

protective measures will be determined. It is obligatory to follow the resultant protection plan. The MoEF will prepare the basin protection plan or/and ensure its preparation with the involvement of related institutions".

Draft Strategic Environmental Assessment Regulation (by MoEF)

This regulation is in the list of legislation envisaged to be enacted in the year 2007 of Turkish National Programme for the Adoption of the Acquis (NAAP), Chapter 27. However, according to the interview conducted with Havva Ozkir (Office Manager in Planning and Strategic EIA Department, General Directorate of EIA and Planning) the draft SEA Regulation will be enacted in 2010 and will cover the environmental assessment of plans and programs subject to the approval of a public authority and enabling public participation in this process. Public institutions, which draw up master plans, physical plans, sectoral plans and programs within the scope of this regulation, will be included. The basin master plans which are related to the development of HEPPs in these basins will be in the scope of this regulation.

National Laws and Regulations Related to the Environmental Impacts of the Projects

The laws and regulations mentioned below, include the national legal requirements to reduce environmental impacts that may occur during construction and operation activities of the hydropower projects.

- Environmental Law numbered 2872;
- Turkish EIA Regulation (Official Gazette dated July 17, 2008 and numbered 26939),
- Regulation on Management and Evaluation of Air Quality (Official Gazette dated May 05, 2009 and numbered 27219);
- Regulation on Control of Air Pollution Originating From Industrial Establishments (Official Gazette dated July 03, 2009 and numbered 27277), (amended by the regulation issued in the Official Gazette dated March 30, 2010 and numbered 27537);
- Water Pollution Control Regulation (Official Gazette dated December 13, 2004 and numbered 25687) (amended by the regulation issued in the Official Gazette dated March 30, 2010 and numbered 27537);
- Regulation on Assessment and Management of Environmental Noise (Official Gazette dated June 04, 2010 and numbered 27601);
- Regulation on Control of Excavation Material, Construction and Demolition Wastes (Official Gazette dated March 18, 2004 and numbered 25406);
- Solid Waste Control Regulation (Official Gazette dated March 14, 1991 and numbered 20814), (amended by the Regulation on Landfilling of Wastes issued in the Official Gazette dated March 26, 2010 and numbered 27533);

- Regulation on Control of Waste Oils (Official Gazette dated July 30, 2008 and numbered 26952), (amended by the regulation issued in the Official Gazette dated March 30, 2010 and numbered 27537);
- Regulation on Control of Used Batteries and Accumulators (Official Gazette dated August 31, 2004 and numbered 25569), (amended by the regulation issued in the Official Gazette dated March 30, 2010 and numbered 27537);
- Regulation on Control of Packaging Material Wastes (Official Gazette dated June 24, 2007 and numbered 26562), (amended by the regulation issued in the Official Gazette dated March 30, 2010 and numbered 27537);
- Hazardous Wastes Control Regulation (Official Gazette dated March 14, 2005 and numbered 25755); (amended by the regulation issued in the Official Gazette dated October 30, 2010 and numbered 27744);
- Regulation on Soil Pollution Control and Point Source Polluted Areas (Official Gazette dated June 08, 2010 and numbered 27605);
- Guideline on Production, Import, Transportation, Preservation, Storage, Sale, Use, Disposal and Control of the Explosive Materials (Official Gazette dated September 29, 1987 and numbered 19589);
- Forest Law numbered 6831, amended by the law numbered 5192;
- Regulation Related to Protection and Utilization of Farmlands (Official Gazette dated March 25, 2005 and numbered 25766);
- Law on Protection of Cultural and Natural Assets (Law Numbered 2863 with Amendment by Law Numbered 5226);
- Regulation on Occupational Health and Safety (Official Gazette dated February 11, 1974 and numbered 14765); and
- Regulation on Health and Safety in Constructive Works (Official Gazette dated December 23, 2003 and numbered 25325).

3.2 EU Environmental Legislation and International Commitments

Environmental Impact Assessment (EIA) Directive (97/11/EC) (amending Directive 85/337/EEC)

The EIA Directive on the assessment of the effects of certain public and private projects on the environment was introduced in 1985 (85/337/EEC) and was amended in 1997 (97/11/EC). The EIA procedure ensures that environmental consequences of projects are identified and assessed before authorisation is given. The public can give its opinion and all results are taken into account in the authorisation procedure of the project. The public is informed of the decision afterwards (URL 5, Website of European Commission (EC), 2008).

The EIA Directive outlines which project categories shall be made subject to an EIA, which procedure shall be followed and the content of the assessment. The projects of

AKENERJI proposed in Seyhan Basin are HEPPs listed in Annex II of this directive and therefore requires an EIA according to this directive.

Strategic Environmental Assessment (SEA) Directive (2001/42/EC)

The purpose of the SEA Directive is to ensure that environmental consequences of certain plans and programmes are identified and assessed during their preparation and before their adoption. The public and environmental authorities can give their opinion and all results are integrated and taken into account in the course of the planning procedure. After the adoption of the plan or programme the public is informed about the decision and the way in which it was made. In the case of likely transboundary significant effects the affected Member State and its public are informed and have the possibility to make comments which are also integrated into the national decision making process. (URL 6, Website of EC, 2008)

Article 3(2) states that an environmental assessment shall be carried out for all plans and programmes which are prepared for agriculture, forestry, fisheries, energy, industry, transport, waste management, water management, telecommunications, tourism, town and country planning or land use and which set the framework for future development consent of projects listed in Annexes I and II of EIA Directive. The projects of ENERJISA in Seyhan Basin are HEPPs listed in Annex II of EIA Directive. These projects are among the components of Seyhan Basin master plan which is subject to an assessment in accordance with EU Directive on SEA.

Water Framework Directive (WFD) Directive (2000/60/EC)

The purpose of the Water Framework Directive (WFD) is to establish a legal framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater across Europe and ensure its long-term, sustainable use.

The directive establishes an innovative approach for water management based on river basins, the natural geographical and hydrological units and sets specific deadlines for Member States to protect aquatic ecosystems. The directive addresses inland surface waters, transitional waters, coastal waters and groundwater, and it establishes innovative principles for water management, including public participation in planning and economic approaches, including the recovery of the cost of water services.

One of the aims of the WFD is to ensure that by 2015 all of Europe's water bodies are of good ecological quality. In order to achieve this Article 4(3) of the directive allows Member States to designate some of their surface waters as heavily modified water bodies or artificial water bodies whereby they will need to meet the corresponding quality criteria required. They will need to meet the “good ecological potential” criterion for these ecosystems rather than “good ecological status”. However, artificial and heavily modified

bodies will still need to achieve the same low level of chemical contamination as other water bodies.

The final decisions will be included in the river basin management plans Member States must prepare for 2009. These plans will contain the measures Member States will implement in order to meet the directive's 2015 objectives, which include ensuring the good chemical status and good ecological potential of all artificial and heavily modified bodies of water.

Subsequent management plans must be prepared every six years. These will review whether the designations are still necessary in light of the steps some Member States are taking to restore the natural state of heavily modified water bodies such as reopening some of rivers' flood plains.

4. ENVIRONMENTAL BASELINE

4.1 Introduction

Seyhan Basin lies between latitudes 36° 30' - 39° 15' N and longitudes 34° 45' - 37° 00' E in the east of Mediterranean and Middle Anatolia. It covers an area of 20,731 km^2. The main part of the basin lies within Adana and Kayseri provinces.

Seyhan Basin can be examined separately as Upper and Lower Seyhan Basins. Upper Seyhan Basin lies in the northern part of the imaginary borderline passing through the elevations of 490 m on Zamanti River and 525 m on Goksu River. The southern part of this imaginary borderline up to Mediterranean Sea is called Lower Seyhan Basin.

Location of the AKENERJI HEPP projects is same as the former CIA Study HEPP projects. Therefore, environmental and socio-economic features of the Seyhan Basin which are discussed in former "CIA of Hydroelectric Power Plant Projects In Seyhan River Basin" Report (August 2010 dated report is prepared by DOKAY Engineering and Consultancy Ltd. Co.) shows same characteristics for AKENERJI HEPP projects. There is no other explanation for those features to add this chapter. Only Goksu River's water quality, water flow regime, and aquatic ecological characteristic features are discussed and explanation of field studies and analyses of these features are given at below sections. CIA of them is discussed at Chapter 5.

4.2 Flow Regime

Field study of determination of the prevailing flow regime along the river section of interest, flow rate measurements will be carried out at twelve different stations along two tributaries of Seyhan River namely Goksu and Dogancay rivers. Field study is conducted between November 27th – 30th 2010 leading by Cevahir DALKILIC (Aquacultural Products Engineering – DOKAY) and specialist of Akim Elektronik İnsaat Bilgisayar Sistemleri Taahhut Sanayi ve Ticaret Ltd. Co.

The locations of the stations for flow rate measurements are selected in accordance with the locations of the weirs and dam axes of the subject HEPP's are shown in map of flow rate measurement stations and field study photos are given at Appendix-A and Appendix-B, respectively. Coordinates of measurement stations are given at Table 4-1.

Table 4-1 Coordinates of Flow Regime Measurement Locations

No	Sample Location	Coordinates		
		UTM Zone	East	North
1	Asmaca Creek	37 S	754983	4190289
2	Dogancay Creek	37 S	714241	4161316
3	Feke I Weir	37 S	762133	4195368

No	Sample Location	Coordinates		
		UTM Zone	East	North
4	Goksu Kaleboynu	37 S	254175	4202663
5	Kavsakbendi Dam	36 S	723511	4160847
6	Kopru Dam	36 S	730817	4166684
7	Menge Dam	36 S	739678	4176760
8	Yamanli III (Himmetli) HEPP	36 S	239227	4194884
9	Yardibi Creek	36 S	244638	4194376
10	Hancer Creek	36 S	254914	4202736
11	Saimbeyli Creek	36 S	243087	4199335
12	Yedigoze Dam	36 S	718605	4139937

The main components of the field works along the river were be linear flow-velocity measurements and cross-sectional area determinations with adequate field equipment. Flow regime measurement equipment is internationally standardized Akım Elektronik Muline. This equipment allows measuring even the shallowest water with different rotor attachments. It can measure flow rate from 0.03 m/sec to 12 m/sec. The rotor isolated from water by mounting by two ball bearings with oil and plastic joint. The photography of sample muline equipment is given in Figure 4-1.

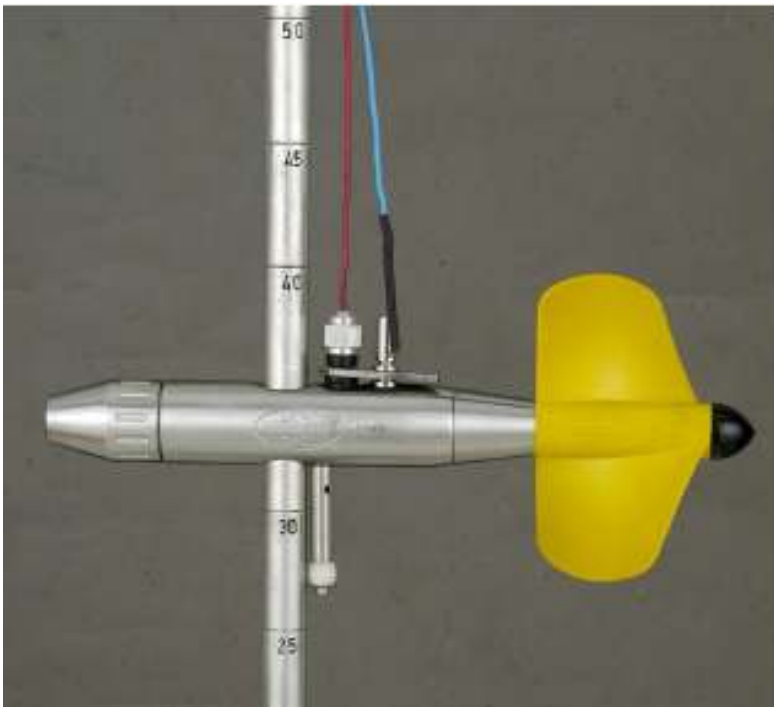


Figure 4-1 Photography of Muline

Flow regime measurement results given at Table 4-2. According to Table 4-2, flow rate at Kavsak Bendi Dam is the highest measured flow rate which is on the Goksu River. Lowest measured flow rate on Goksu River is Kaleboynu. Dogancay and Saimbeyli Creeks are the lowest flow rated tributaries.

Table 4-2 Flow Regime Measurement Results

No	Sample Location	Flow Measurement Results (m^3/sec)	Current Velocity (cm/sec)
1	Asmaca Creek	4.350	84.3
2	Dogancay Creek	0.468	38.7
3	Feke I Weir	11.620	130.5
4	Goksu Kaleboynu	5.160	45.6
5	Kavsakbendi Dam	69.190	117.2
6	Kopru Dam	27.524	87.3
7	Menge Dam	25.310	89.5
8	Yamanli III (Himmetli) HEPP	11.549	73.4
9	Yardibi Creek	10.830	40.2
10	Hancer Creek	2.707	62.5
11	Saimbeyli Creek	0.467	38.3
12	Yedigoze Dam	38.229	68.6

The measurement results are given at Appendix-C and assessments of these measurements are at Section 5-2.

4.3 Water Quality

In the context of CIA study, existing surface water quality along the hydropower cascade, water samples will be taken from Seyhan River at twelve different locations in December 1st – 2nd, 2010 to identify the existing water quality of these water resources. The coordinates of surface water sampling locations are given in Table 4-3 and map of surface water sampling in Appendix-D.

Table 4-3 Coordinates of Surface Water Sampling Locations

Sample No	Sample Location	Start Date	Finish Date	Coordinates		
				UTM Zone	East	North
S1 S 2405-1	Cukur Kisla	December 01, 2010	December 02, 2010	37 S	262762	4225971
S2 S 2405-2	Saimbeyli Creek	December 01, 2010	December 02, 2010	37 S	243059	4199331
S3 S 2405-3	Gokkaya Dam	December 01, 2010	December 02, 2010	37 S	244614	4194416
S4 S 2405-4	Under Yamanli III Weir	December 01, 2010	December 02, 2010	37 S	239228	4194879
S5 S 2405-5	Feke I Weir	December 01, 2010	December 02, 2010	36 S	762380	4195577
S6 S 2405-6	Asmaca Creek	December 01, 2010	December 02, 2010	36 S	754994	4190292
S7 S 2405-7	Feke II Dam	December 01, 2010	December 02, 2010	36 S	751394	4181653
S10 S 2407-1	Kopru Dam	December 02, 2010	December 03, 2010	36 S	736731	4166333
S11 S 2407-2	Kavsakbendi Dam	December 02, 2010	December 03, 2010	36 S	723536	4160876
S12 S 2407-3	Menge Dam	December 02, 2010	December 03, 2010	36 S	739670	4176823
S8 S 2405-8	Yedigoze Dam	December 01, 2010	December 02, 2010	36 S	717046	4141802
S9 S 2405-9	Dogancay Creek	December 01, 2010	December 02, 2010	36 S	714330	4161283

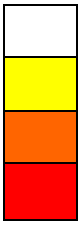
Samples are taken preserved and analyzed at the DOKAY Environmental Laboratory in Ankara.[1] Parameters, methods to analyze these parameters are given at Table 4-4.

Table 4-4 Water Quality Parameters to be Analyzed

Parameters	Methods	Preservation Time
Aluminum (Al)	EPA 200.7	1 Month
Ammonium Nitrate (NH_4^+-N)	SM 4500-NH_3 F.	21 Day
Arsenic (As)	EPA 200.7	1 Month
Cupper (Cu)	EPA 200.7	1 Month
Barium (Ba)	EPA 200.7	1 Month
Biochemical Oxygen Demand (BOD5)	SM 5210 B.	24 Hour
Bor (B)	EPA 200.7	1 Month
Mercury(Hg)	EN 1483-E12-4	1 Month
Zinc (Zn)	EPA 200.7	1 Month
Dissolved Oxygen (O_2)	SM 4500-O C. SM 4500-O G. TS 5677 EN 25814	5 Hour
Iron (Fe)	EPA 200.7	1 Month
Phenol	SM 5530 C.	21 Day
Floride (F^-)	SM 4500-F^- D.	1 Month
Cadmium (Cd)	EPA 200.7	1 Month
Chemical Oxygen Demand (COD)	SM 5220 D.	1 Month
Total Kjeldahl Nitrogen (Norg), Toplam	SM 4500 Norg B.	24 Hour
Cloride (Cl^-)	SM 4500 - Cl^- B.	1 Month
Cobalt (Co)	EPA 200.7	1 Month
Coliform Bacteria, Fecal	TS ISO 9308-1 TS ISO 9308-2	24 Hour
Coliform Bacteria, Total	TS ISO 9308-1 TS ISO 9308-2	24 Hour
Chrome (Cr), Toplam	EPA 200.7	1 Month
Chrome +6 (Cr^{6+})	SM 3500-Cr B.	24 Hour
Lead (Pb)	EPA 200.7	1 Month
Manganese (Mn)	EPA 200.7	1 Month
Surface-active substances (MBAS) (mg/L)	SM5540 C.	2 Day
Mineral oils (C10-C40 Index)	ISO 9377-2	–
Nickel (Ni)	EPA 200.7	1 Month
Nitrate (NO_3^--N)	SM 4500-NO_3^- E.	24 Hour
Nitrite (NO_2^--N)	SM 4500-NO_2^- B.	24 Hour
Oxygen Saturation (%O_2)	SM 4500-O C. SM 4500-O G. TS 5677 EN 25814	5 hour
Pesticides (30 parameters)	DIN 38407-F2, EN ISO11369 (F12)	7 Day
pH	TS 3263 ISO 10523	6 Hour
Radioactivity Alfa- Beta Activities	Radioactivity	–
Color	TS 6392 EN ISO 7887	5 Day
Selenium (Se)	EPA 200.7	1 Month
Free Chloride (Cl_2)	SM 4500-Cl^- G.	5 dk
Temperature	SM 2550 B.	On the site
Sodium (Na)	EPA 200.7	1 Month
Sulfate (SO_4^{2-})	SM 4500-SO_4^{2-} D.	1 Month
Sulfur (Sulfide) (S^{2-})	SM 4500-S^{2-} F.	7 Day
Total Dissolved Solid Particulate Matter	SM 2540 C.	24 Hour
Total Phosphor (P)	SM 4500-P C.	1 Month
Total Organic Carbon (TOC)	DIN EN 1484	7 Day
Total Cyanide (CN^-)	SM 4500-CN^- C.	24 Hour
Oil and Grease	TS 7887	1 Month

[1] *DOKAY Environmental Laboratory is accredited by Turkish Accreditation Agency (TURKAK) and authorized by the MoEF for environmental measurements, sampling and analyses.*

The measured parameters of the surface waters are compared with the inland water quality (Table 1) given in the Regulation on Amendment in Turkish Water Pollution Control Regulation (WPCR) which became affected upon publication in the Official Gazette dated March 30, 2010 and numbered 27537. The water quality in sampling locations is evaluated according the classes stated in WPCR. Classes given in WPCR represent different water quality levels as described below:



Class I: High quality water

Class II: Slightly polluted water

Class III: Polluted water

Class IV: Extremely polluted water

Any water resource should satisfy all the parameters given for a category to be classified as within that water quality class. Measurement and analyses results of sampling locations and the range of classes of measured parameters are given in Table 4-5 and analysis reports are given in Appendix-E. Colors in the table show the water classification as shown below.

Table 4-5 Analysis Results of Samples

Parameter	Unit	Surface Water Quality Measurement Locations												Water Quality Classification			
		S1 Cukur Kisla	S2 Saimbeyli Creek	S3 Gokkaya Dam	S4 Under Yamanli III Weir	S5 Feke I Weir	S6 Asmaca Creek	S7 Feke II Dam	S8 Kopru Dam	S9 Kavsakbendi Dam	S10 Menge Dam	S11 Yedigoze Dam	S12 Dogancay Creek	Class I	Class II	Class III	Class IV
Temperature	ºC	9.3	12.8	11.8	12.1	12.0	11.9	12.1	13.9	14.1	13.3	14.9	12.7	**25**	**25**	**30**	**> 30**
pH	-	7.94	8.25	7.92	7.88	7.89	8.22	7.91	8.08	8.08	8.13	7.84	8.85	**6.5-8.5**	**6.5-8.5**	**6.0-9.0**	**except 6.0-9.0**
Dissolved Oxygen (O_2)	mg/L	9.38	10.55	9.99	9.88	9.91	10.22	9.37	9.26	9.60	8.94	8.27	9.72	**8**	**6**	**3**	**< 3**
Oxygen Saturation (% O_2)	%	114.7	126.6	120.7	119.7	120.7	124.0	114.1	112.6	117.2	109.6	101.7	120.8	**90**	**70**	**40**	**< 40**
Chlorure (Cl^-)	mg/L	6.5	5.0	8.5	7.5	8.0	46.0	584.8	119.5	69.5	125.0	65.0	8.0	**25**	**200**	**400**	**> 400**
Sulfate (SO_4^{2-})	mg/L	13.5	18.6	93.5	92.4	88.1	56.3	117.1	79.7	54.3	84.5	45.3	4.9	**200**	**200**	**400**	**> 400**
TSS (Total Suspended Solids)*	mg/L	9.2	< 1.0 **	108.4	359	144.1	< 1.0 **	< 1.0 **	24.8	100.4	6.8	2.4	< 1.0 **	**Natural Protection Area and recreation 5**		**For Various Purposes (including naturally salty, mineral and bitter lakes) 15**	
Ammonium Nitrogen (NH_4-N)	mg/L	< 0.15 **	0.18	< 0.15 **	< 0.15 **	< 0.15 **	0.17	0.36	0.59	< 0.15 **	< 0.15 **	< 0.15 **	0.19	**0.2**	**1**	**2**	**> 2**
Nitrate Nitrogen (NO_3^- - N)	mg/L	1.40	1.10	0.96	0.94	0.99	0.55	0.92	0.78	0.92	0.77	0.98	0.23	**5**	**10**	**20**	**> 20**
Nitrite Nitrogen (NO_2^- - N)	mg/L	0.012	0.025	0.004	0.006	0.008	< 0.002	0.009	0.005	0.005	0.005	< 0.002	0.004	**0.002**	**0.01**	**0.05**	**> 0.05**
Total Phosphorus (P)	mg/L	< 0.3 **	< 0.3 **	0.5	3.5	1.7	< 0.3 **	< 0.3 **	< 0.3 **	< 0.3 **	< 0.3 **	< 0.3 **	< 0.3 **	**0.02**	**0.16**	**0.65**	**> 0.65**
TDS (Total Dissolved Solids)	mg/L	10.0	260.0	326.0	304.0	238.0	382.0	1,324.0	326.0	292.0	370.0	366.0	302.0	**500**	**1,500**	**5,000**	**> 5,000**
Color	mg/L Pt/Co scale	7.1	7.6	7.1	7.6	8.2	7.1	6.0	4.9	6.5	4.3	6.5	6.0	**5**	**50**	**300**	**> 300**
Sodium (Na)	mg/L	4.555	4.390	6.303	6.067	6.280	30.350	375.20	108.30	43.41	73.46	43.97	6.60	**125**	**125**	**250**	**> 250**
COD	mg/L	< 20.0 **	< 20.0 **	20.3	31.9	64.2	< 20.0 **	34.9	< 20.0 **	< 20.0 **	< 20.0 **	< 20.0 **	< 20.0 **	**25**	**50**	**70**	**> 70**
BOD	mg/L	< 4.0 **	< 4.0 **	5.0	7.8	5.8	< 4.0 **	< 4.0 **	< 4.0 **	< 4.0 **	< 4.0 **	< 4.0 **	< 4.0 **	**4**	**8**	**20**	**> 20**
TOC (Total Organic Carbon)	mg/L	1.1	1.0	0.9	1.6	0.9	1.0	1.0	0.7	0.9	0.9	1.2	1.0	**5**	**8**	**12**	**> 12**
Total Kjeldahl Nitrogen (N_{org}),	mg/L	1.7	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	**0.5**	**1.5**	**5**	**> 5**
Oil and grease**	mg/L	< 1.5 **	3.6	< 1.5 **	1.6	< 1.5 **	< 1.5 **	< 1.5 **	< 1.5 **	< 1.5 **	1.6	< 1.5 **	< 1.5 **	**0.02**	**0.3**	**0.5**	**> 0.5**
MBAS((materials giving rxn with methly blue.)	mg/L	0.06	< 0.06 **	< 0.06 **	< 0.06 **	< 0.06 **	< 0.06 **	< 0.06 **	< 0.06 **	< 0.06 **	< 0.06 **	< 0.06 **	< 0.06 **	**0.05**	**0.2**	**1**	**> 1.5**
Phenols	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	**0.002**	**0.01**	**0.1**	**> 0.1**
Mineral Oils (C10-C40-Index)	mg/L	< 0.1 (LOD)	< 0.1 (LOD)	< 0.1 (LOD)	< 0.1 (LOD)	< 0.1 (LOD)	< 0.1 (LOD)	< 0.1 (LOD)	< 0.1 (LOD)	-< 0.1 (LOD)	< 0.1 (LOD)	< 0.1 (LOD)	< 0.1 (LOD)	**0.02**	**0.1**	**0.5**	**> 0.5**
Pesticides (30 parameters)***	mg/L	< 0.05 x 10^{-3}	< 0.05 x 10^{-3}	< 0.05 x 10^{-3}	< 0.05 x 10^{-3}	< 0.05 x 10^{-3}	< 0.05 x 10^{-3}	< 0.05 x 10^{-3}	< 0.05 x 10^{-3}	< 0.05 x 10^{-3}	< 0.05 x 10^{-3}	< 0.05 x 10^{-3}	< 0.05 x 10^{-3}	**0.001**	**0.01**	**0.1**	**> 0.1**

Parameter	Unit	Surface Water Quality Measurement Locations												Water Quality Classification			
		S1 Cukur Kisla	S2 Saimbeyli Creek	S3 Gokkaya Dam	S4 Under Yamanli III Weir	S5 Feke I Weir	S6 Asmaca Creek	S7 Feke II Dam	S8 Kopru Dam	S9 Kavsakbendi Dam	S10 Menge Dam	S11 Yedigoze Dam	S12 Dogancay Creek	Class I	Class II	Class III	Class IV
Mercury(Hg)	mg/L	< 0.0030	< 0.0030	< 0.0030	< 0.0030	< 0.0030	< 0.0030	< 0.0030	< 0.0030	< 0.0030	< 0.0030	< 0.0030	< 0.0030	**0.1**	**0.5**	**2**	**> 2**
Cadmium (Cd)	mg/L	0.0053	0.0056	0.0057	0.0053	0.0055	0.0054	0.0053	0.0055	0.0056	0.0056	0.0054	0.0055	**3**	**5**	**10**	**> 10**
Lead (Pb)	mg/L	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100	**10**	**20**	**50**	**> 50**
Arsenic (As)	mg/L	< 0.0030	< 0.0030	0.0106	0.0098	0.0117	< 0.0030	0.0089	0.0056	< 0.0030	0.0076	< 0.0030	< 0.0030	**20**	**50**	**100**	**> 100**
Copper (Cu)	mg/L	0.0705	0.0707	0.0792	0.0772	0.0980	0.0785	0.0698	0.0840	0.0698	0.0550	0.0618	0.0696	**20**	**50**	**200**	**> 200**
Chromium (Cr), Total	mg/L	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100	0.0190	< 0.0100	< 0.0100	< 0.0100	**20**	**50**	**200**	**> 200**
Chromium (Cr^{6+})	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.010	< 0.01	< 0.01	**LOD**	**20**	**50**	**> 50**
Cobalt (Co)	mg/L	< 0.0030	< 0.0030	< 0.0030	0.0032	< 0.0030	< 0.0030	< 0.0030	< 0.0030	0.0063	< 0.0030	< 0.0030	< 0.0030	**10**	**20**	**200**	**> 200**
Nickel (Ni)	mg/L	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100	0.0597	< 0.0100	< 0.0100	< 0.0100	**20**	**50**	**200**	**> 200**
Zinc (Zn)	mg/L	0.0324	0.0451	0.0500	0.0482	0.0671	0.0386	0.0293	0.0388	0.0353	0.0352	0.0341	0.0347	**200**	**500**	**2000**	**> 2000**
Total cyanide (CN^-)	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	**10**	**50**	**100**	**> 100**
Florure (F^-)	mg/L	< 0.3	< 0.3	0.3	< 0.3	0.3	< 0.3	0.5	0.4	0.3	0.4	0.3	0.3	**1000**	**1500**	**2000**	**> 2000**
Free Chlorine (Cl_2)	mg/L	0.09	0.05	0.10	0.12	0.14	0.02	0.05	0.13	0.03	0.07	0.03	0.03	**10**	**10**	**50**	**> 50**
Sulphur (S^{2-})	mg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**2**	**2**	**10**	**> 10**
Iron (Fe)	mg/L	0.1844	0.1875	0.8178	2.8850	1.7290	0.1280	0.1509	0.2581	1.4930	0.1773	0.1717	0.0859	**300**	**1000**	**5000**	**> 5000**
Manganese (Mn)	mg/L	0.0255	0.5004	0.0614	0.1686	0.0617	0.0632	0.0333	0.2327	0.0725	0.0385	0.2044	0.0125	**100**	**500**	**3000**	**> 3000**
Boron (B)	mg/L	0.2136	0.3098	0.3700	0.2373	0.1211	< 0.0100	0.7306	< 0.0100	< 0.0100	< 0.0100	< 0.0100	< 0.0100	**1000[e]**	**1000[e]**	**1000[e]**	**> 1000**
Selenium (Se)	mg/L	0.0070	0.0070	0.0116	< 0.0050	0.0071	< 0.0050	< 0.0050	0.0054	0.0080	0.0076	0.0093	0.0098	**10**	**10**	**20**	**> 20**
Barium (Ba)	mg/L	0.0554	0.0524	0.0610	0.0792	0.0618	0.0883	0.0570	0.0717	0.0743	0.0671	0.0768	0.0196	**1000**	**2000**	**2000**	**> 2000**
Aluminium (Al)	mg/L	0.0812	0.0354	0.3092	0.6985	0.3726	0.0256	0.0490	0.1261	0.2000	0.0822	0.0699	0.0274	**0.3**	**0.3**	**1**	**> 1**
Fecal Coliform Bacteria	kob/100 mL	265	250	> 1000	> 1000	>1000	160	210	> 1000	> 1000	70	100	88	**10**	**200**	**2000**	**> 2000**
Total Coliform Bacteria	kob/100 mL	840	820	> 1000	> 1000	>1000	610	720	> 1000	> 1000	320	480	560	**100**	**20000**	**100000**	**> 100000**
Radioactivity (Alfa activity	Bq/L	< 0.07	< 0.08	< 0.09	< 0.26	< 0.12	< 0.09	< 0.19	< 0.08	< 0.09	< 0.08	< 0.08	< 0.04	**1**	**10**	**10**	**> 10**
Beta Activity	Bq/L	0.08	0.09	0.10	0.24	0.14	0.07	0.71	0.15-	0.12	0.17	0.09	0.06	**10**	**100**	**100**	**> 100**

LOD **Limit of Detection**

* TSS parameter cannot be compared with Table 1 in WPCR because there is no classification in Table 1. TSS is compared with Table 2 “Eutrophication Control Limit Values Of Lakes, Ponds, Swamps And Dam Catchment Areas”

** It is observed that the detection limit for these analyses by using those methods are not possible to conduct other more precise measurement

*** 31 Pesticides parameters are analyzed by *Agrolab Laborgruppe*. In Table 1 of WPCR, the limit value for pesticides is given as “Total Pesticides” but detailed list or explanation of these pesticides is not given. Therefore, it is determined that all 31 Pesticides are below “Class I” limit value since they are under “0.05 x 10^{-3}” mg/L.

Since any water resource should satisfy all the parameters given for a category to be classified as within that water quality class, it can be stated that the quality class of surface water in Asmaca Creek, Dogancay Creek and Yedigoze Dam is *Class II*; in Cukur Kısla, Gokkaya Dam, Kopru Dam and Kavsakbendi Dam is *Class III*, in Saimbeyli Creek, Yamanli III Weir, Feke I Weir, Feke II Dam and Menge Dam is *Class IV* as given Table 4-3. The impact assessment of the water quality on aquatic ecological characterization is given at Section 5-3.

4.4 Aquatic Ecology

A specifically-designed aquatic flora and fauna survey will be conducted along the river section of interest in order to determine both the ecological structure of the Project Area and the relevant protection status of the freshwater species constituting the Valued Ecosystem Components (VEC's).

The field study for the determination of the aquatic floral and faunal structure of the Project Area was carried out by team of DOKAY personnel Environmental Engineer Emre Kaya and Aquatic Engineer Cevahir Dalkılıc supervised by Asst. Prof. Dr. Cevher Ozeren of Hacettepe University Hydrobiology Department.

In this context, the following studies were carried out in the CIA Study Area:

- To define the aquatic flora and fauna species
- To define the status of the globally threatened species and restricted range species within the aquatic ecosystem
- To define and list of the aquatic flora and fauna species that might be affected during construction activities.
- To create a periodical bio-monitoring program for identification and regulation such negative effects may arise from HEPPs on aquatic flora (algae, diatome, macrophytes) and fauna (zooplankton, benthos, freshwater fish) species.

Field study were carried out in eight sampling stations in the vicinities of the respective HEPP's will be sufficient for both (i) determination of the existing aquatic ecological characteristics of the Project Area, and (ii) assessment of the potential cumulative impacts on the aquatic ecosystem. However, the exact number and the corresponding locations of the sampling stations will be selected *in-situ*.

In addition to the subject HEPP projects, the main tributaries of Goksu and Dogancay rivers will also be taken into consideration during the selection of the sampling stations. Further, such factors as (i) river flow, (ii) habitat characteristics and diversity, and (iii) structure of the river bed will also be taken into account for the selection of the exact locations of the aquatic flora and fauna sampling stations along the subject segment of

Seyhan River. Coordinates of aquatic ecological characterization sampling stations are given at Table 4-6 and map of aquatic ecological characterization in Appendix-F.

Table 4-6 Coordinates of Aquatic Ecological Characterization Sampling Stations

No	Sampling Locations	Coordinates		
		UTM Zone	East	North
1	Cukurkisla-Yamanli I HEPP	37	262032	4224598
2	Gurlesen-Saimbeyli HEPP	37	243046	4199160
3	Yardibi Koyu-Gokkaya HEPP	37	244567	4194174
4	Himmetli-Yamanli III HEPP	36	763198	4196421
5	Feke Creek-Feke I HEPP	36	751825	4193894
6	Feke II Dam	36	750977	4180404
7	Dogancay Creek	36	714531	4160804
8	Yedigoze Dam	36	717823	4140674

The methods of sampling aquatic flora and fauna are given below.

4.4.1 Aquatic Flora

The organisms which form the aquatic flora were examined into two groups as microphyte (attached form-algae, free form-phytoplanktonic organisms) and macrophyte (emergent, floating plants).

For sampling of phytoplanktonic organisms, plankton net that of 1m in length with a pore size of 44 µm and a diamater of 20 cm was used. By the use of this net the following procedure applied:

- The net was kept totally in water for 3-4 minutes in the direction of the water flow.
- After this time interval, the planktons collected in the reservoir at the bottom of the net.
- The samples collected in the reservoir transferred to plastic containers having a volume of 250 ml.
- 10 ml of 37% previously prepared formaldehyde solution added for each 100 ml of sampled mixture of water and algae for fixation.

For sampling of attached algae that lives on the pebbles, stones, plants and shells at the same survey station, the following procedure applied:

- The pebbles, stones, plants shells were taken from the water,
- The algae forms attached on this surfaces scraped by the use of a knife or other similar tool.

- The scraped algae comminities and the remainings on the scraping tool was put inside of a plastic container of 250 ml.
- 10 ml of 37% previously prepared formaldehyde solution added for each 100 ml of sampled mixture of water and algae for fixation.

Macrophyte which is called as floating, submerged, emergent plants inside the waterbody was identified both in the field and in the laboratuary. Samples of the aquatic flora identified usually as genus level. Phytoplanktonic organisms and algae sampling in the field study are shown in Figure 4-2 and Figre 4-3.

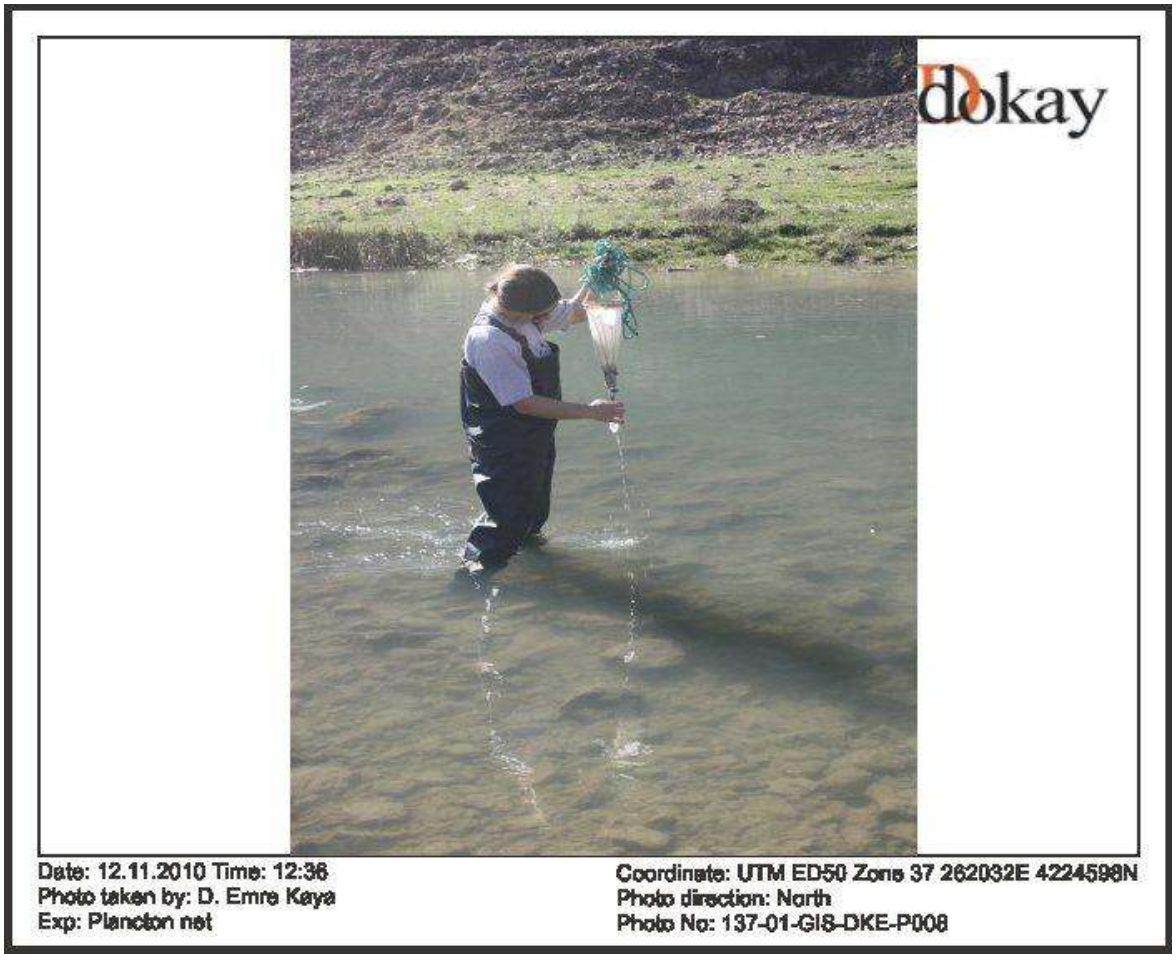


Figure 4-2 Phytoplanktonic organisms sampling

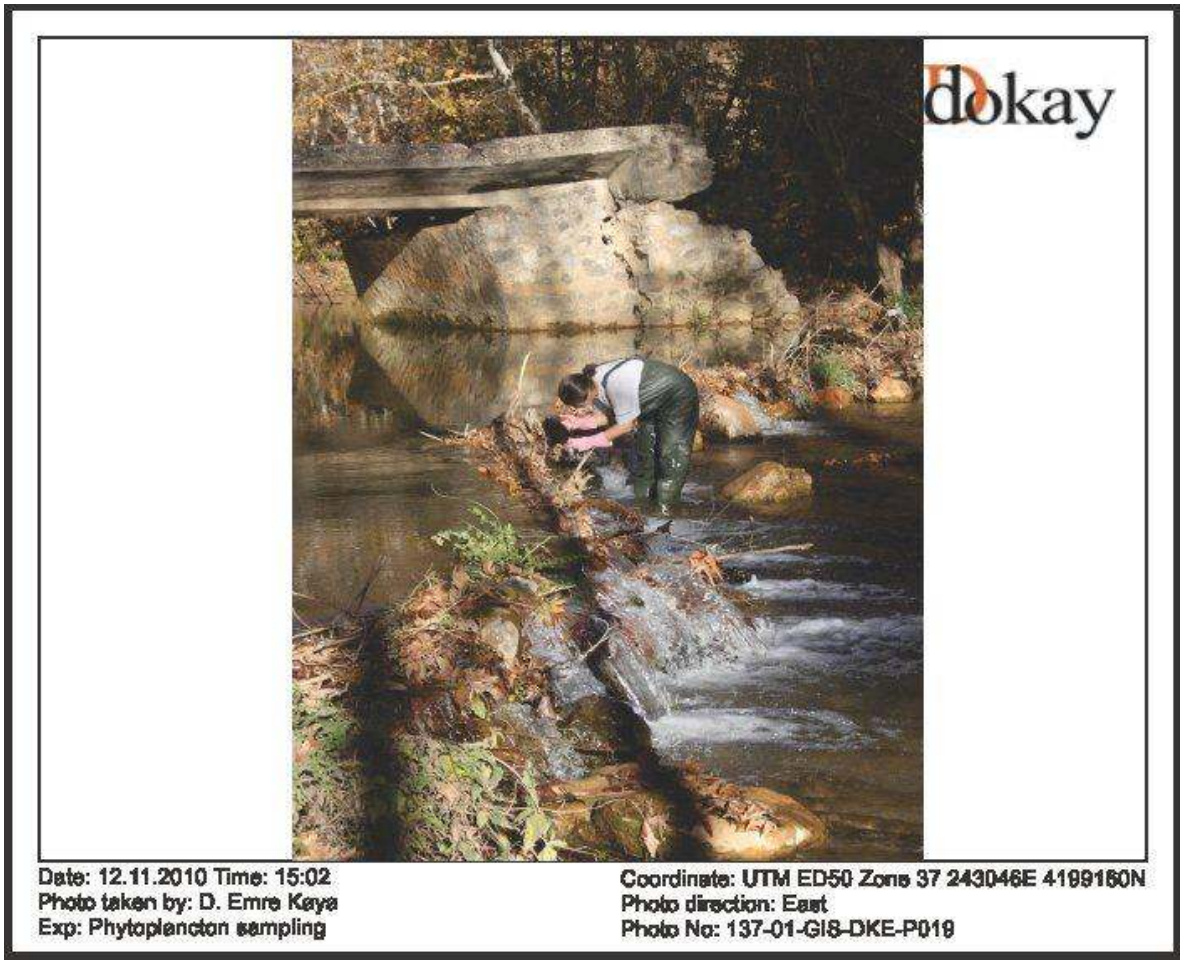


Figure 4-3 Algae sampling

4.4.2 Aquatic Fauna

Aquatic Invertebrate

Aquatic fauna elements classified as 'Invertebrate Organisms' and 'Vertebrate Organisms' in this study.

The organisms which form the aquatic invertebrate were examined into two groups as zooplanktonic organism (free form) and benthos (found in (infaunal) and on (epifaunal) sediment).

The zooplanktonic organisms are consumer and found in the second step of the food chain in, whereas the benthic organisms are also consumer and found in the third step of the food chain in aquatic ecosystem. The zooplankton in the fresh water system is represented by three dominant groups. These are; Cladocera and Copepoda, the superclassis of Crustacaea, and Phylum Rotifera.

The zooplanktonic samples collected by a plankton nets of which has a diameter of 20 cm with 55 µm pore size. The following procedure applied to collect zooplanktonic samples;

- The net kept totally in water for 3-4 minutes in the direction of the water flow.
- The samples collected in the reservoir transferred to plastic containers having a volume of 250 ml.
- 10 ml of 37% previously prepared formaldehyde solution added for each 100 ml of sampled mixture of water.

The method of sampling the benthic species differ according to the bottom structure of the sampling location and the type of the benthic organisms. The two sampling methods suggested in the following paragraphs usually aim to sample Mollusca, Annelide, Plathyhelminthes and Arthropoda species (especially Insecta family). Zooplankton sampling is presented in Figure 4-4.

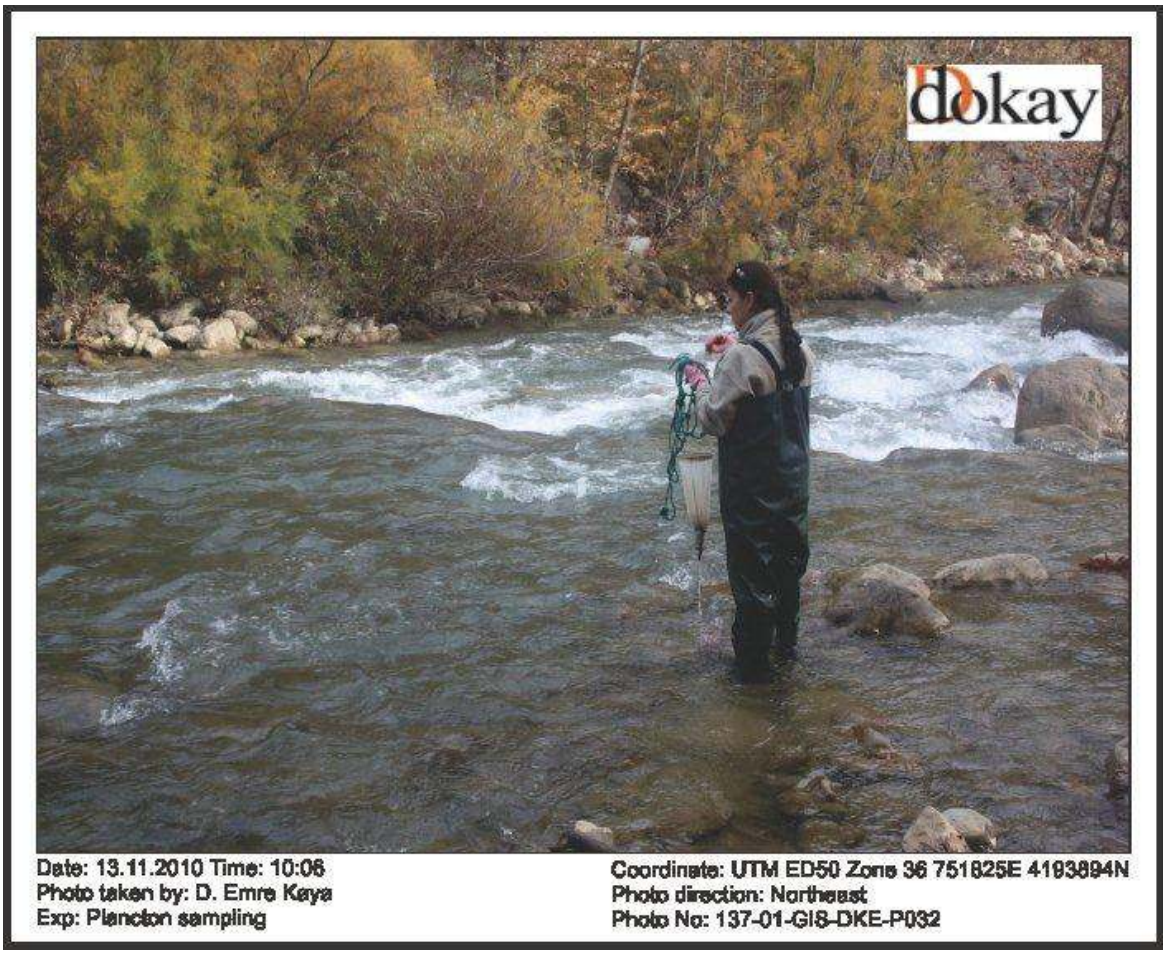


Figure 4-4 Zooplankton sampling

Eckman Grap is useful for sampling benthic communities inhabiting soft bottom aquatic environments. The dredge generally has the size of 9"x9"x9". As the dredge is lowered, the hinged upper doors swing open, allowing water to pass through and minimize

the shock wave. When the dredge reaches the bottom, a messenger is sent down the line which trips the spring-loaded jaws. The jaws snap shut, preventing washout of the sample. The dredges are constructed of stainless steel with special Heliarc welding for extra strength and trouble-free life. A simple cable release system with convenient bar grip enables the operator to set the dredge with greater safety. The sampling procedure was as follows:

- Move in the river to adequate depth to send the dredge in to the bottom. The mouth of the dredge is opened and send to the bottom by free fall. Since the dredge is a heavy weighting device it was sunk in to the soft bottom of the river bed.
- The open mouth of the dredge buried in to the sediments up to a reasonable depth to collect sediments.
- A messenger (that is usually heavy) sent through the cable of the dredge and the messanger pushed the mechanism of the dredge sunk into the bottom sediments to close the mouth of the dredge.
- The sediments would be sampled inside the dredge when the mouth closed.
- The closed dredge took out of the water.
- The sediments containing benthics collected in the dredge and this sample was transferred to plastic containers having a volume of 250 ml.
- 10 ml of 70 % volume of alcohol added for each 100 ml of sampled mixture of water and organism for fixation.

Collection by hand is generally used in open water. The samples collected by hand under pebbles, stones transferred to plastic containers having a volume of 250 ml. 10 ml of 70% volume of alcohol is added for each 100 ml of sampled mixture of water and organism for fixation.Benthic organims sampling in soft and under stone, pebbles bottoms are presented in Figure 4-5 and Figure 4-6.

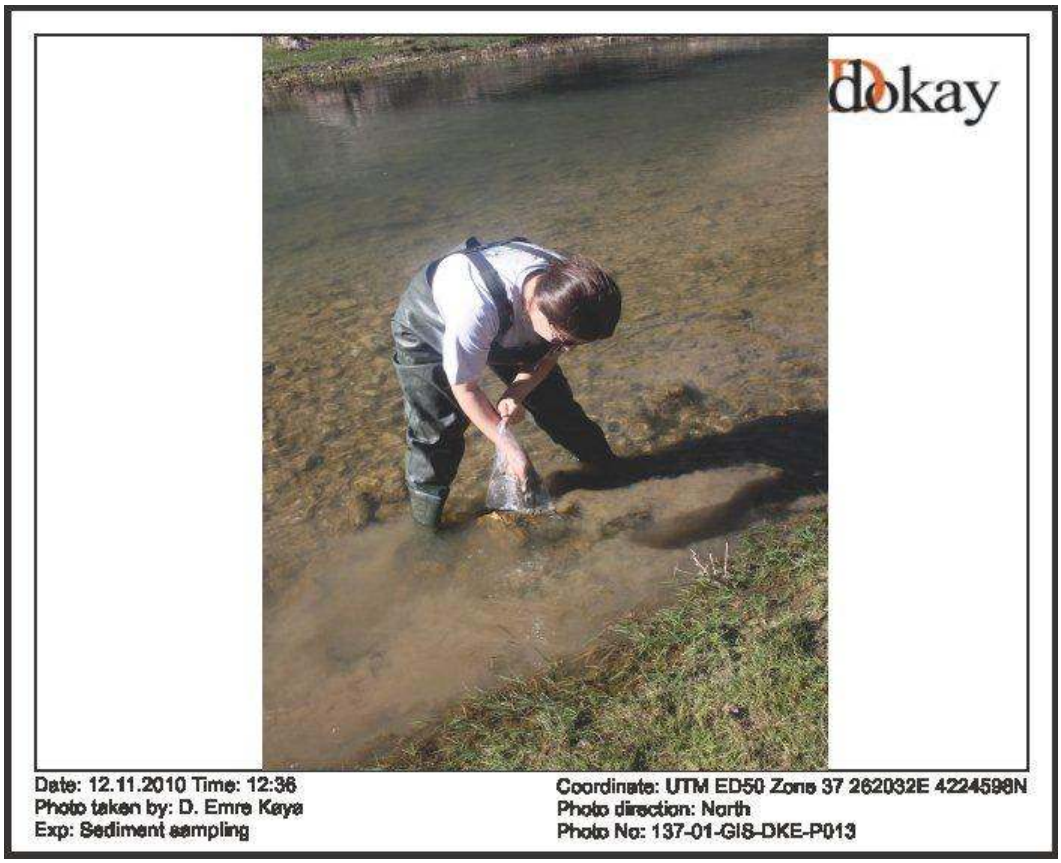


Figure 4-5 Benthic organisms sampling in soft bottom

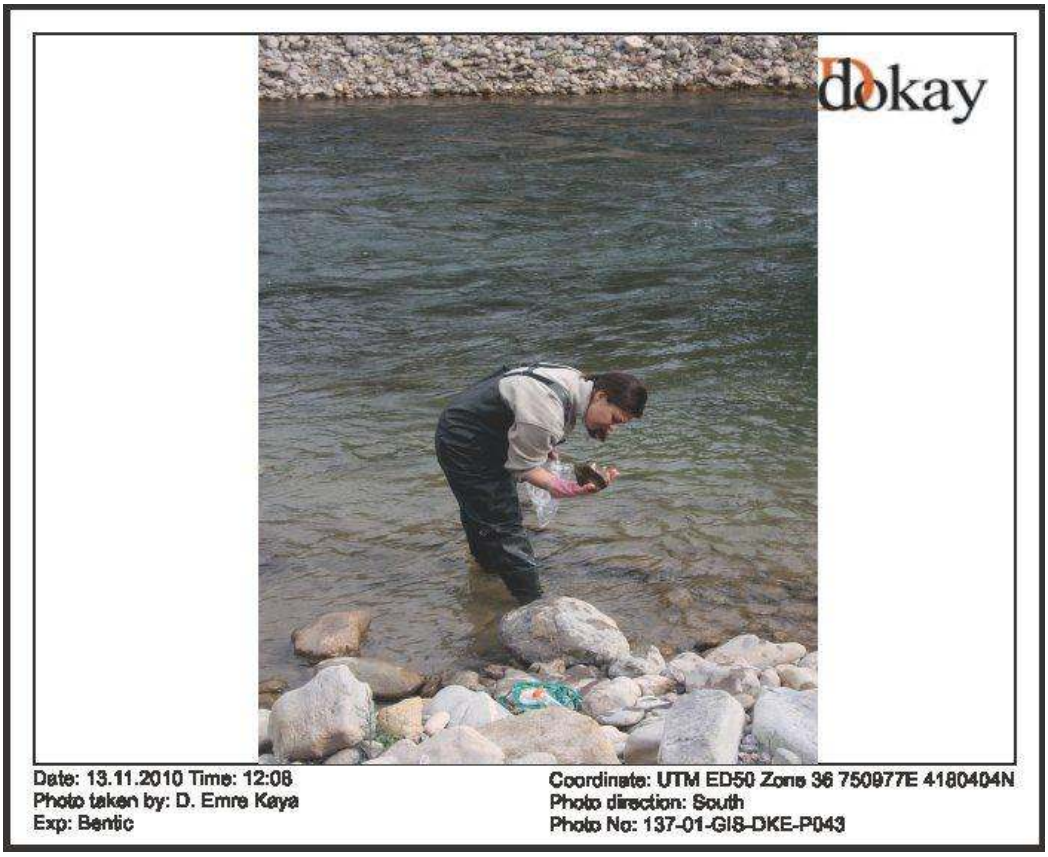


Figure 4-6 Benthic organisms sampling under stones, pebbles

Aquatic Vertebrate-Freshwater Fishes

Fishes are the most important group within the vertebrate aquatic animals. Fish sampling methodology is mostly important for revealing the fish species inhabitated in the water bodies. To select the fish sampling methodology, stream size (greater or smaller than 5 m), stream depth (deep or shallow), stream character (temporary or permenant), water characters (salty, freshwater or brackish water) and habitat richness are important. Moreover, life cycle (diurnal-for most of the fish species), nocturnal (such as Silurus species), migratory (diadrom fishes such as Salmo macrostigma), biology (herbivour, omnivour, carnivour fish) and/or size of the fish species (small; large) are also important for selecting the fish sampling methodology.

Various methods (such as butterfly net, trawl, entangling net, non-entangling net, cast net, fyke net, fishing line and electrofishing) were used for catching the fish in studies made for determining the hydrophilous fauna while taking into consideration whether the species to be caught are large or small in size, they are benthic (living in deep water) or pelagic (living on surface) species, they are nocturnal or diurnal, the qualities of the habitat they live in (depth, flow speed, vegetation state, luminance etc.) (Bohlin et al., 1989; Baker and Huggins, 2005).

In general, electrofishing and cast-net sampling methods are used in riverine fishes. These two methods are more useful to determine the fish species in small creeks and streams which is 5-10 meter width. Electrofishing is much more effective than seining in the small and shallow freshwaters (Mann and Penczak, 1984; Bohlin et al., 1989; Steinmetz, 1990).

Besides these methods, entagling-net (for *Cyprinus carpio*), non-entagling net (other Cyprinid species), fyke-net (for nocturnal and migratory fish species such as *Silurus*) prefer to use in big river system (more than 20 m width) with professional fisherman.

These methods not only provide effectively very good results in sampling of fish, but also they do not harm fish species and they are easy to carry and be used. These device usually used during day-light hours in the field (see Figure 4-7).

The results of field study are given in following sections, cumulative assessment of impacts on aquatic ecological characteristics due to water quality and flow regime is discussed at Section 5-4.

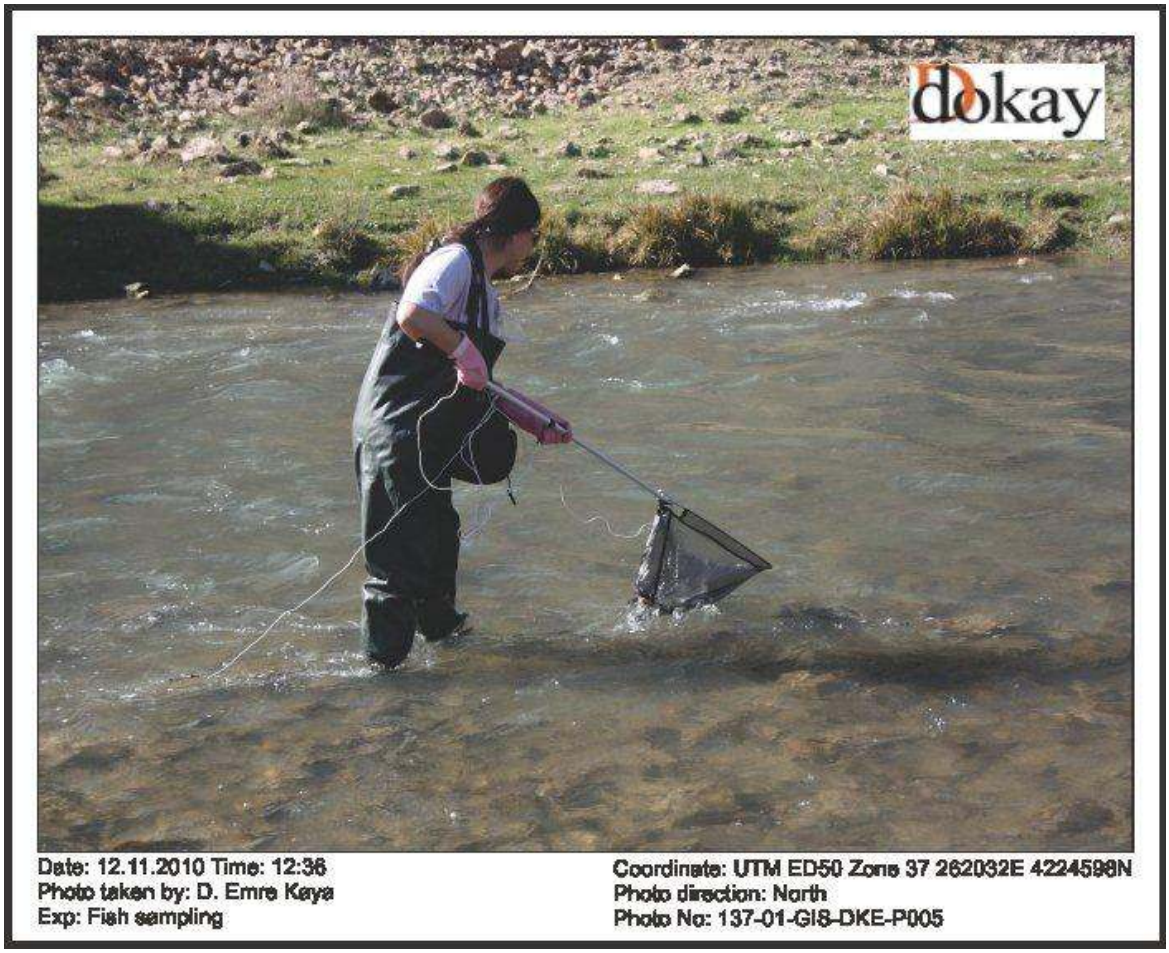


Figure 4-7 Electro-fishing Sampling

4.4.3 Curukkisla – Yamanli I HEPP

In order to identify the aquatic flora and fauna elements of the Yamanli I HEPP, upper part of the HEPP (upstream) was investigated. The width and the depth of the sampling location is about 10-15m and 15-60cm respectively. The bottom structure generally consists of gravel and stones, with sandy areas near the bank side of the stream. However, the bank vegetation is usually composed of herbaceous plants. There was no any macrophyte in the waterbody in this period. (see Figure 4-8).

Within the context of aquatic flora, phytoplanktonic organisms and algae were examined and it has been determined that the species belong to Bacillariophyta is dominant group with five species. In addition, *Navicula* and *Synedra* genus belong to Bacillariophyta phylum accepted as bioindicator genus in the pollutant water (Atıcı, 1997) and these were common in the sampling location. Other phytoplanktonic organisms and algae determined in the sampling location are given in Table 4-7.

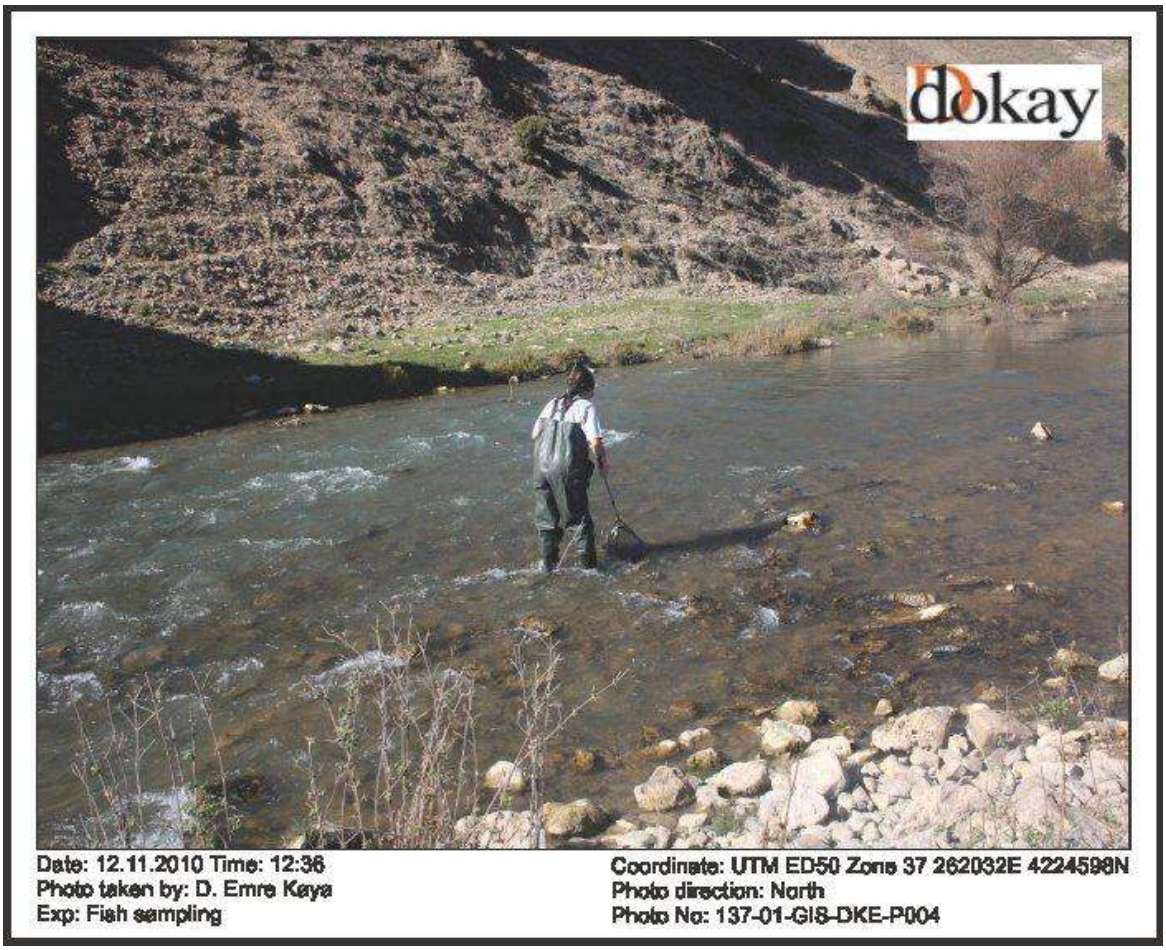


Figure 4-8 Sampling location of Cukurkısla-Yamanli I HEPP

Zooplanktonic and benthic organisms found in the sampling area are given in Table 2. When Table 2 is examined, species richness is found quite high in Rotifera phylum. It was also mentioned that Rotifera species richness is generally high when compared to Cladocera and Copepoda in Turkish inland waters (Bekleyen, 2003; Altındag and Yigit, 2004; Yigit and Altındag, 2005; Bekleyen and Tas, 2008).

The benthic organisms identified in field study belong to Arthropoda and Annelida phylum and Pleucoptera and Tricoptera larvae were dominant group among them. Moreover, another group from Arthropoda phylum identified as *Gammarus* and this organism was also dominant in the sampling location (see Table 4-8).

Table 4-7. Phytoplanktonic organisms and algae determined from the sampling location of Yamanli I HEPP

PHYLUM	CLASS	ORDER	FAMILY	GENUS
BACILLARIOPHYTA	BACILLARIOPHYCEAE	Bidduphiales	Catenulaceae	*Amphora*
		Surirellales	Surirellaceae	*Cymatopleura*
		Fragilariales	Fragilariaceae	*Synedra*
		Naviculales	Naviculaceae	*Navicula*
				Gyrosigma
CH OROPHYTA	CHLOROPHYCEAEA	Chlorococcales	Hydroictyaceae	*Pediastrum*
STREPTOPHYTA	ZYGNEMATOPHYCEAE	Zygnematales	Desmidiaceae	*Staurastrum*

Table 4-8 Zooplanktonic and benthic organisms determined from the sampling location Yamanli I HEPP

PHYLUM	CLASS	ORDER	FAMILY	GENUS/ SPECIES
ROTIFERA*	EUTATORIA	Ploima	Colurellidae	*Colurella obtusa* (Gosse, 1886)
ARTHROPODA	BRANCIOPODA*	Cladocera	Daphniidae	*Ceriodaphnia quadrangula* (Muller, 1785)
	INSECTA**	Diptera	Chironomidae	*Chironomus* sp
		Pleurocoptera larvae		
		Tricoptera larvae		
	MALACOSTRACA**	Amphipoda	Gammaridae	*Gammarus*
ANNELIDA**		Arhynchobdellida	Hirunidae	*Hirudo*

* Zooplanktonic organisms ** Benthic organisms

Electrofishing device was used to catch the freshwater fishes in the sampling area of Yamanli I HEPP. As a result of the fishing, two species (*Capoeta damascina*, *Squalius lepidus*) from Cyprinidae family were identified. These species is not evaluated as protected and/or threatened species according to the Bern Convention (2002), IUCN Red List (2010) CITES (2004). Besides, bio-ecological features of the species are given in Appendix-G.

4.4.4 Gurlesen - Saimbeyli HEPP

To identify the aquatic organisms inhabited in the Yamanli III HEPP area, the field study was done in the upper part of the CIA Study Area which is located between Gurlesen and Sultanbeyli. Bottom structure of the stream is composed of stone, gravel and sand. Stones which are found in the bottom of the stream densely covered with moss. There is no any macrophyte observed in the stream. The bank vegetation of the stream is formed of annual and bienal herb (densely Graminae), perennial herb and trees (*Platanus*). The width and depth of the sampling location is about 7 m and 15-70 cm respectively (See Figure 4-9).

Within the scope of aquatic flora, it has been determined that the species belong to Bacillariophyta is dominant group with five species (See Table 4-9). Besides, *Navicula* and *Synedra* was the dominant genus within the Bacilloriophyta. Atıcı (1997) mentioned that *Navicula* and *Synedra* genus belong to Bacillariophyta phylum accepted as bioindicator genus in the pollutant and/or semi pollutant water which is polluted because of the organic waste. This stream was classified as Class II (slightly pollution) because of the content of chloride, total phosphorous, total coliform bacteria and fecal coliform according to the water quality criteria. There is a linear correlation between the total phosphorous and the microphyte. Algae are producer organisms and phosphour content of the water is significantly important for these organisms to produce.

Table 4-9 Phytoplanktonic organisms and algae determined from the sampling location of Saimbeyli-Yamanli III HEPP

PHYLUM	CLASS	ORDER	FAMILY	GENUS
BACILLARIOPHYTA	BACILLARIOPHYCEAE	Bacilloriales	Bacillariaceae	*Nitzcshia*
		Cymbellales	Cymbellaceae	*Cymbella*
			Gomophonemataceae	*Gomphonema*
		Naviculales	Naviculaceae	*Navicula*
				Gyrosigma

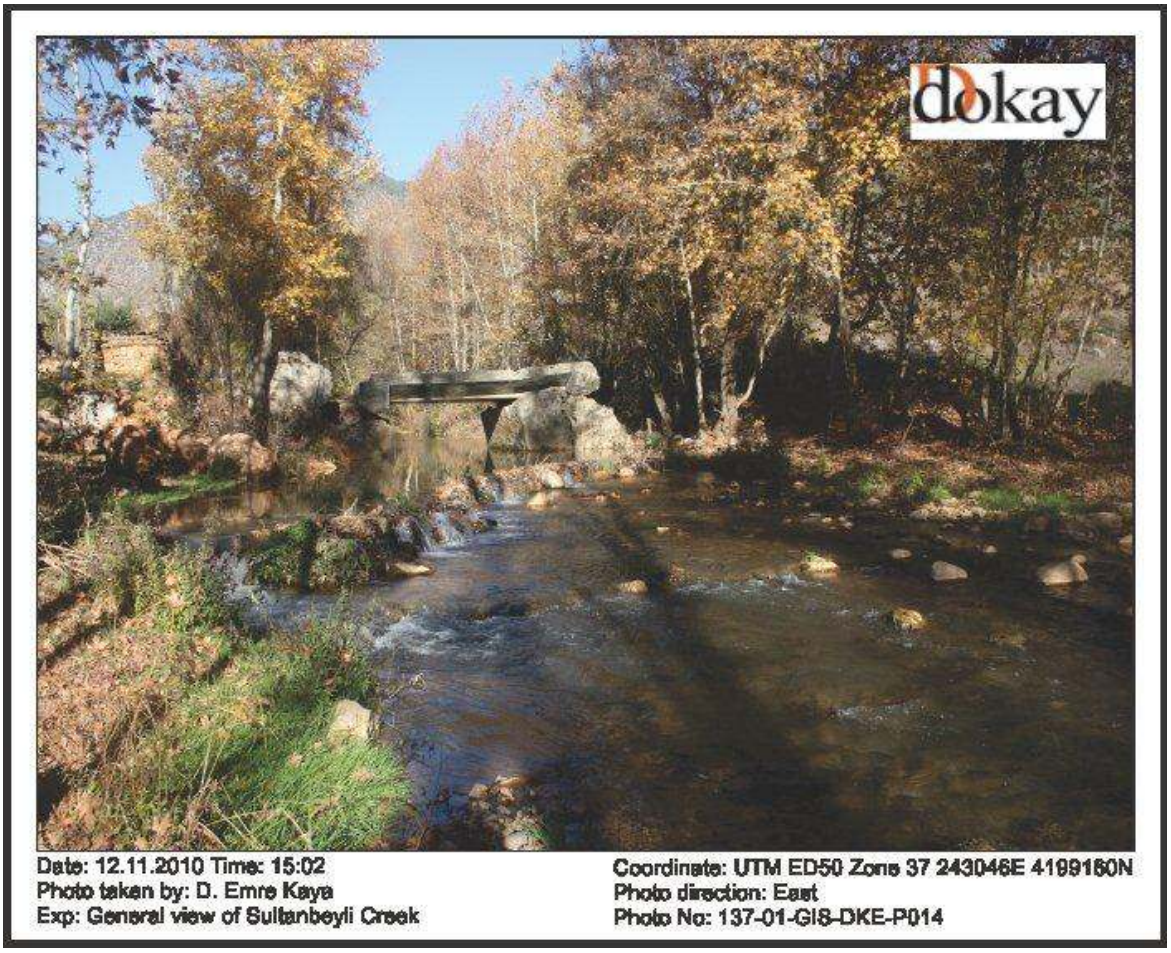


Figure 4-9 Sampling location of Sultanbeyli-Yamanli III HEPP

Zooplanktonic structure of the sampling location is composed of Rotifera phylum with three species. Besides, the benthic organisms identified in area belong to Arthropoda phylum and *Gammarus* belong to Amphipoda order was dominant (see Table 4-10).

Table 4-10 Zooplanktonic and benthic organisms determined from the sampling location Saimbeyli-Yamanli III HEPP

PHYLUM	CLASS	ORDER	FAMILY	GENUS/ SPECIES
ROTIFERA*	EUTATORIA	Ploima	Colurellidae	*Colurella obtusa* (Gosse, 1886)
			Notommatidae	*Cephalodella ventriges* (Dixon-Nutall, 1901)
				Cephalodella gibba (Ehrenberg, 1832)
			Lecanidae	*Lecane closterocerca* (Schmarda, 1859)
ARTHROPODA	INSECTA**	Pleurocoptera larvae		
	MALACOSTRACA**	Amphipoda	Gammaridae	*Gammarus*

* Zooplanktonic organisms ** Benthic organisms

Electroshocker was used to catch the freshwater fishes in the sampling area. As a result of hunting, three species (*Alburnus adanensis* Adana bleak; *Capoeta damascina* and *Garra rufa*-Doctor fish) from Cyprinidae family were identified. None of the species are categorized as protected and/or threatened species according to the Bern Convention

(2002), IUCN Red List (2010) and CITES (2004) inhabited in this sampling location, but *Alburnus adanensis* is an endemic species in Seyhan and Ceyhan River basins. Besides, some biological and ecological features of the species are given in Appendix-G.

4.4.5 Yardibi Village - Gokkaya HEPP

Gokkaya HEPP is located between the Yamanli II and Yamanli III HEPP. The sampling location of this HEPP is found the upper part of the Yardibi Village. The current velocity of the stream is rather high. The bottom structure of the stream is usually composed of muddy, but there are stony and rocky substratum are found where the flow rate is high (see Figure 4-10). Bank vegetation of the stream is formed generally with *Salix* and annual, biennial herb and perennial herb. The width and depth of the river is approximately 15 m and 20-100 cm (middle part of the stream) respectively.

Following to the aquatic flora survey, seven species belong to Bacillariophyta and one species from Steroptophyta identified and Bacillariophyta is the dominant group. Phytoplan and algae species identified from the sampling location are given in Table 4-11.

Zooplanktonic and benthic organisms found in the sampling area are given in Table 6. When Table 6 is examined, only one species (*Cephalodella gibba*) belong to Rotifera phylum was identified. In the scope of the determination the benthic organisms, nematoda and Chrinomid larvae were identified. When zooplantonic and benthic organisms are evaluated, the sampling location is poor in terms of zooplankton and benthos. High flowing rate might be caused for this situation.

Table 4-11 Phytoplanktonic organisms and algae determined from the sampling location of Gokkaya HEPP

PHYLUM	CLASS	ORDER	FAMILY	GENUS/ SPECIES
BACILLARIOPHYTA	BACILLARIOPHYCEAE	Cymbellales	Cymbellaceae	*Cymbella*
		Surirellales	Surirellaceae	*Surirella*
				Cymatopleura
		Fragilariales	Fragilariaceae	*Synedra*
		Naviculales	Naviculaceae	*Navicula*
				Gyrosigma
		Tabellariales	Taballeriaceae	*Tabellaria*
STREPTOPHYTA	ZYGNEMATOPHYCEAE	Zygnematales	Desmidiaceae	*Staurastrum*

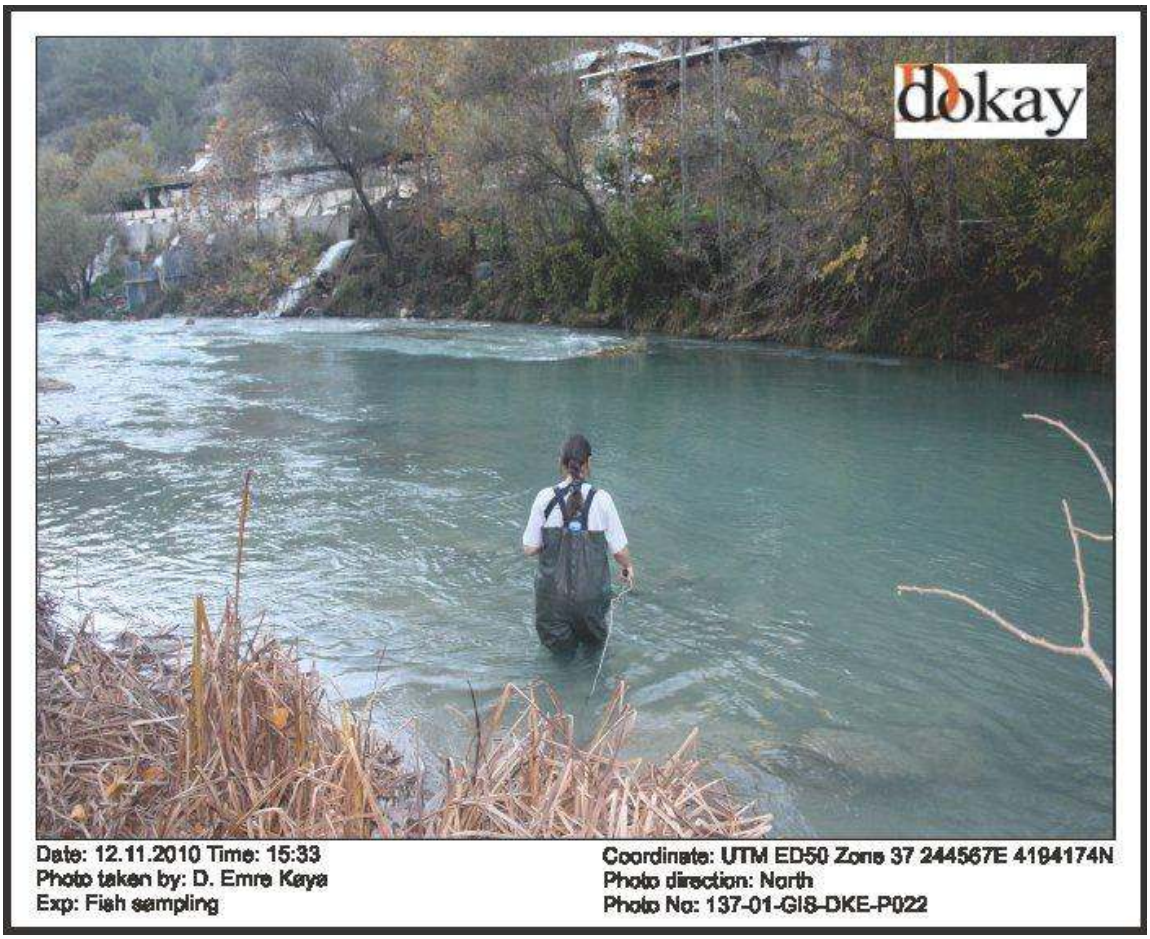


Figure 4-10 Sampling location of Yardibi-Gokkaya HEPP

Electroshocker is used to catch the freshwater fishes in the sampling area. As a result of the fishing two species (*Squalius Lepidus*-Chub; *Capoeta damascina*) from Cyprinidae family identified and none of them are categorized as protected and/or threatened species according to the Bern Convention (2002), IUCN Red List (2010) and CITES (2004). Besides, some biological and ecological features of the species are given in Appendix-G.

4.4.6 Himmetli-Yamanli III HES

The aquatic organism field studies to identify the aquatic flora and fauna species in the Yamanli III HEPP area was conducted at Himmetli and Cumhurlu location. The current velocity of the stream is quite high and the bottom structure usually composed of clay. Because of the high flow rate, sampling of fishing was done the tributary of this stream (see Figure 4-11 and Figure 4-12).

Bank vegetation of the main stream is formed generally with *Salix* and annual, biennial herb and perennial herb. The width and depth of the sampling location is more than 20 m and 1 m, respectively. Bottom structure is composed of mud.

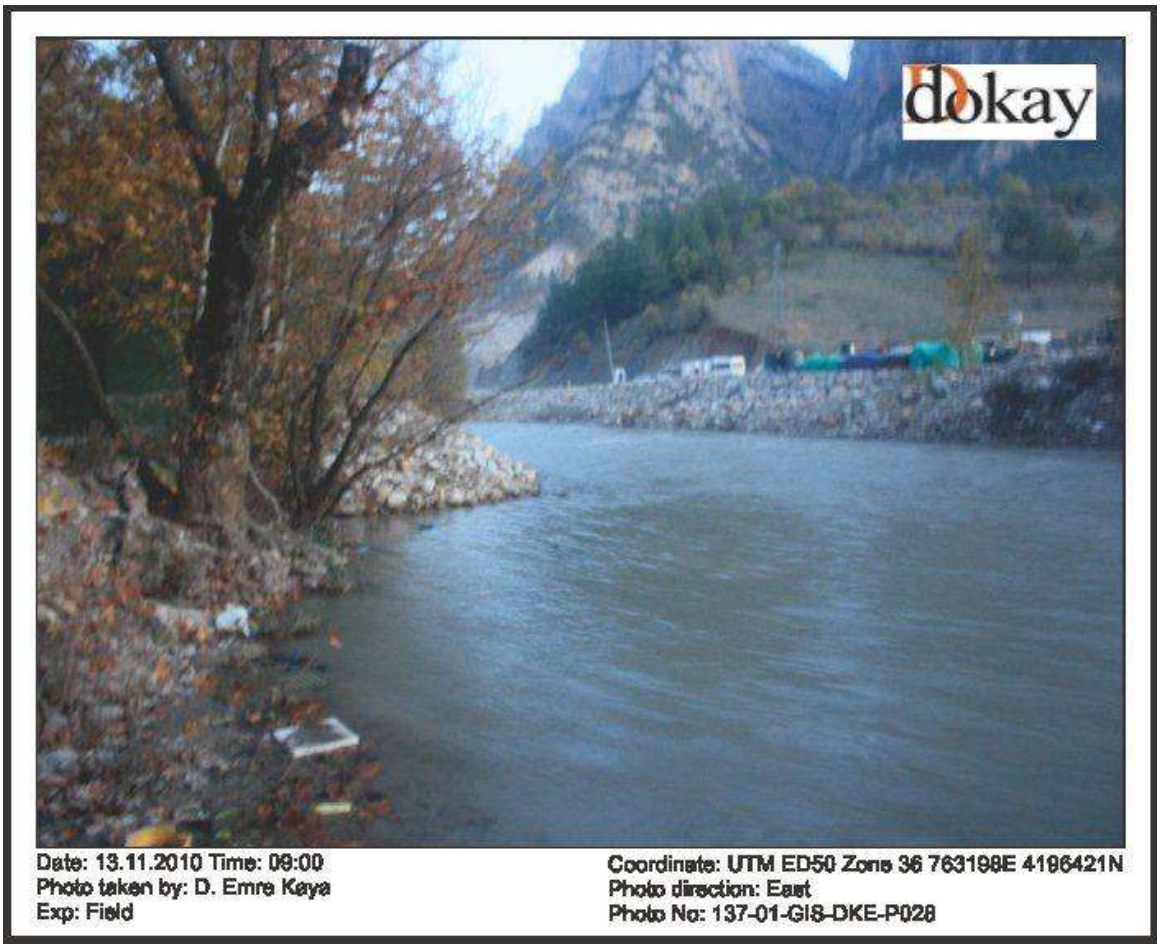


Figure 4-11 Sampling location of Himmetli, Cumhurlu Koyu-Yamanli III HEPP

Within the scope of aquatic flora, five species from Bacillariophyta and two species from Chlorophyta were identified. Bacillariophyta is dominant group with five species. In addition, *Navicula* and *Synedra* genus belong to Bacillariophyta phylum accepted as bioindicator genus in the pollutant water (Atıcı, 1997), are common in the sampling location. Microphyte determined in the sampling location is given in Table 4-12.

Table 4-12 Phytoplanktonic organisms and algae determined from the sampling location of Himmetli HEPP

PHYLUM	CLASS	ORDER	FAMILY	GENUS/ SPECIES
BACILLARIOPHYTA	BACILLARIOPHYCEAE	Cymbellales	Cymbellaceae	*Cymbella*
			Gomophonemataceae	*Gomphonema*
		Surirellales	Surirellaceae	*Surirella*
		Fragilariales	Fragilariaceae	*Synedra*
		Naviculales	Naviculaceae	*Navicula*
CHLOROPHYTA	CHLOROPHYCEAEA	Chlorococcales	Hydroictyaceae	*Pediastrum*
		Nostocales	Nostocaceae	*Anabaena*

Within the scope of aquatic invertebrates, one specie from Rotifera phylum (*Cephalodella ventipes*), one specie from Nematoda and one specie (*Tubifex tubifex*) from Annelida phylum were identified. Kazanci and Girgin (1998) expressed that Tubificidae belongs to Oligochaeta is accepted as bio-indicator animal that live in polluted water.

Sampling area according to the ecological characteristics is accepted as polysaprobic zone.

Electroshocker was used to catch the freshwater fishes in the sampling area. As a result of the fishing process, three species (*Squalius lepidus*-Chub; *Capoeta damascina* and *Alburnus danensis*-daba Bleak) from Cyprinidae family identified and none of them are categorized as protected and/or threatened species according to the Bern Convention (2002), IUCN Red List (2010) and CITES (2004), but *Alburnus adanensis* is an endemic species in Seyhan and Ceyhan river basins. The population density of this specie is quite high. Besides, some biological and ecological features of the fish species are presented at Appendix-G.

Figure 4-12 Tributary of Goksu River in the Himmetli-Yamanli III HEPP

4.4.7 Feke Creek - Feke I HEPP

Two sampling locations are selected to identify the aquatic flora and fauna elements from Feke I HEPP. One of them is located upstream and the other one is downstream. For this purpose, Asmaca Creek which is located at the upstream of the Feke Weir was studied. This sampling location is important to give some information about the aquatic organisms after the weir construction (see Figure 4-13).

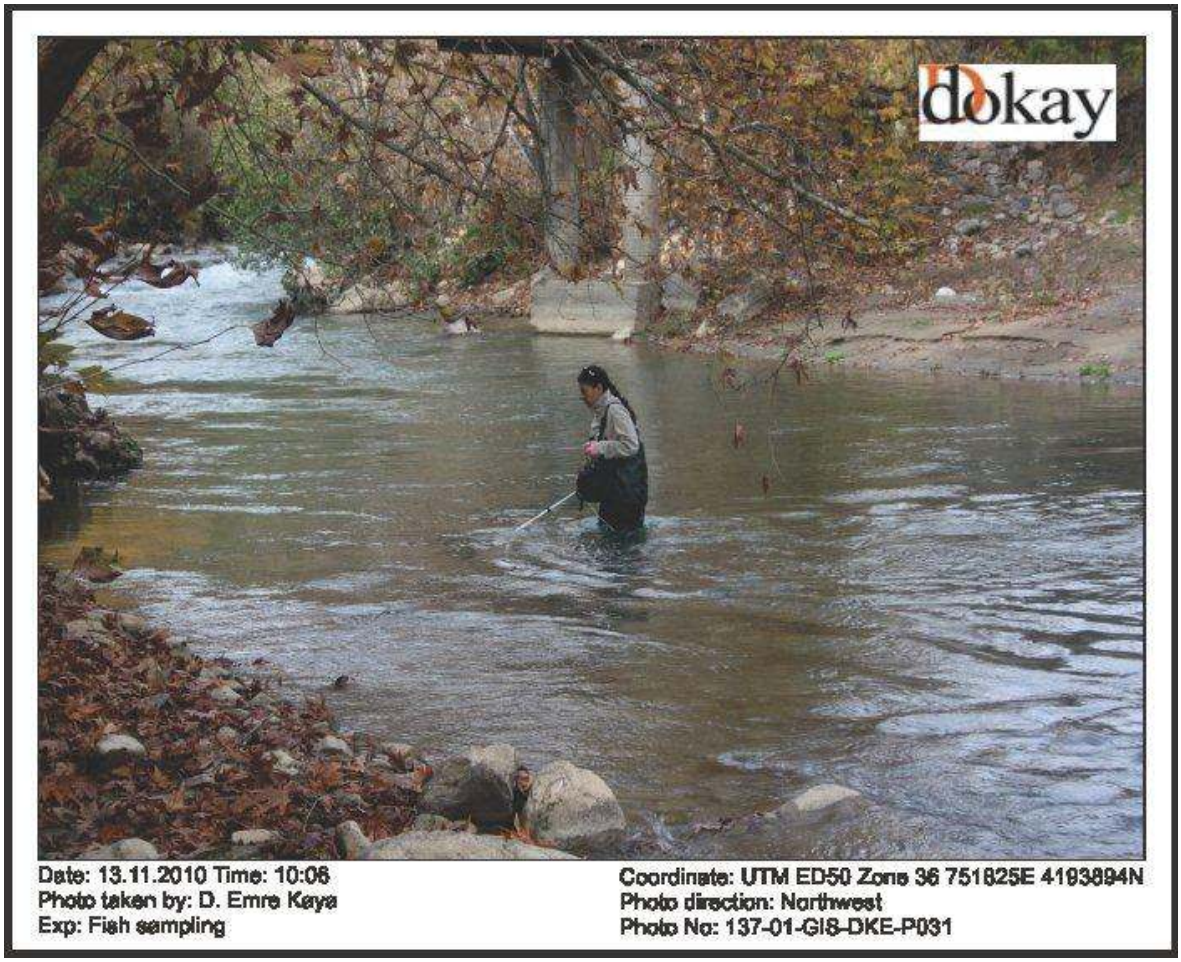


Figure 4-13 Asmaca Weir Sampling Location-II

The bottom structure of the creak is usually composed of gravel and stones, but there is muddy substratum in the bank of the stream. The bank vegetation is formed usually with trees (especially, plane tree) are found where the flow rate is high. The width and depth of the river is approximately 10 m and 15-60 cm (middle part of the stream), respectively.

Following to the aquatic flora survey, 5 species belong to Bacillariophyta and 2 species from Chlorophyta pyhlum were identified and *Oscillatoria* was dominant genus in the sampling location (see Table 4-13).

Table 4-13 Phytoplanktonic organisms and algae etermined from the sampling location of Feke I HEPP

PHYLUM	CLASS	ORDER	FAMILY	GENUS
BACILLARIOPHYTA	BACILLARIOPHYCEAE	Bacilloriales	Bacillariaceae	*Nitzcshia*
		Cymbellales	Cymbellaceae	*Cymbella*
			Gomophonemataceae	*Gomphonema*
		Fragilariales	Fragilariaceae	*Synedra*
		Naviculales	Naviculaceae	*Navicula*
CHLOROPHYTA	CHLOROPHYCEAEA	Chlorococcales	Hydroictyaceae	*Pediastrum*
		Oscillatoriales	Oscillatoriaceae	*Oscillatoria*

From zooplanktonic and benthic organisms, only two taxa, one of them from Nematoda and the other one from Diptera larvae (Chrinomidae) were identified. The sampling location was found quite poor in terms of invertebrate organisms.

Electroshocker was used to catch the freshwater fishes in the sampling area. As a result of the fishing three species (*Capoeta damascina, Alburnus adanensis*-Adana Bleak; *Garra rufa*-Doctor fish) from Cyprinidae family identified and none of them are categorized as protected and/or threatened species according to the Bern Convention (2002), IUCN Red List (2010) and CITES (2004), but *Alburnus adanensis* is an endemic species in Seyhan and Ceyhan river basins. The population density of this species is quite high. Besides, some biological and ecological features of the species are given in Appendix-G.

4.4.8 Feke II HEPP

The aquatic organism survey was done in the downstream of the Feke II HEPP. Current velocity of the sampling location is not very high and this situation is affected all the aquatic organisms species. The bank vegetation of the sampling area is formed by oak trees and annual, biennial herb and perennial herb. The width and depth of the sampling location is more than 20 m and 1 m, respectively. Bottom structure is composed of muddy, Stones and gravels (see Figure 4-14).

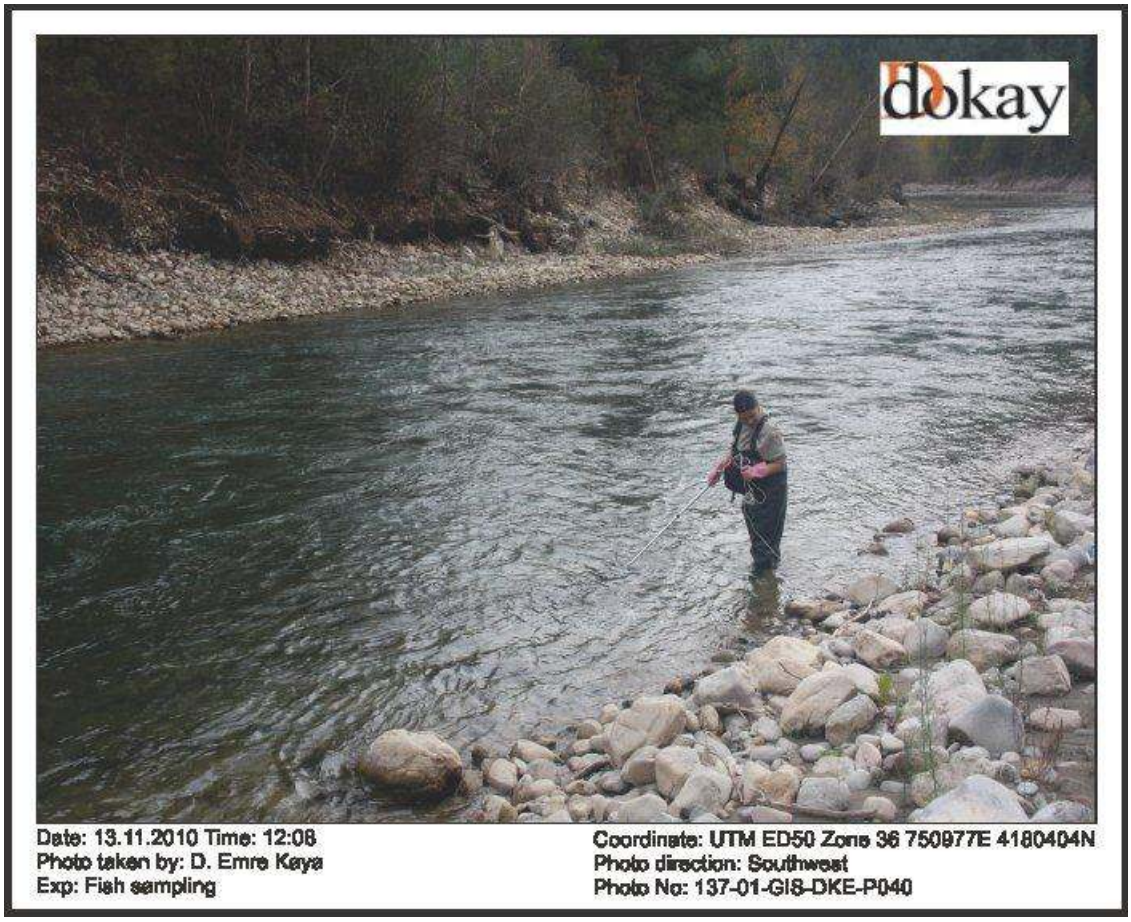


Figure 4-14 Sampling location of Feke II HEPP

According to the aquatic flora survey, 11 species belong to Bacillariophyta, 3 species from Chlorophyta and 3 species from Streptophyta pyhlum were identified in the sampling location (see Table 4-14).

Table 4-14 Phytoplanktonic organisms and algae determined from the sampling location of Feke II HEPP

PHYLUM	CLASS	ORDER	FAMILY	GENUS
BACILLARIOPHYTA	BACILLARIOPHYCEAE	Bacilloriales	Bacillariaceae	*Nitzcshia*
		Bidduphiales	Thalassiasiraceae	*Cyclotella*
			Catenulaceae	*Amphora*
		Cymbellales	Cymbellaceae	*Cymbella*
			Gomophonemataceae	*Gomphonema*
		Surirellales	Surirellaceae	*Surirella*
				Cymatopleura
		Fragilariales	Fragilariaceae	*Synedra*
		Naviculales	Naviculaceae	*Navicula*
				Gyrosigma
		Tabellariales	Taballeriaceae	*Tabellaria*
CHLOROPHYTA	CHLOROPHYCEAEA	Chlorococcales	Hydroictyaceae	*Pediastrum*
		Sphaeropleales	Scenedesmaceae	*Scenedesmus*
		Nostocales	Nostocaceae	*Anabaena*
HETEROKONTOPHYTA	CHRYSOPHYCEAE	Chromulinales	Chromulinaceae	*Dinobryon*
STREPTOPHYTA	ZYGNEMATOPHYCEAE	Zygnematales	Desmidiaceae	*Cosmarium*
				Staurastrum

According to the aquatic invertebrate survey, 6 species from Rotifera and one species from Cladocera / Arthropoda phylum were identified from the sampling location. This station has a stagnant waterbody and because of the zooplanktonic organism richness might be increased (see Table 4-15).

When the benthic organisms are examined, two taxa from Annelidae and two taxa from Athropoda phylum were identified. These taxa were also indicated the stagnant watercourse structure (see Table 4-15). Besides, Kazanci and Girgin (1998) expressed that Tubificidae belongs to Oligochaeta is accepted as bioindicator animal that live in polluted water. The sampling area according to the ecological characteristics is accepted as polysaprobic zone.

Table 4-15 Zooplanktonic and benthic organisms determined from the sampling location of Feke II HEPP

PHYLUM	CLASS	ORDER	FAMILY	GENUS
ROTIFERA*	EUTATORIA	Ploima	Synchaetidae	*Polyarthra vulgaris* Carlin, 1943
			Asplanchnidae	*Asplanchna priodonta* Gosse, 1850
			Colurellidae	*Colurella obtusa* (Gosse, 1886)
			Notommatidae	*Cephalodella ventriges* (Dixon-Nutall, 1901)
				Cephalodella gibba (Ehrenberg, 1832)
			Lecanidae	*Lecane closterocerca* (Schmarda, 1859)
ARTHROPODA	BRANCIOPODA*	Cladocera	Daphniidae	*Ceriodaphnia*

				quadrangula (Muller, 1785)
	INSECTA**	Diptera	. Chironomıdae	*Chironomus* sp
			Tabanidae	
ANNELIDA**		Haplotoxida	Tubificidae	*Tubifex tubifex* (Mueller, 1774)
		Arynchhobdellida	Hirudinidae	*Hirudo* sp.

* Zooplanktonic organisms ** Benthic organisms

Electroshocker was used and cast-net for hunting the freshwater fishes in the sampling area. As a result of the fishing two species (*Capoeta damascina, Garra rufa*- Doctor fish) from Cyprinidae family identified and none of them are categorized as protected and/or threatened species according to the Bern Convention (2002), IUCN Red List (2010) and CITES (2004), The population density of this species is quite high. Besides, some biological and ecological features of the species are given in Appendix-F.

4.4.9 Dogancay

Dogancay River is one of the main tributary of the Seyhan River. In this study, the upper part (upstream) of the Dogancay HEPP is examined to identify the aquatic organism inhabited in the stream.

The bank vegetation of the stream is generally formed with annual herb. Inside of the stream, mosses were dominant and stones covered mosses densely whereas there was no any floating and/or emergent macrophyte in the stream. The bottom structure of the stream composed of stones and mud (see Figure 4-15).

The width and depth of the sampling location is about 5 m and 10-40 cm, respectively. Current velocity was found very slow in this period.

According to aquatic flora survey, 3 species belong to Bacillariophyta and 2 species from Chlorophyta and 1 species from Streptophyta pyhlum was identified and *Anabeana* was dominant genus in the sampling location (see Table 4-16).

Table 4-16 Phytoplanktonic organisms and algae determined from the sampling location of Dogancay HEPP

PHYLUM	CLASS	ORDER	FAMILY	GENUS
BACILLARIOPHYTA	BACILLARIOPHYCEAE	Bidduphiales	Catenulaceae	*Amphora*
		Fragilariales	Fragilariaceae	*Synedra*
		Naviculales	Naviculaceae	*Navicula*
CHLOROPHYTA	CHLOROPHYCEAEA	Synechococcales	Merismopedioideae	*Merismopedia*
		Nostocales	Nostocaceae	*Anabaena*
STREPTOPHYTA	ZYGNEMATOPHYCEAE	Zygnematales	Desmidiaceae	*Cosmarium*

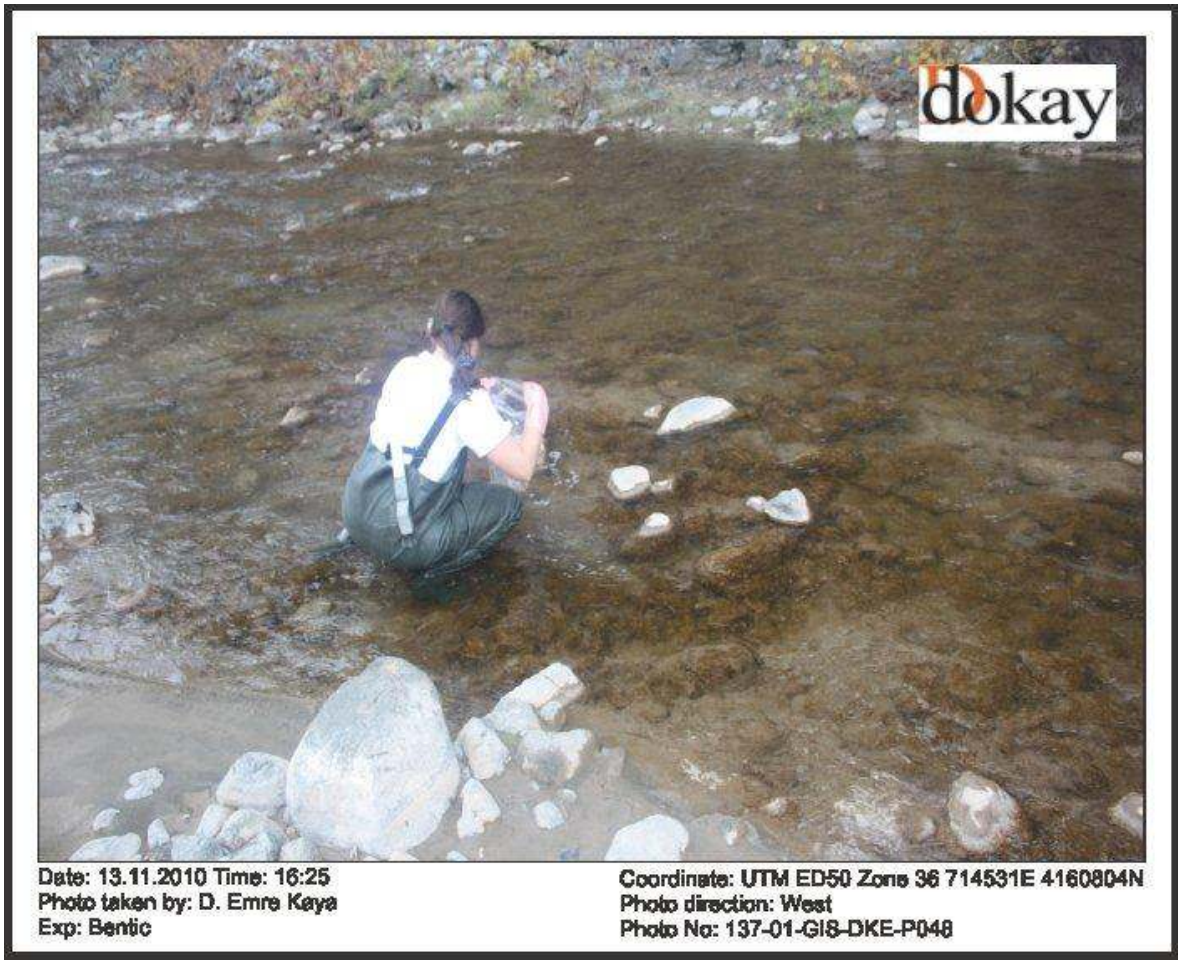


Figure 4-15 Sampling location of Dogancay HEPP

When aquatic invertebrate is examined, 3 zooplanktonic organisms from the Rotifera were identified. Besides, two benthic organisms (Chrinomid larvae and *Tubifex tubifex*) and one Nematoda species were identified (see Table 4-17). This invertebrate biodiversity indicated that the water quality of the stream was poor. Kazanci and Girgin (1998) expressed that Tubificidae species is accepted as bioindicator animal that live in semi polluted and/or polluted water.

Table 4-17 Zooplankronic and benthic organisms determined from the sampling location of Dogancay HEPP

PHYLUM	CLASS	ORDER	FAMILY	GENUS
ROTIFERA*	EUTATORIA	Ploima	Synchaetidae	*Polyarthra vulgaris* Carlin, 1943
			Colurellidae	*Colurella obtusa* (Gosse, 1886)
			Notommatidae	*Cephalodella ventriges* (Dixon-Nutall, 1901)
				Cephalodella gibba (Ehrenberg, 1832)
	INSECTA**	Diptera	Chironomıdae	*Chironomus* sp
ANNELIDA**		Haplotoxida	Tubificidae	*Tubifex tubifex* (Mueller, 1774)

* Zooplanktonic organisms ** Benthic organisms

For determination the freshwater fishes inhabited in the stream, electroshocker was used for capturing fish. As a result of fishing, one species (*Capoeta damascina*) from Cyprinidae family identified. Bio-ecological features of this species are given in Appendix-G.

4.4.10 Yedigoze HEPP

The sampling location of the Yedigoze HEPP area is located between the Yedigoze HEPP and Uctepe HEPP. The width of the sampling location is about 60 m, and the depth is 30 cm close to the bank whereas its more than 1.5 m in the central part of the river. Bank vegetation of the sampling location is usually composed of trees and bottom structure is formed with densely clay (see Figure 4-16).

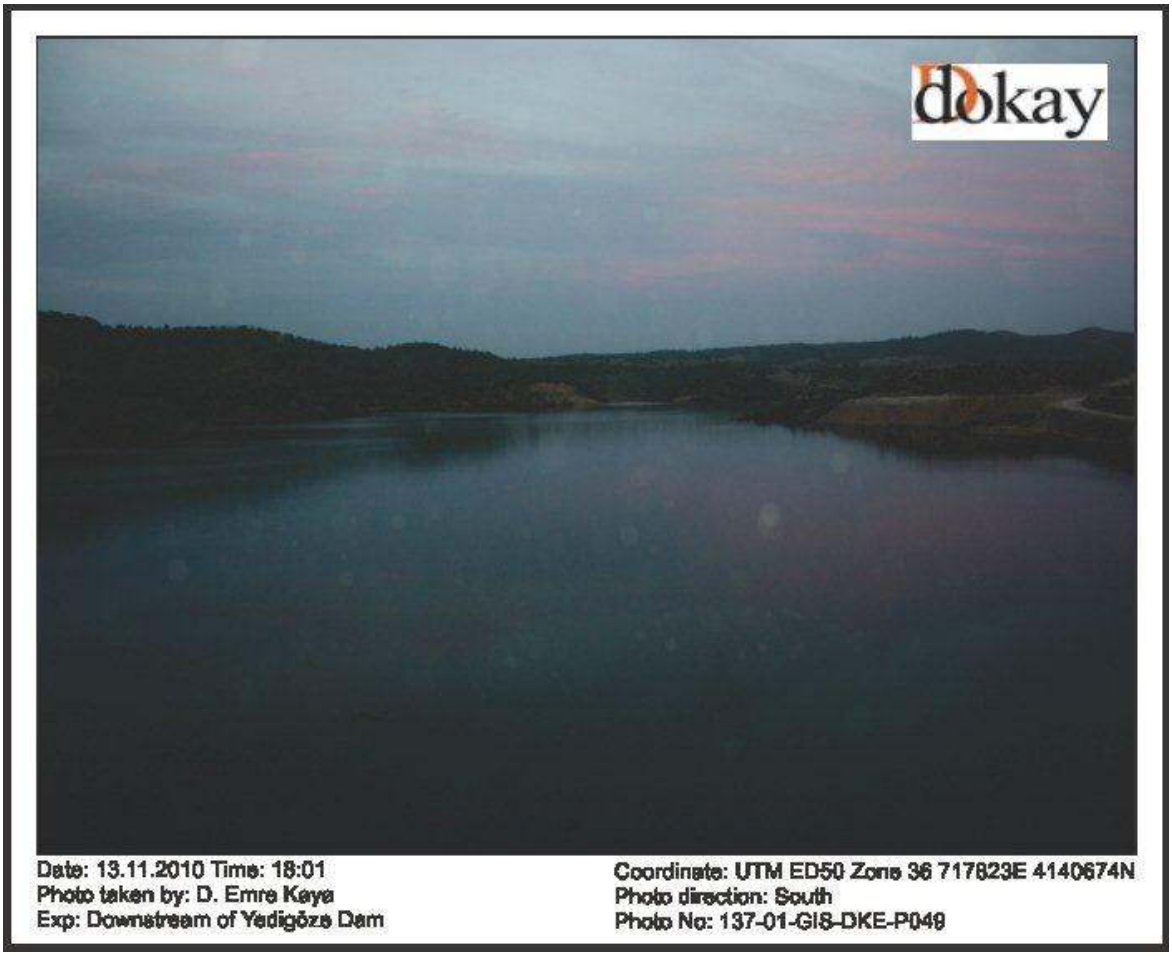


Figure 4-16 Sampling location of Yedigoze HEPP

The river is lacked of floating, submerged and/or emergent plants. For identification the algae (attached form) and phytoplankton (free form) content of the river, Bacillariophyta was found dominant group as in other sampling location. Besides, *Oscillatoria* belongs to Cyanophyta and *Navicula* from Bacillariophyta was determined the dominant genus with high population density (see Table 4-18).

Table 4-18 Phytoplanktonic organisms and algae determined from the sampling locations of Yedigoze HEPP

PHYLUM	CLASS	ORDER	FAMILY	GENUS
BACILLARIOPHYTA	BACILLARIOPHYCEAE	Bidduphiales	Thalassiasiraceae	*Cyclotella*
		Cymbellales	Cymbellaceae	*Cymbella*
		Naviculales	Naviculaceae	*Navicula*
				Gyrosigma
CHLOROPHYTA	CHLOROPHYCEAEA	Oscillatoriales	Oscillatoriaceae	*Oscillatoria*
STREPTOPHYTA	ZYGNEMATOPHYCEAE	Zygnematales	Desmidiaceae	*Staurastrum*

This sampling location was also poor structure in terms of zooplanctonic and benthic organisms. Following to the aquatic invertebrate survey, 3 species from Rotifera were identified from the sampling location. Besides, two taxa from Annelidae and one taxa from Athropoda was identified (see Table 4-19). Kazanci and Girgin (1998) expressed that Tubificidae belongs to Oligochaeta is accepted as bio-indicator animal that live in polluted water. This river is classified as Class II (slightly polluted) in water quality criteria according to the results of nitrate, total phosphorous, color.

Electrofishing device was used in the river bank because of the clay bottom structure of the river and *Luciobarbus pectoralis* (Barbel), *Capoeta damascina* (Ray-finned Fish), *Garra rufa* (Doctor fish) ve *Alburnus adanensis* (Adana bleak) from Cyprinidae were identified. Moreover, *Silurus glanis* (Wels) and *Cyprinus carpio* (Carp) which was escaped from the dam lake, is inhabited the depth part of the river in terms of the knowledge about literature and conservation with local people.

Table 4-19 Zooplankronic and benthic organisms determined from the sampling location of Yedigoze HEPP

PHYLUM	CLASS	ORDER	FAMILY	GENUS
ROTIFERA*	EUTATORIA	Ploima	Synchaetidae	*Polyarthra vulgaris* (Carlin, 1943)
			Asplanchnidae	*Asplanchna priodonta* Gosse, 1850
				Cephalodella gibba (Ehrenberg, 1832)
			Lecanidae	*Lecane closterocerca* (Schmarda, 1859)
ARTHROPODA	INSECTA**	Diptera	Chironomıdae	*Chironomus* sp
ANNELIDA**		Haplotoxida	Tubificidae	*Tubifex tubifex* (Mueller, 1774)
		Arynchhobdellida	Hirudinidae	*Hirudo* sp.

* Zooplanktonic organisms ** Benthic organisms

4.4.11 General Assessment of Aquatic Ecological Characterization

Aquatic ecosystem characterization field study regarding to determine the CIA of Goksu River is summarized below:

- According to the results of field study in terms of phytoplankton and algae diversity, Bacilloriophyta is dominant in all sampling locations. Also, significant groups with

respect to their quantitative and qualitative characteristics both in the river freshwater of Turkey and all around the world.

- Both *Navicula* and *Synedra* was the dominant genus within the Bacilloriophyta. Atıcı (1997) mentioned that *Navicula* and *Synedra* genus belong to Bacillariophyta phylum accepted as bio-indicator genus in the pollutant and/or slightly pollutant water which is polluted because of the organic waste.
- Floating, submerged and emerged vegetation within the streams was found poor. Besides, mosses are common nearly at all sampling locations.
- Zooplanktonic organisms, Rotifera species are common as other freshwater inlands in Turkey, but species diversity is poor in result of field study.
- Observed benthic organisms at the sampling locations; Diptera larvae were dominant almost all sampling locations. Besides, *Tubifex* from Annelidae phylum is a bio-indicator species in the polluted waters.
- As a result of fishing in sampling location, one specie (*Silurus glanis*) from Siluridae, six species (*Alburnus adanensis*, *Luciobarbus pectoralis, Capoeta damascina*, *Squalius lepidus, Garra rufa*) from Cyprinidae family were identified.
- Among the identified freshwater fishes in the field study, *Alburnus adanensis* (Adana bleak) is an endemic species in Seyhan and Ceyhan river basins. The population density of this specie is quite high in the CIA study area. This specie is frequently living in the slightly flowing, sandy and pebble areas and well adapted to the still water systems, therefore, it won't be negatively affected by the planned HEPPs.
- *Silurus glanis* (Wels) inhabited in the Yedigoze HEPP area is evaluated as 'protected species' according to the Bern Convention Appendix III in European. This species prefer to live generally in deep and still part of the big river system, therefore, it won't be negatively affected by the planned HEPPs.
- Native population of *Cyprinus carpio* (Wild carp) is categorized as vulnerable–VU according to the IUCN Red List (2010) criteria, but this criteria is included the River Danube subpopulation where native forms are lived. So, this species is not protected status in Turkish inlands and also it prefers to live in still and deep water system.
- *Alburnus orontis* (Bleak) is evaluated as *endangered fish species according to the IUCN Red List,* is inhabited Karaisali location in the downstream of the Seyhan River. So, this species is not negatively affected by planned HEPP.

5. CUMULATIVE IMPACT ASSESSMENT

5.1 Methodology of Cumulative Assessment

As mentioned in the previous sections, during the operation phase of the HEPPs, the most significant potential cumulative impacts will be observed in aquatic environment. These potential impacts include:

- Change of water flow regime from a river system to a series of lakes;
- Change of water quality; and
- Change of aquatic ecological characteristics of the Goksu River.

A field study, including flow measurements, surface water quality measurements and determination of aquatic ecological characteristics, was performed in order to set baseline conditions and assess potential impacts of the HEPPs accordingly.

The assessment of cumulative impacts of the HEPP projects in the Goksu River has been carried out considering the results of these field studies and report on "Cumulative Impact Assessment of HEPP in Seyhan River Basin" prepared by DOKAY in August 2010.

One of the main impacts of HEPPs on aquatic environment is that HEPP disturbs the continuity of aquatic environment in the river. Fish ladder in the HEPP enables fish movements between upstream and downstream of the project. In this report, the Goksu River is divided into segments considering fish movements in the aquatic environment. A HEPP project not having fish ladder is the end point of one segment while it is the beginning point of the other one since it prevents fish passage from one segment to the other. As given in Table 5-1, Feke II Dam and HEPP, Kavsak Bendi Dam and HEPP and Yedigoze Sani Bey Dam and HEPP projects do not have fish ladders. The other projects on Goksu River and Dogancay Creek enable fish passage from upstream to downstream or vice versa. In this report, cumulative impacts of the projects of concern will be assessed for three segments presented in Appendix-F.

Table 5-1 Features of Concerned Projects Related to Flow Regime and Fish Passage

Name	Design Flow (m^3/sec)	Annual Average Flow (current situation) (m^3/sec)	Annual Average Flow (future situation) (m^3/sec)	Minimum Environmental Flow (m^3/sec)	Maximum Environmental Flow (m^3/sec)	Fish Passage
Yamanli I Weir and HEPP*	-	-	-	-	-	-
Yamanli II Weir and HEPP	20	-	-	0.68	No maximum	Yes
Saimbeyli Weir and HEPP	5.5	-	-	0.4 **(June-February)**	0.75 **(March-May)**	Yes
Gokkaya Dam and HEPP	42.78	-	-	2.5 **(June-February)**	5.0 **(March-May)**	Yes
Himmetli Weir and HEPP	49	27.64	27.05	3.0 **(June-February)**	7.0 **(March-May)**	Yes
Feke I Weir and HEPP	55.8	-	-	2.0	No maximum	Yes
Feke II Dam and HEPP	128	51.17	-	No flow loss due to type of the HEPP (powerhouse at the toe)		No
Menge Dam and HEPP	180	-	-	No flow loss due to type of the HEPP (powerhouse at the toe)		Yes
Kusakli Weir and HEPP	180	50.57	49.83	No flow loss due to type of the HEPP (powerhouse at the toe)		Yes
Kopru Dam and HEPP	190	-	-	No flow loss due to type of the HEPP (powerhouse at the toe)		Yes
Kavsak Bendi Dam and HEPP	-	-	-	9.42	No maximum	No
Dogancay Weir and HEPP	17.65	10.48	-	0.25 **(June-November)**	1.0 **(December-May)**	Yes
Yedigoze Dam and HEPP	9.308	144.6	143	No flow loss due to type of the HEPP (powerhouse at the toe)		No

* There is no information about Yamanli I Weir and HEPP Project.

5.2 Cumulative Impacts on Water Flow Regime

To elaborate a more detailed understanding of the prevailing flow regime along the Goksu River section of interest, flow rate measurements have been carried out at twelve different stations (weirs and dam axis) along two tributaries of Seyhan River namely Goksu River and Dogancay Creek. Measurements have been performed in November, 2010. This period can be considered in a season with lower precipitation amount which means the lowest flow value might have been observed from the field study. Details of the field study are given in Section 4.2.

In this Section, cumulative impacts of the HEPP Projects on water flow regime are discussed regarding the flow rate measurement results and project features mentioned in the individual EIA Reports.

Water flow regime along the Goksu River section will be affected from the HEPP Projects in two ways.

- Decrease in water level in the riverbed in-between weir and HEPP; and
- Change in water flow regime of river system due to dams.

In some of the HEPP projects (namely Yamanli I Weir and HEPP, Yamanli II Weir and HEPP, Saimbeyli HEPP, Gokkaya Dam and HEPP, Himmetli HEPP, Feke I HEPP, Kavsak Bendi Dam and HEPP, Dogancay Dam and HEPP), while most of the river flow is diverted from weir or dam to HEPP via energy tunnel, some amount of the flow, called environmental flow, is released to the riverbed in order to maintain continuity of aquatic life. Therefore, water flow between weir or dam and HEPP is expected to decrease. Environmental flow to be released from each Project is given in Table 5-2.

Table 5-2 Flow Measurement Results and Estimated Future Flow Depths for Lower Flow Sections

Lower Flow Section No.	Lower Flow Section	Flow Measurement Results						Environmental Flow (m^3/s)		Estimated Depth* (m)		Estimated Width* (m)	
		Location No.	Measurement Location	Flow Rate (m^3/s)	Max. Water Depth (m)	Flow Width (m)	Cross-sectional Area (m^2)	Max.	Min.	Max.	Min.	Max.	Min.
1	Yamanli I Weir and HEPP	4	Goksu Kaleboynu	5.160	0.85	17.0	11.31	-	0.68	-	0.26	-	9.90
2	Yamanli II 1st Stage Weir and HEPP	4	Goksu Kaleboynu	5.160	0.85	17.0	11.31	-	0.68	-	0.26	-	9.90
3	Yamanli II 2nd Stage Weir and HEPP	4	Goksu Kaleboynu	5.160	0.85	17.0	11.31	-	0.68	-	0.26	-	9.90
4	Gokkaya Dam and HEPP	9	Yardibi	10.830	2.50	18.0	26.92	5.00	2.50	1.59	1.03	15.00	9.49
5	Saimbeyli Weir and HEPP	11	Saimbeyli Deresi	0.467	0.32	6.5	1.22	0.75	0.40	0.34	0.23	9.96	7.56
6	Himmetli Weir and HEPP	8	Yamanli III (Himmetli)	11.549	2.15	10.5	15.74	7.00	3.00	1.51	0.90	9.50	8.50
7	Feke I Weir and HEPP	3	Feke I Weir	11.620	1.61	10.5	11.23	-	2.00	-	0.41	-	6.28
8	Kavsak Bendi Dam and HEPP	5	Kavsak Bendi	69.190	4.04	24.0	59.04	-	9.42	-	1.21	-	13.43
9	Dogancay Weir and HEPP	2	Dogancay	0.468	0.30	5.5	1.21	1.00	0.25	0.45	0.16	9.20	4.79

* Depth and width are estimated according to commited environmental flow that is going to released from HEPP at the operational phase

In the HEPP projects, where powerhouse is at the toe of the dam (namely, Feke II Dam and HEPP, Menge Dam and HEPP, Kusakli Weir and HEPP, Kopru Dam and HEPP and Yedigoze Dam and HEPP), flowing water is collected in the reservoir and then sent to the powerhouse. Therefore, no loss of flow will be observed due to this type of HEPP Projects.

In this section of the CIA Report, sections with lower flow rate due to environmental flow are defined and presented. Moreover, based on the flow measurement results and environmental flow rate given in the individual EIA Reports, flow depth and flow width of the sections with lower flow rate are estimated by using GIS tools. Figures displaying the water level in the cross sections with the lower flow rate are also prepared at GIS based and given in Appendix-H. Flow measurement results and estimated future flow characteristics are given in Table 5-2. During estimation process, it is assumed that cross sections of the flow measurement locations representing the associated section of river with lower flow rate. Moreover, since flow measurements were conducted at arid period, it is thought that the estimated water levels based on the results of these measurements will represent the worst case scenario likely to occur in arid periods.

In the Segment 1 of the Goksu River section of concern (see Appendix-H), almost all projects (except Feke II Dam and HEPP) have energy tunnel, and therefore decrease in water level in some sections of the river is expected. Total length of Goksu River section, of concern, is approximately 165 km. River flow will decrease in a total of 52 km length calculated in GIS regarding design values mentioned in the individual EIAs of the Projects located in the Segment 1. Sections with lower flow rate are presented in the map in Appendix-H.

As seen in the map, water level is expected to decrease at seven different sections in Segment 1 of the River. One of these sections is in the Saimbeyli Creek (one of the tributary of Goksu River). As seen in Table 5-2, minimum water level in-between Saimbeyli Weir and Saimbeyli HEPP in the operation phase is estimated as 0.23 m. Similarly, water level for three sections, (i) between Yamanli I Weir and Yamali HEPP, (ii) between Yamanli II 1st Stage Weir and Yamanli II 1st Stage HEPP and (iii) between Yamanli II 2nd Stage Weir and Yamanli II 2nd Stage HEPP, along the Goksu River in the operation phase is estimated as 0.26 m (see Table 5-2). Other minimum water levels expected to observe in the sections of lower flow rate are higher than 0.4 m.

Dam and HEPP projects dominate in the Segment 2 of the Goksu River of concern (see Appendix-F). There is only one weir and HEPP project (Kusakli Weir and HEPP) which is a run-of-river type HEPP. Therefore, there will be no flow loss in the riverbed of this segment. Instead, this segment will predominantly behave like a lake system due to dam reservoirs. River water in this segment (between Feke II Dam and HEPP and Kavsak Bendi Dam and HEPP) will almost behave as a still water system. Since river water will be

held in the reservoir of these projects, there will not be peak flows in the river, i.e. dams will regulate the flow regime in the riverbed.

In the Segment 3 of the study area (see Appendix-F), there will be energy tunnel and powerhouse of Kavsak Bendi Dam and HEPP Project as well as Dogancay Weir and HEPP Project and Yedigoze Sani Bey Dam and HEPP Project. There will be two sections of lower flow with a total length of 12 km. One with a length of approximately 2 km belongs to Kavsak Bendi Dam and HEPP Project and the other one with a length of nearly 10 km belongs to the Dogancay Weir and HEPP Project (see Appendix-H). As seen in Table 5-2, between Dogancay Weir and Dogancay HEPP units, the flow depth due to environmental flow is estimated as 0.16 m which is the lowest depth among the other estimated ones. Regarding the measured water depth (0.30 m), it is seen that water depth will be half of the current depth during operation phase. On the other hand, current water depth measured for Kavsak Bendi Dam and HEPP Project (4.04 m) is expected to decrease to 1.21 m (see Table 5-2).

Construction of Yedigoze Sani Bey Dam and HEPP Project has been completed and it is in impoundment phase. The total reservoir area of the Project is expected to be 16.5 km^2, which is a large area. Since the reservoir area of Yedigoze Sani Bey Dam and HEPP is very large, this segment might behave like a lake environment.

5.3 Cumulative Impacts on Water Quality

Surface water samplings and analyses have been conducted at 12 locations on the Goksu River in order to determine baseline water quality. Details of the study and results are given in Section 4.3 and Table 4-5.

As seen in Appendix-D, the first five water quality sampling locations are within the "Segment 1". When results of water quality analyses belong to Segment 1 are assessed, it is seen that quality of water is in Class I with respect to many parameters including heavy metals, dissolved oxygen and so on. On the other hand, analyses results of S4 (under Yamanli III Weir) and S5 (Feke I Weir) indicate that wastewater discharges might have been done by near-by villages. Fecal Coliform and Total Coliform Bacteria, BOD and COD results indicate an organic pollution especially in the downstream part of the Segment 1. Organic pollution and higher TSS concentration at the downstream part of this segment as well as Oil and Grease concentration at two locations (namely Saimbeyli Creek and under Yamanli III Weir) might have been as a result of construction activities of the HEPP Projects.

There will be seven HEPPs operating within the Segment 1. Five of these HEPPs are AKENERJI Projects. HEPPs in this segment are run-of-river type HEPP except Gokkaya Dam and HEPP and Feke II Dam and HEPP Projects.

In the operation phase of these HEPPs, as a result of change in water flow regime (i.e. river system to a series of lakes system and sections of lower flow rate), evaporation rate will increase and therefore, salinity of water system will increase especially in summer period. Since there will be two dams (Gokkaya Dam and Feke II Dam) with small reservoir areas in this segment, increase in salinity due to dams is expected to be at low level. In addition, temperature of water in the section with lower flow rate (see Appendix-H) is expected to increase as a result of a decrease in water depth. Another impact on lower flow rate sections of river might be a change in DO levels of the water.

During field study, small villages, namely Himmetli and Yardibi villages, were observed close to the HEPP projects of AKENERJI. It was also observed that these villages have no sewage systems. Results of water quality analysis performed at a location close to these villages indicate an organic pollution originating from wastewater discharges of these villages. In the operation phase of the HEPPs, surface water quality of the sections with lower flow is expected to be negatively affected from wastewater discharges.

In the operation phase of the HEPPs with reservoirs, an important effect on water quality will be an increase in nitrogen concentration due to nitrification within the reservoir. Anaerobic conditions to dominate in the deeper part of the reservoir will further the conversion of organic nitrogen to ammonia and cause an increase in ammonia

concentration. Nitrosomonas and Nitrobacter in the upper part of the reservoir, convert the ammonia to nitrite and nitrate in the presence of oxygen, nitrification. Nitrification process likely to occur in the reservoir area causes an increase in nitrogen concentration and thus a decrease in surface water quality. Increase in nitrate concentration and presence of phosphate, which was measured at high concentration in the sample taken from S4 and S5, might cause an increase in phytoplanktons in the water body. This causes eutrophication. Indeed, as the phytoplanktons die and decompose, organic matter get in high levels and the decomposing organisms deplete the water of available oxygen.

In the impoundment phase and early operation phase of the HEPPs with reservoir, change in water quality as a result of nitrification which is furthered from the roots of plants at the bottom of reservoir is expected.

Domestic wastewater will be generated from the personnel during the operation phase of the HEPP projects. Surface water and groundwater may be contaminated due to improper handling and discharge of domestic wastewater. Necessary infrastructure should be present in the HEPPs in accordance with the related legislation. The wastewater generation resulting from each project and treatment methods have been assessed in individual EIAs in accordance with the Turkish "*Water Pollution Control Regulation*". The cumulative impact of domestic wastewater is rated as low because the extent of the impact is restricted and the severity is mild.

As seen in Appendix-D, the water quality sampling locations of S7, S8, S9 and S10 are within the "Segment 2". When results of water quality analyses belong to Segment 2 are assessed, it is seen that quality of water is in Class I with respect to many parameters including heavy metals, dissolved oxygen and so on. On the other hand, analyses results of S7 (Feke II Dam) indicate that wastewater discharges might have been done. Fecal Coliform and Total Coliform Bacteria and COD results indicate an organic pollution at this location. It can be said that construction activities of the HEPP projects in the Segment 2 do not cause any negative impacts on the water quality of the river.

There will be four HEPPs operating within the Segment 2. HEPPs in this segment are in general HEPP with powerhouse at the toe of dam, except Kavsak Bendi Dam and HEPP and Kusakli Weir and HEPP projects. Dam lakes will dominate at this segment in the operation phases.

As mentioned in the above paragraphs, in the operation phase, water quality is expected to be negatively affected by nitrification process likely to occur in dam lakes and eutrophication.

In the impoundment phase and early operation phase of these HEPPs, change in water quality as a result of nitrification which is furthered from the roots of plants at the bottom of reservoir is also expected.

As seen in Appendix-D, the water quality sampling locations of S11 and S12 are within the “Segment 3”. When results of water quality analyses belong to Segment 3 are assessed, it is seen that quality of water is in Class I with respect to many parameters including heavy metals, dissolved oxygen and so on. On the other hand, water quality classes change with respect to other parameters.

There will be two HEPPs operating within the Segment 3, namely Dogancay Weir and HEPP and Yedigoze Sani Bey Dam and HEPP. The total reservoir area of the Yedigoze Sani Bey Dam and HEPP Project, which is in the impoundment phase, is expected to be 16.5 km^2. Since the reservoir area is very large, this segment might behave like a lake environment.

As mentioned in the above paragraphs, in the impoundment phase and early operation phase of the Project, change in water quality as a result of nitrification which is furthered from the roots of plants at the bottom of reservoir is expected.

On the other hand, in the operation phase of the Dogancay Weir and HEPP and Kavsak Bendi Dam and HEPP, as a result of change in water flow regime, evaporation rate will increase and therefore, salinity of water system will increase especially in summer period. In addition, temperature of water in the sections with lower flow rate (see Appendix-H) is expected to increase as a result of a decrease in water depth. Another impact on lower flow rate sections of river might be a change in DO levels of the water.

5.4 Cumulative Impacts on Aquatic Environment

To elaborate a more detailed understanding of the aquatic ecological characteristics along the Goksu River the impacts on aquatic environment by water flow regime and water quality results are assessed with each other. As it is mentioned before, three separated field studies are conducted to determine water flow regime, water quality and aquatic ecological characterization. Details of these field studies are given in Chapter 4 and cumulative impacts are discussed at above sections.

HEPPs have both *negatively and positively* affect on aquatic ecosystem depending on change in water flow regime and water quality. Biodiversity of fish can be affected due to these changes. The vital water quality limit values and flow regimes are given at Table 5-3. The cumulative impacts on fish at segments are determined according to this table. The vital limit values are necessary. Fish can continue its lifetime if the existing values are acceptable for Class I water quality however there can be changes of its lifetime period such as reproduction, growing, and migration season etc.

Table 5-3 Vital habitat properties for freshwater fish species

Latin Name		English Name	Vital Water Quality Criteria for Fish (Maximum)							Habitat (Stream: S; Lake:L, River: R)		Spawning Habitat Character	
			Temperature (C^o)	pH	DO (mg/L)	NH_4-N (mg/L)	o-PO_4 (mg/L)	Turbidity (mg/l)	NO_2-N (mg/L)	Spawning	Juvenil	Temperature. (C^o)	Current velocity (cm/sec)
CYPRINIDAE													
	Cyprinus carpio,	Carp	5-32	6.0-8.5	> 5	0.09	0.5	400	0.09	R/L	R/L	14-22	< 5
	Alburnus adanensis	Adana Bleak	8-27	6.0-8.5	> 5	0.09	0.5	400	0.09	R/L/S	R/L/S	13-15	20-50
	Luciobrbus pectorlis	Barbel	8-29	6.0-8.5	> 5	0.09	0.5	400	0.09	R/L/S	R/L/S	12-20	35-49
	Capoeta damascina	-	10-32	6.0-8.5	> 5	0.09	0.5	400	0.09	R/L/S	R/L/S	12-22	20-50
	Garra rufa	-	8-30	6.0-8.5	> 5	0.09	0.5	400	0.09	S/R	R/L/S	12-20	20-50
	Squalius lepidus	Chub	8-30	6.0-8.5	> 5	0.09	0.5	400	0.09	S/R	R/L/S	12-20	15-75
SILURIDAE													
	Silurus glanis	Wels	5-32	6.0-8.5	> 5	0.09	0.5	400	0.09	R/L	R/L	14-22	< 5

The positive effects of planned dams and weirs on the fish fauna in the CIA Study Area are listed below:

- Construction of dams will cause change in flow of rivers and creeks by changing running water to still water. This causes increase the population density and species diversity of phytoplanktonic organisms, algae and zooplanktonic organisms.

- Weirs and dams may prevent the possible flood by means of the water control, therefore may have positive effects upon the species living in the low flowing and still water regimens.

- The accumulated water in the dam lake area will cause the water quality increase. The water quality of environmental flow will affect water quality of river which will create an appropriate environment for the fish species in this habitat.

- As the productivity of the dams will increase in the first years following the water retention in the dams, some fresh water fishes (*Alburnus adanensis, Capoeta damascina, Luciobarbus pectoralis, Squalius lepidus, Garra rufa*) such as will be positively affected for growing.

- According to Table 4-2, most of the existing current velocities are higher than necessary current velocity for habitat of observed fish. However, this doesn't affect the fish because fish have adopted existing current velocity to live and spawn. One and only negative effect for fish is they cannot grow larger because of the high current velocity which will change due to dam construction. Dams will cause still water rather than river. So that fish will get larger in the future.

On the other hand, the negative effects of the dams and weirs can be categorized as follows:

- According to Section 5.3, there is no fish ladder in Feke II Dam and Kavsak Bendi Dam. The passage of fish is blocked however there is no migrating fish elaborated in the CIA Study Area. Fish use the tributaries in the same segment

- The existing fish species will negatively be affected from the water level change during the reproduction period. Decrease in water flow rate and depths will occur however this situation will not affect fish movement since the future water flow rate and depths are at acceptable levels.

- Due to the fact that dams limit the reproduction of the species which live and reproduce particularly, a gen decrease will occur depending upon the population decrease or interspesific increase.

- Although the environmental flow that is going to be released from dams is lower in terms of heat, it will increase degree by degree towards to the downstream of the stream water as from its release. The dissolved oxygen will be higher in the area of releasing and will become acceptable after few kilometers.

- The transformation from running water to still water regime may cause some negative effects in the distribution and nutrition pattern of some stream water fish species however these species may maintain their life in the tributaries.

- The water quality is affected due to construction of HEPP projects. According to Table 4-5, in some parts of the Goksu River NO_2-N and NH_4-N parameters are higher than vital limit values given at Table 5-3 for freshwater fish species. At Cukurkisla and Saimbeyli Creek locations NO_2-N is higher than vital limit value 0.09 mg/L. At Asmaca Creek, Feke II Dam and Dogancay Creek locations NH_4-N is higher than vital limit value 0.09 mg/L. These parameters are diluted with tributaries so that habitat of fish doesn't be affected.

In order to minimize such effects, the following suggestions should be considered:

- In order not to affect the existing species negatively during the construction stage of HEPP's, precautions and monitoring programme should be actualized. The water flow especially during the reproduction period of fish between April and July should not be cut-off.

- Following the water retention in the dams, some fresh water fishes such as *Alburnus adanensis, Capoeta damascina, Luciobarbus pectoralis, Squalius lepidus, Garra rufa* will get larger.

- The dam reservoirs cause economic benefit for fish market. If this situation is planned for CIA Study Area, the new fish species should be selected according not to harm any existing fish species. Population density of these economical benefited fish should be monitored regularly

- The required vital water depth must be provided with acceptable environmental flow. The minimum water depth should be 10 – 50 cm, and current velocity must be 20 – 50 cm/sec.

- Considering all the issues above mentioned, diversity and population density of the aquatic organisms inhabited in the CIA Study Area should be controlled by long-term bio-monitoring programme both in construction and operating period for avoiding the negative impacts of the planned HEPPs. This monitoring programme and locations according to impact assessment on fish are discussed in Chapter 6.

6. ENVIRONMENTAL MONITORING

Environmental monitoring studies are being conducted for HEPP projects of ENERJISA. These studies are designed to monitor cumulative impacts of the HEPP projects in the basin on seasonal water quality and fish fauna.

In this section of the report, environmental monitoring studies for AKENERJI Projects are suggested regarding the results of field studies (flow measurements, water quality analysis and aquatic ecological characteristics determination study) as well as cumulative impacts of the HEPPs on water regime, water quality and aquatic life.

6.1 Water Flow Regime Monitoring

As mentioned in the Section 4.2 of this report, flow measurements at 12 critical locations in terms of likeliness of flow regime change have been carried out at a period of minimum flow. By using flow measurement results, current flow characteristics and relationship between flow rate and water depth in a cross-section are evaluated and assessed. River sections with lower flow rate and flow depth are determined and assessed in Section 5.1

As a result of cumulative assessment given in the Section 5, water flow regime monitoring study locations are determined considering AKENERJI Projects and presented on the map in Appendix-I. As seen on the map, four locations are suggested for water flow regime monitoring study. Since flow rate and flow depth in the riverbed is important for the continuity of aquatic life, lower flow sections to be occurred between the units of the HEPP Project are critical. Therefore, three of the monitoring locations numbered 2, 3 and 4 are the ones belonging to the lower flow sections. The first monitoring location is in the downstream of Yamanli II 1st Stage Weir and HEPP Project in order to observe total flow rate coming to AKENERJI Projects. Water flow regime monitoring study is suggested to perform in a seasonal (quarterly) base in order to check flow conditions to be present in a whole year.

6.2 Water Quality Monitoring

As mentioned in the Section 4.3 of this report, in order to determine current water quality of the river, surface water quality analyses have been performed for water samples taken from 12 locations along the River. Water quality analyses results are evaluated and cumulative impacts of the HEPP Projects on water quality are assessed in the Section 5.2.

Water quality is important for the continuity of aquatic life. Therefore, regarding baseline water quality of the river (results of the water quality analyses), cumulative

impacts of HEPPs on the water quality and critical parameters for the continuity of aquatic life, a water quality monitoring programme is suggested for quarterly bases.

Suggested water quality monitoring locations are presented on the map in Appendix-I. As seen in the appendix, seven locations critical for aquatic life are selected as monitoring locations. Two of these locations are for the determination of water quality in dam lakes and the other locations are for the water quality at lower flow sections and tributary of the river.

Regarding the current situation in terms of water quality and possible impacts of the HEPPs, the parameters given in Table 6-1, are suggested to be seasonally analyzed at these monitoring locations. It is suggested to perform a full-set of water quality parameters, as in the field study, once in a year when the water depth is at the lowest level i.e. at fall season in the monitoring locations numbered 1, 2, 4, and 5.

Table 6-1 Water Quality Monitoring Parameters (Suggested)

Parameters	Methods	Preservation Time
Aluminum (Al)	EPA 200.7	1 Month
Ammonium Nitrate (NH_4^+-N)	SM 4500-NH_3 F.	21 Day
Biochemical Oxygen Demand (BOD_5)	SM 5210 B.	24 Hour
Dissolved Oxygen (O_2)	SM 4500-O C. SM 4500-O G. TS 5677 EN 25814	5 Hour
Chemical Oxygen Demand (COD)	SM 5220 D.	1 Month
Coliform Bacteria, Fecal	TS ISO 9308-1 TS ISO 9308-2	24 Hour
Coliform Bacteria, Total	TS ISO 9308-1 TS ISO 9308-2	24 Hour
Nitrate (NO_3^--N)	SM 4500-NO_3^- E.	24 Hour
Nitrite (NO_2^--N)	SM 4500-NO_2^- B.	24 Hour
pH	TS 3263 ISO 10523	6 Hour
Free Chloride (Cl_2)	SM 4500-Cl^- G.	5 dk
Temperature	SM 2550 B.	On the site
Sodium (Na)	EPA 200.7	1 Month
Total Dissolved Solid Particulate Matter	SM 2540 C.	24 Hour
Total Phosphor (P)	SM 4500-P C.	1 Month
Total Suspended Solids (TSS)	TS EN 872	2 days
Chlorophyl-A*	SM 10200 H	24 hours

* *Chlorophyl-A should be measured only in the dam lakes in order to check eutrophication.*

6.3 Aquatic Ecological Characteristics Monitoring

As mentioned in the Section 4.4 of this report, in order to determine aquatic ecological characteristics a field study has been performed at eight locations along the Goksu River. Aquatic ecological characteristics are defined in Section 4.3 and cumulative impacts of the HEPP Projects on aquatic life are assessed in Section 5.3.

Considering all the issues mentioned in the above sections, species diversity and population density of the aquatic organisms inhabited in the study area should be

controlled by long-term bio-monitoring programme both in construction and operating period for avoiding the negative impacts of the planned HEPPs.

The bio-monitoring program should be carried out;

- To control the biodiversity and population density of the algae, zooplankton and fish biodiversity seasonally in the study area before and after the construction of the planned HEPPs;
- To control the effectiveness of the fish ladders;
- To control the movement range of the fishes before and after the construction activities;
- To control the reproduction and/or spawning behavior of the fishes; and
- To check the population density of the endemic and protected species.

Suggested seasonal bio-monitoring locations are presented on the map in Appendix-I.

7. CONCLUSION

One of the main impacts of HEPPs on aquatic environment is that HEPP disturbs the continuity of aquatic environment in the river. Fish ladder in the HEPP enables fish movements between upstream and downstream of the project. In this report, the Goksu River is divided into segments considering fish movements in the aquatic environment. A HEPP project not having fish ladder is the end point of one segment while it is the beginning point of the other one since it prevents fish passage from one segment to the other (see Table 5-1). In this report, cumulative impacts of the projects of concern will be assessed for three segments presented in Appendix-F.

The potential cumulative impacts of the HEPP projects in the CIA Study Area have been assessed in accordance with the three environmental features due to construction and operation of the HEPP projects;

- Change of water flow regime from a river system to a series of lakes;
- Change of water quality; and
- Change of aquatic ecological characteristics of the Goksu River.

A field study, including water flow measurements, surface water quality measurements and determination of aquatic ecological characteristics, was conducted in order to set baseline conditions and assess potential impacts of the HEPPs accordingly.

Water flow regime along the Goksu River section will be affected from the HEPP Projects in two ways.

- Decrease in water level in the riverbed in-between weir and HEPP; and
- Change in water flow regime of river system due to dams.

In some of the HEPP projects, while most of the river flow is diverted from weir or dam to HEPP via energy tunnel, some amount of environmental flow (see Table 5-2) is released to the riverbed in order to maintain continuity of aquatic life. Therefore, water flow between weir or dam and HEPP is expected to decrease.

According to this change in the water flow regime four locations are suggested for water flow regime monitoring study. Since flow rate and flow depth in the riverbed is important for the continuity of aquatic life, lower flow sections to be occurred between the units of the HEPP Project are critical. Therefore, three of the monitoring locations numbered 2, 3 and 4 are the ones belonging to the lower flow sections.

Surface water samplings and analyses have been conducted at 12 locations on the Goksu River in order to determine baseline water quality.

Water quality is important for the continuity of aquatic life. Therefore, regarding existing water quality of the river, color, BOD, COD, Cl^-, NH_4-N, NO_2-N, and coliform parameters show negative impact on Goksu River. These parameters have cumulative impacts of HEPPs on the water quality and critical parameters for the continuity of aquatic life, a water quality monitoring programme is suggested for quarterly bases.

According to this, seven locations critical for aquatic life are selected as monitoring locations. Two of these locations are for the determination of water quality in dam lakes and the other locations are for the water quality at lower flow sections and tributary of the river.

HEPPs have both *negatively and positively* affect on aquatic ecosystem depending on change in water flow regime and water quality. Biodiversity of fish can be affected due to these changes. According to aquatic ecological characteristics of the Goksu River construction period of the HEPPs have polluted the water at some level. In order not to affect the existing species negatively during the operational stage of HEPP's, precautions and monitoring programme should be actualized. The water flow especially during the reproduction period of fish between April and July should not be cut-off.

Considering all the issues mentioned in the above sections, species diversity and population density of the aquatic organisms inhabited in the study area should be controlled by long-term bio-monitoring programme both in construction and operating period for avoiding the negative impacts of the planned HEPPs.

The CIA study has shown that change in water flow regime and water quality has significant affect on aquatic ecosystem, however, all major adverse cumulative impacts can be mitigated to acceptable levels through the proposed monitoring programme.

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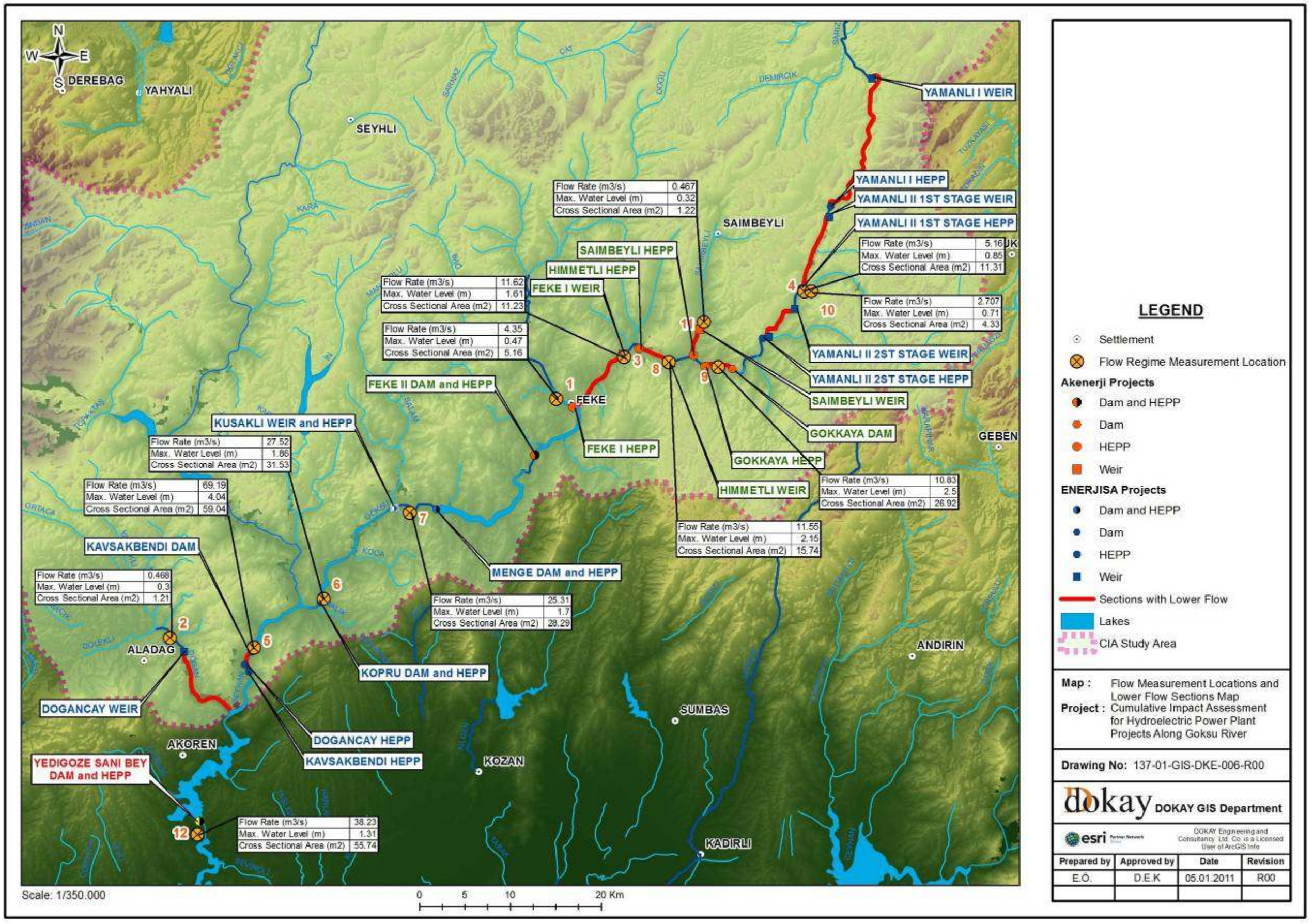
LIST OF APPENDICES

Appendix-A – Map of Flow Rate Measurement Stations


N
W
E
S
DEREBAG
YAHYALI
SEYHLI
SAIMBEYLI
ANDIRIN
GEBEN
SUMBAS
KOZAN
KADIRLI
AKOREN
ALADAG
YAMANLI I WEIR
YAMANLI I HEPP
YAMANLI II 1ST STAGE WEIR
YAMANLI II 1ST STAGE HEPP
YAMANLI II 2ST STAGE WEIR
YAMANLI II 2ST STAGE HEPP
SAIMBEYLI WEIR
SAIMBEYLI HEPP
HIMMETLI HEPP
FEKE I WEIR
FEKE II DAM and HEPP
FEKE
FEKE I HEPP
GOKKAYA DAM
GOKKAYA HEPP
HIMMETLI WEIR
KUSAKLI WEIR and HEPP
KAVSAKBENDI DAM
MENGE DAM and HEPP
KOPRU DAM and HEPP
DOGANCAY WEIR
DOGANCAY HEPP
KAVSAKBENDI HEPP
YEDIGOZE SANI BEY DAM and HEPP
Flow Rate (m3/s) 0.467
Max. Water Level (m) 0.32
Cross Sectional Area (m2) 1.22
Flow Rate (m3/s) 5.16
Max. Water Level (m) 0.85
Cross Sectional Area (m2) 11.31
Flow Rate (m3/s) 2.707
Max. Water Level (m) 0.71
Cross Sectional Area (m2) 4.33
Flow Rate (m3/s) 11.62
Max. Water Level (m) 1.61
Cross Sectional Area (m2) 11.23
Flow Rate (m3/s) 4.35
Max. Water Level (m) 0.47
Cross Sectional Area (m2) 5.16
Flow Rate (m3/s) 27.52
Max. Water Level (m) 1.86
Cross Sectional Area (m2) 31.53
Flow Rate (m3/s) 69.19
Max. Water Level (m) 4.04
Cross Sectional Area (m2) 59.04
Flow Rate (m3/s) 10.83
Max. Water Level (m) 2.5
Cross Sectional Area (m2) 26.92
Flow Rate (m3/s) 11.55
Max. Water Level (m) 2.15
Cross Sectional Area (m2) 15.74
Flow Rate (m3/s) 25.31
Max. Water Level (m) 1.7
Cross Sectional Area (m2) 28.29
Flow Rate (m3/s) 0.468
Max. Water Level (m) 0.3
Cross Sectional Area (m2) 1.21
Flow Rate (m3/s) 38.23
Max. Water Level (m) 1.31
Cross Sectional Area (m2) 55.74
Scale: 1/350.000
0 5 10 20 Km
LEGEND
Settlement
Flow Regime Measurement Location
Akenerji Projects
Dam and HEPP
Dam
HEPP
Weir
ENERJISA Projects
Dam and HEPP
Dam
HEPP
Weir
Sections with Lower Flow
Lakes
CIA Study Area
Map : Flow Measurement Locations and Lower Flow Sections Map
Project : Cumulative Impact Assessment for Hydroelectric Power Plant Projects Along Goksu River
Drawing No: 137-01-GIS-DKE-006-R00
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