SUSTAINABILITY ASSESSMENT OF A HYDROPOWER PROJECT: A CASE STUDY OF KAYRAKTEPE DAM AND HEPP

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ABSTRACT

SUSTAINABILITY ASSESSMENT OF A HYDROPOWER PROJECT:
A CASE STUDY OF KAYRAKTEPE DAM AND HEPP

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Nowadays, the world faces with lack of electricity access, water scarcity, climate change and global warming. The hydropower industry has a crucial role to deal with these problems as well as to develop projects for sustainable development. However, if social, environmental and economical impacts of a hydroelectric power plant (HEPP) project are not considered, it might lead to irreparable destructions. Nowadays, in Turkey, due to social and environmental problems resulting from hydropower projects, the opponents of HEPP projects are increasing. Whether there are any deficiencies in hydropower project's development procedure causing environmental and social problems is researched in this thesis. The laws and legislations in Turkey related to hydropower project are investigated.

The International Hydropower Association (IHA) has developed Hydropower Sustainability Assessment Protocol for hydroelectric power projects. It assesses the projects according to economic, social and environmental measurements. Thus a case study, namely Kayraktepe Dam and HEPP Projects is evaluated to identify social, environmental and economical effects of the project at an early stage by using this Sustainability Assessment Protocol. The effects of large scale dam are compared with the effects of medium dam and five diversion weirs on social, environmental and economical issues.

Keywords: Hydropower, Kayraktepe, Sustainability Assessment Protocol, International Hydropower Association, Sustainable Development

ÖZ

HİDROELEKTRİK PROJESİNİN SÜRDÜRÜLEBİLİRLİK DEĞERLENDİRMESİ:
KAYRAKTEPE BARAJI VE HES PROJESİNİN BİR ÖRNEK OLARAK İNCELENMESİ

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Dünya, bugünlerde elektrik kesintisi, su kesintisi, hava değişimi ve küresel ısınma ile karşı karşıya kalmaktadır. Hidroelektrik sektörü bu problemlerle baş etmede büyük rol oynamaktadır. Aynı zamanda, sürdürebilir kalkınmayı geliştirecek projeler sağlamaktadır. Fakat hidroelektrik santrallerin (HES) sosyal, çevresel ve ekonomik etkileri düşünülmezse, geri dönüşümü olmayan yıkımlara sebep olabilir. Türkiye'de son zamanlarda, sosyal ve çevresel sorunlardan dolayı, HES karşıtı görüşler artmaktadır. Bu sorunların, HES projelerinin gelişmesindeki süreçte bir eksiklikten kaynaklanıp kaynaklanmadığı araştırılmıştır. HES projeleri ile ilgili Türkiye'deki, kanun ve yönetmelikler incelenmiştir.

Uluslararası Su Enerjisi Birliği, hidroelektrik projeleri için Sürdürülebilirlik Değerlendirme Protokolü'nü geliştirmiştir. Bu protokolde, projelerin sosyal, ekonomik ve çevresel etkileri değerlendiriliyor. Bu tezde, fizibilite aşamasındaki Kayraktepe Projeleri, Uluslararası Su Enerjisi Birliğinin Sürdürülebilirlik Değerlendirme Protokolü kullanılarak incelenmiş, sosyal, çevresel ve ekonomik etkileri değerlendirilmiştir. Böylece, büyük barajın etkileri, orta büyüklükteki bir baraj ve beş HES tesisinin etkileri çevresel, sosyal ve ekonomik yönden karşılaştırılmıştır.

Anahtar Kelimeler: Su gücü, Kayraktepe, Sürdürülebilirlik Değerlendirme Protokolü, Uluslararası Su Enerjisi Birliği, Sürdürülebilir Kalkınma

To my parents, my sister and my husband for their endless love and support

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INTRODUCTION

1.1 Scope of the Dissertation

The hydropower industry has a crucial role to deal with the world's significant problems such as fresh water scarcity and lack of electricity access. In addition, it can contribute sustainable development.

International Hydropower Association (IHA) has developed Sustainability Assessment Protocol to enhance sustainable hydropower industry. In order to assess the projects with respect to economic, social and environmental measurements during project life cycle stages, there are four assessment tools, namely early stage, preparation, implementation and operation assessment tool. It can be applied before significant decision in its project life cycle.

This dissertation includes hydropower and sustainability issues and it seeks to:

- The role of hydropower in sustainable development.
- Turkish laws and legislations related to hydropower projects and deficiencies in hydropower project development process.
- Assessment of the old and new Kayraktepe Dam and Hydroelectric Power Plant Projects in sustainability point of view to identify social, environmental and economical problems at an early stage.

1.2 Literature Review

In 1982, the first feasibility report of Kayraktepe Dam and HEPP project were prepared by the consortium of Su-İş, EPDC, TMB and Su-Yapı. In 1994, after Göksu Delta had been recognized as Ramsar Site, Environmental Impact Assessment report was prepared. In 1997, the feasibility study report was revised by EPDC and Su-İş. In 2008, Kayraktepe Dam and HEPP were awarded to private company. Negotiations with DSİ have not been settled yet.

In 1998, Biro studied the environmental impacts of the first Kayraktepe Dam and HEPP project. This study focused on three major external costs caused by the Kayraktepe Project which are the loss of agricultural income from the existing fields and trees in the reservoir area, the loss of value from the national forests which would remain under water and the non-use values placed on the environment by the local people. These costs were added to the Project's cost-benefit analysis. By this way, the effects of local environmental costs on cost-benefit ratio were illustrated (Biro, 1998). Moreover, she also prepared the thesis on "Prospects for Local Community Participation in the Management of the Göksu Delta Protected Sprecial Area in Turkey".

In 2007, the thesis named "Vulnerability of Coastal Areas to Sea Level Rise: a Case Study on Göksu Delta" was studied by Özyurt. In this thesis, a coastal vulnerability assessment model related to sea level rise was developed and applied to the Göksu Delta. This study was not used to evaluate sustainability of a hydropower projects.

In 2010, Sever studied on environmentally acceptable alternative solution for Kayraktepe Dam and HEPP (Sever, 2010). In this thesis, alternative formulation of the Kayraktepe Project proposed by the private company was investigated.

1.3 Dissertation Roadmap

This dissertation is divided into three main sections:

i) Sustainability assessment in the hydropower projects are explained in Chapters 2, 3 and 4. In chapter 2, the role of hydropower in sustainable development and the origin of dam debates are mentioned briefly. Chapter 3 is composed of IHA's sustainability assessment protocol. IHA’s aspects and its protocols published in 2006 and 2010 related to hydropower projects are clarified concisely. In chapter 4, Turkish laws and legislations related to hydropower projects are researched. Moreover, whether there are any deficiencies in hydropower project’s development process is investigated.

ii) Sustainability assessment of the Kayraktepe Dam and HEPPs projects are illustrated in Chapter 5. Brief information about the Kayraktepe Projects is given. Then, the measurements of Early Stage Assessment Tools are explained. Finally, Early Stage Assessment Tool is applied to the Kayraktepe Projects and the results are discussed.

iii) Conclusions and recommendations are given in Chapter 6.

CHAPTER 2

HYDROPOWER AND SUSTAINABILITY

2.1 Awareness Need for Sustainable Development

Nowadays, humanity faces lots of challenges including freshwater scarcity, lack of electricity, global warming, poverty, and difficult living conditions. In addition, rapid population growth increases these challenges and affects environment, social and economic development enormously.

According to Figure 2.1, between 1950 and 2000, the world population increased nearly 3.5 billion. For mid-year 2010, latest official current world population is 6,852,472,823 (Rosenberg, 2011). According to, United Nations Population Funds' estimation, the world population will grow to about 9 billion in 2050 (UN, 2011). This population increases the challenges especially related to water, energy and natural resources.

The population growth will cause more water requirement. Unfortunately, approximately a billion people have no access to an adequate water supply (IHA's White Paper, 2003). In Figure 2.2, water withdrawal as a percentage of total availability is illustrated for the entire world. This figure shows some developing countries might suffer water scarcity in 2025.

A new global analysis illustrates that approximately 80% of the world's population lives in areas where the fresh water supply is not secure. The most severe threat category covers 3.4 billion people (Black, 2010).

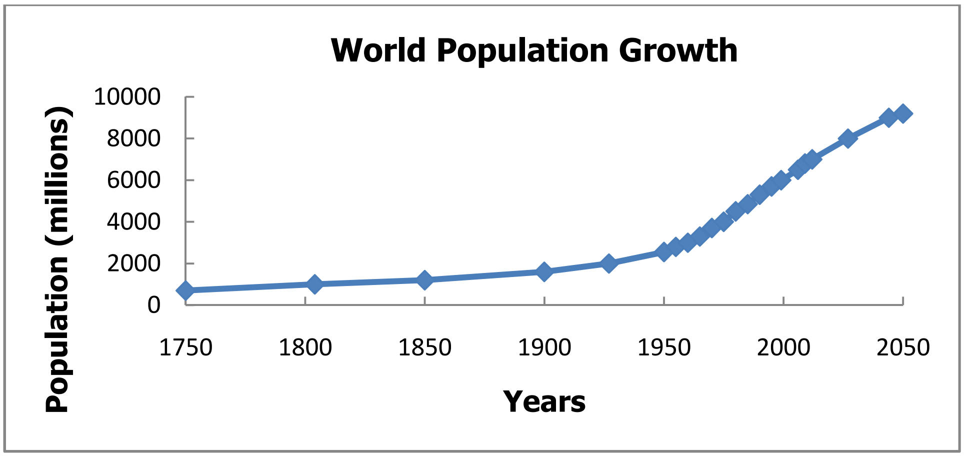

Figure 2.1 World Population Growth (Rosenberg, 2011)

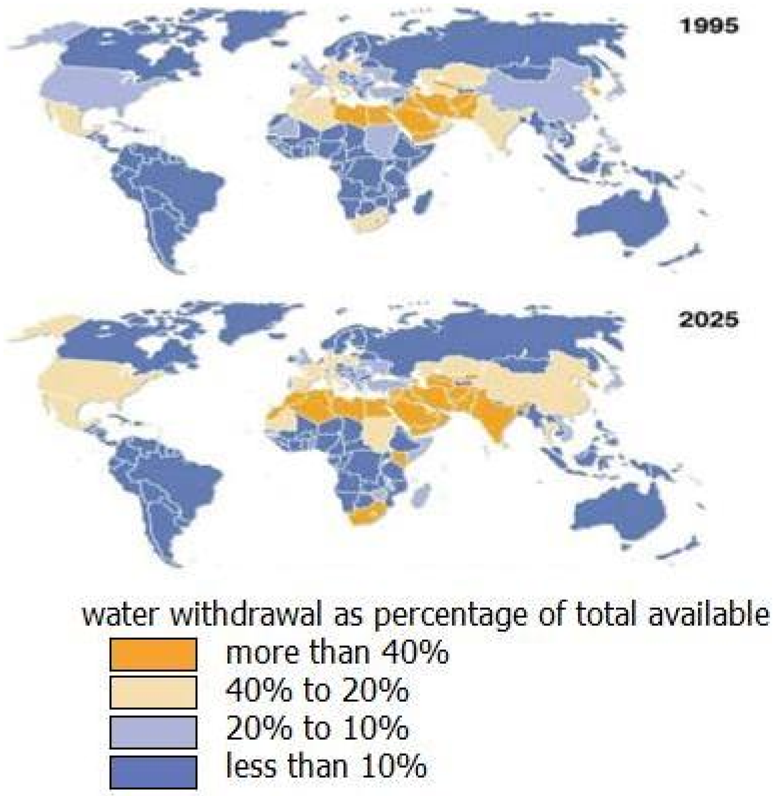

Figure 2.2 Fresh Water Availability (IHA white Paper, 2003)

The effects of the dams, canals, aqueducts, and pipelines on fresh water availability are represented in Figure 2.3 and 2.4.

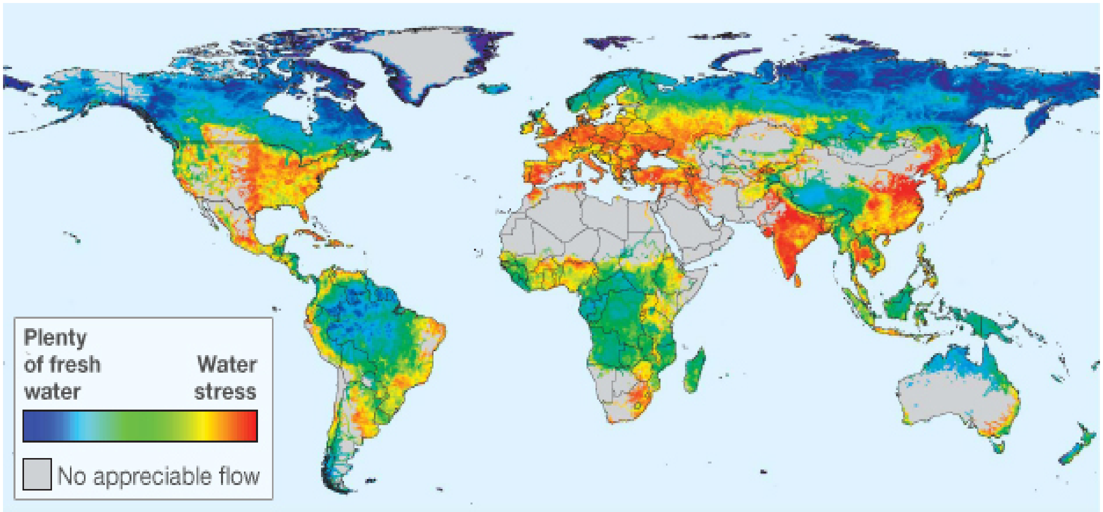

Figure 2.3 Natural Fresh Water Availability (Black, 2010)

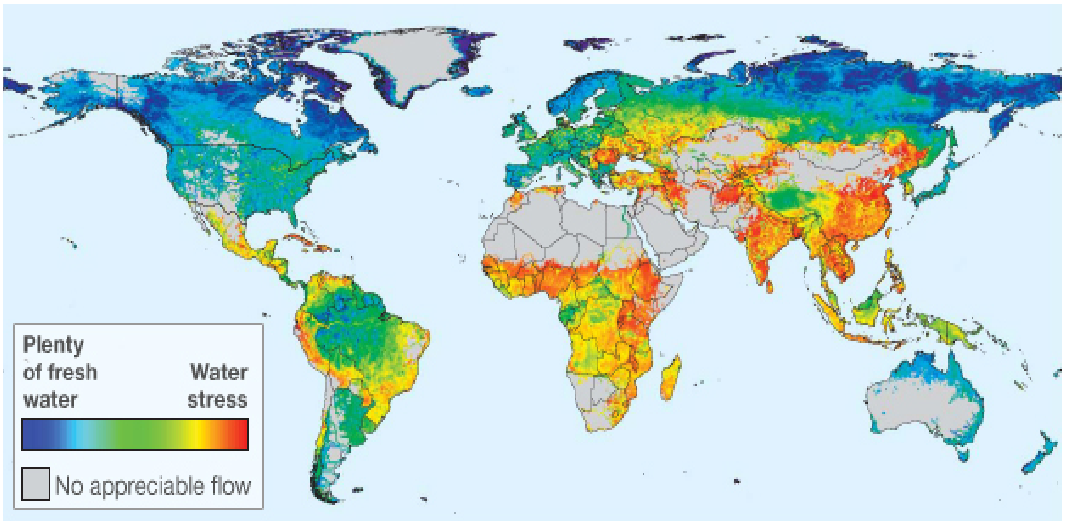

Figure 2.4 Managed Fresh Water Availability (Black, 2010)

Besides water scarcity, Figure 2.5 shows that about 1.6 billion people cannot access electricity.

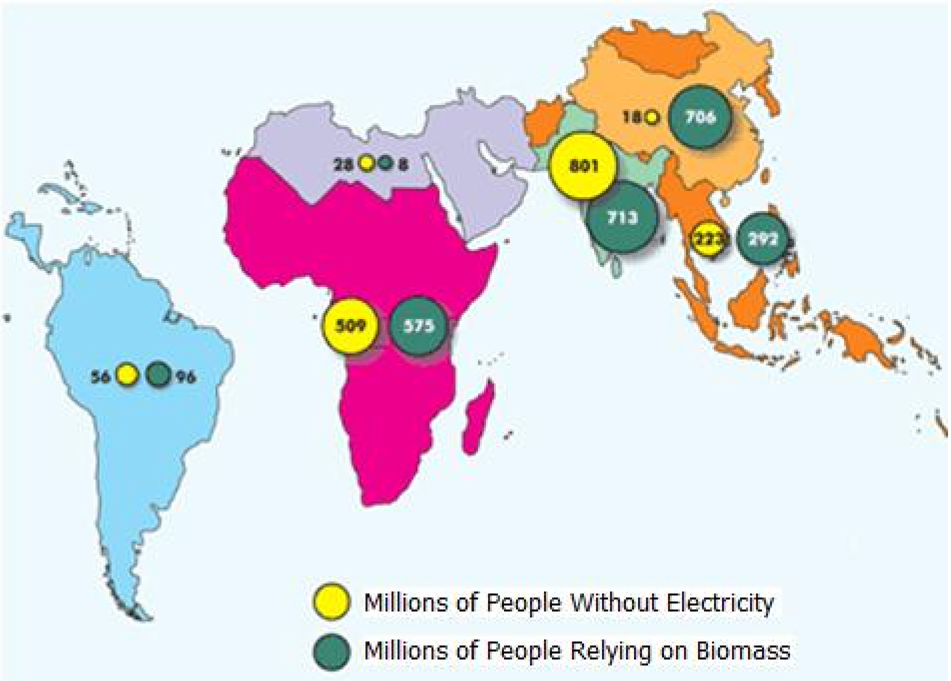

Figure 2.5 Global Energy Poverty (IHA white Paper, 2003)

As illustrated by Figure 2.6, the majority of world's electricity is supplied from fossil fuels. Carbon dioxide, sulfuric and nitric acids are produced due to the burning of fossil fuels. The combustion of fossil fuels brings about greenhouse gas emission by increasing the amount of carbon dioxide in the atmosphere. Hence, it contributes to not only global warming but also air pollution (Wikipedia, 2011). Each year, millions of deaths occur because of air pollution. Deaths attributable to air pollution are illustrated in Figure 2.7.

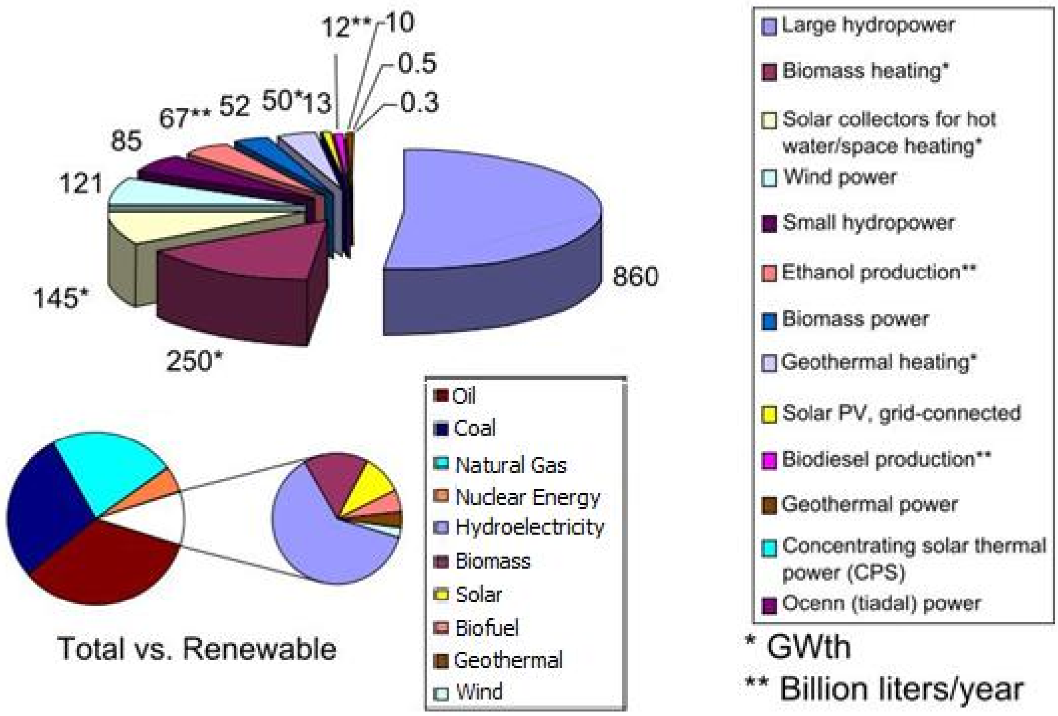

Figure 2.6 The World's Energy Sources (REN21, 2009)

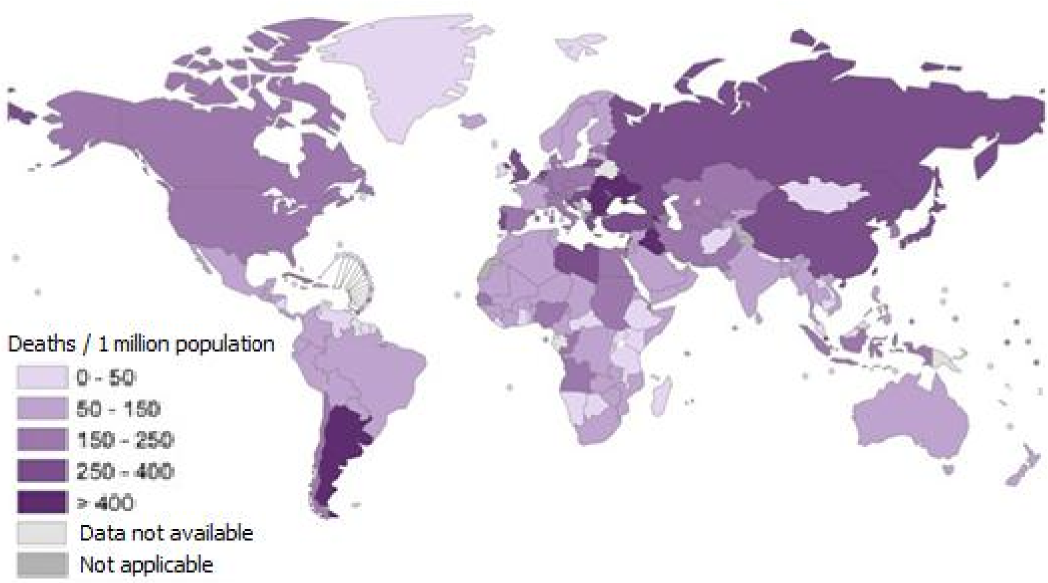

Figure 2.7 Deaths Attributable to Air Pollution (WHO, 2011)

Table 2.1 gives some information about types of energy resources. For example; diesel, heavy oil, coal, and natural gas cause higher greenhouse gas and SO_2 emission than hydropower, wind power and solar photovoltaic do. On the other hand, their energy payback ratios, which are the ratios of total energy produced during the lifetime of the plants divided by the energy required to construct, operate, fuel and decommission them, are very small when compared to hydro and wind power's energy payback ratios.

Table 2.1 Information about Electricity Generating Options (IHA white Paper, 2003)

Electricity Generating Options (classified by level of service)	Energy Payback Ratio	Greenhouse Gas Emissions (kt eq. CO_2/TWh)	Land Requirements (km^2/TWh/y)	SO_2 Emissions (t SO_2/TWh)
Options capable of meeting base load and peak load				
Hydropower with reservoir (designed for electricity generation, not irrigation)	**205** 48 – 260	**15** 2 – 48	**152** 2 –200	**7**
Diesel		**778** 778 – 883		**1285**
Heavy oil without scrubbing		**778**		**8013**
Base load options with limited flexibility				
Hydropower run-of-river	**267** 30 - 267	**2**	**1**	**1**
Coal (1% S): existing plant without SO_2 scrubbing	**7** 7 - 20	**1050** 900 – 1 180	**4**	**5274**
Coal (2% S): modern plant with SO_2 scrubbing	**5**	**960**		**104**
Nuclear	**16** 5 - 107	**15** 2 – 59	**0.5**	**3**
Natural gas combined cycle (gas delivered + 2000 km)	**5**	**443** 389 – 511		**314**
Large fuel cell (natural gas to hydrogen conversion)	**3**	**664**		**470**
Biomass: energy plantation	**5** 3 – 5	**118**	**533** 533 – 2 200	**26**
Sawmill waste combustion	**27**		**1**	**26**
Intermittent options that need backup generation (such as hydro with reservoir or oil-fired turbines)				
Wind power	**80** 5 – 80	**9** 7 – 124	**72** 24 – 117	**69**
Solar photovoltaic	**9** 1 – 14	**13** 13 – 731	**45** 27 – 45	**24**

Consequently, nowadays, the world faces with lack of electricity access, water scarcity and pollution. In order to overcome these challenges, it is essential to be aware of sustainable development on social, economic and environmental issues to meet the needs of the present population without compromising the ability of future generations to meet their own needs. For this reason, the uses of renewable, clean, environmentally friendly energy sources are very important for sustainable development and humanity.

2.2 Hydropower's Role in Sustainable Development

International Hydropower Association claims that hydropower can contribute sustainable development by improving economic viability, by preserving ecosystems and by enhancing social justice. IHA's opinions related to hydropower are explained below (IHA, 2003):

- Improving economic viability

The lifetimes of hydropower schemes are about 50 to 100 years. Furthermore, it has high reliability because of well-known technology, and is being used for more than a century. Therefore, they are very cheap in long term considered. Moreover, national development, additional economic activities, e.g., new industries, additional amenity, e.g., recreation and infrastructure are some benefits for economic viability. In addition, qualified food production due to improved irrigation, fishery developments, navigation, flood control and the certain availability of fresh water supports sustainable development. According to Table 2.1, hydropower has the highest energy payback ratio. During its lifetime, it can produce more than 200 times of the energy which is needed for its construction. Both its efficiency and its flexibility are very high. Dams with large reservoirs can meet demand fluctuations instantaneously. Also, hydropower can play an important role in optimizing the efficiency of total power system when it is used in mixed system.

- Preserving ecosystems

Hydropower is a clean and renewable energy source. It does not deplete natural resources. In contrast, it leaves them available for future generation. It is environmentally friendly because it does not pollute air like fossil fuels. Hence, it helps prevent global warming. In addition, many species benefit from reservoirs as a permanent water resource in arid climates.

- Enhancing social justice

Hydropower projects supply the equity between present and future generations by leaving a cleaner world and natural resources to future generations and by providing electricity source with long viability and low maintenance. Hydropower contributes to poverty alleviation and balancing discrepancies between developing and developed countries. It meets the developing countries' energy demand by assisting in the management of freshwater and food supplies.

For these reasons, hydropower projects are considered as renewable, clean, and environmentally friendly energy sources. However, hydropower projects' contribution to sustainable development should be considered under social, environmental and economical effects. Hydropower projects have both advantages and disadvantages. In Table 2.2, some advantages and disadvantages of hydropower projects are listed with respect to economic, social and environmental aspects (IHA white Paper, 2003). These disadvantages cause dam debates.

Table 2.2 Advantages versus Disadvantages of Hydropower Projects (IHA white Paper, 2003)

ADVANTAGES DISA	DVANTAGES
Economic Aspects	
Provides low operating and maintenance costs	High upfront investment
Provides long life span (50 to 100 years)	Precipitation dependent
Meets load flexibly (i.e hydro with reservoir)	In some cases, the storage capacity of reservoirs may decrease due to sedimentation
Provides reliable service	Requires long-term planning
Includes proven technology	Requires long-term agreements
Instigates and fosters regional development	Requires multidisciplinary involvement
Provides highest energy efficiency rate	Often requires foreign contractors and funding
Generates revenues to sustain other water uses	
Creates employment opportunities	
Saves fuel	
Provides energy independence by exploiting national resources	
Optimizes power supply of other generating options (thermal and intermittent renewables)	
Social Aspects	
Leaves water available for other uses	May involve resettlement
Often provides flood protection	May restrict navigation
May enhance navigation conditions	Local land use patterns are modified
Often enhances recreational facilities	Waterborne disease vectors may need to be checked
Enhances accessibility of the territory and its resources (access roads and ramps, bridges)	Requires management of competing water uses
Provides opportunities for construction and operation with a high percentage of local manpower	Effects on impacted peoples' livelihoods need to be addressed
Improves living conditions	
Sustains livelihoods (freshwater, food supply)	
Environmental Aspects	
Produces no atmospheric pollutants and only very few GHG emissions	Inundation of terrestrial habitat
Enhances air quality	Modification of hydrological regimes
Produces no waste	Modification of aquatic habitats
Avoids depleting non-renewable fuel resources (i.e., coal, gas, oil)	Water quality needs to be monitored/managed
Often creates new freshwater ecosystems with increased productivity	Temporary introduction of methylmercury into the food chain needs to be monitored/managed
Enhances knowledge and improves management of valued species due to study results	Species activities and populations need to be monitored/managed
Helps to slow down climate change	Barriers for fish migration, fish entrainment
Neither consumes nor pollutes the water it uses for electricity generation purposes	Sediment composition and transport may need to be monitored/managed

2.3 Dam debates

The report of World Commission on Dams (WCD, 2000) concluded that water infrastructure projects, including hydropower schemes, had "too often" been developed at an environmentally or socially unacceptable cost. Although, the report neither completely eliminated construction of dam for electricity production nor promoted only small hydro, it became very powerful tool at the hand of environmental activities that have been campaigning for the freedom of the rivers for a long time. Furthermore, in the report options for both energy and water were evaluated. In public, the energy role of dams is discussed, and alternatives that are suggested to large dams are more likely related to energy dams. However, in semi-arid areas like Turkey, a dam more than often has multiple functions such as energy, water supply, irrigation and flood control. Thus, WCD report made it difficult to find international finance to water infrastructure project. For this reason, developing countries faced difficulties to develop the projects. Therefore, debates on hydropower became more intensive in the international area. Many developing countries and hydropower industry played great role to promote hydropower as a renewable energy and key to sustainable development. It has been declared in World Summit on Sustainable development summit in Johannesburg, "Diversify energy supply by developing advanced, cleaner, more efficient, affordable and cost-effective energy technologies, including fossil fuel technologies and renewable energy technologies, hydropower included, and their transfer to developing countries on concessional terms as mutually agreed". Later in World Water Forum, Kyoto, and March 2003 - Ministerial Declaration stated that "We recognize the role of hydropower as one of the renewable and clean energy sources, and that its potential should be realized in an environmentally sustainable and socially equitable manner." After that, in international Conference on Renewable, Bonn in 2004 the importance of hydropower for development was made clear by several developing country energy ministers. Although, hydropower has been re-recognized by the international community, means and rules for sustainable development project remained within the context of WCD report (Öztürk and Tiğrek, 2010).

Finally, in 2010, IHA has developed Hydropower Sustainability Assessment Protocol to evaluate hydropower projects by considering economical, social and environmental issues. IHA's Sustainability Assessment Protocol is explained in Chapter 3 and 5 in detail.

CHAPTER 3

IHA'S SUSTAINABILITY ASSESSMENT PROTOCOL

3.1 General Information about International Hydropower Association

In 1995, International Hydropower Association (IHA) was formed as a forum under the auspices of UNESCO in order to encourage and disseminate good practice and further knowledge about hydropower. Today, IHA has its own offices in United Kingdom, Africa, the Americas, Asia, Australasia, Europe and the Middle East. In addition, it has members in more than 50 countries. The wide range of members covers organizations and individuals in industry, international organizations, governments, scientific and academic institutions, and civil society. IHA studies about how to improve the role of hydropower in meeting the world's growing water and energy needs as a clean, renewable and sustainable technology. Therefore, one of the main aims of the IHA is to provide awareness of hydropower's role in sustainable development as an important source of renewable energy (IHA's web site, 2010).

3.2 IHA's View of Sustainability

According to the International Hydropower Association, sustainability is a fundamental component of social responsibility, sound business practice and natural resource management. It includes economic development, social development and environmental protection. IHA states that the main aims of sustainable development are eradicating poverty, changing unsustainable patterns of production and consumption, protecting and managing the natural resource base that underpins economic and social development. Therefore, in 2006 IHA has developed Sustainability Assessment Protocol to evaluate new energy projects, new hydro projects and the management and operation of existing hydropower facilities. The primer aim of this protocol is to assist IHA members in assessing performance of the project (IHA, 2006). In 2010, because of a resurgence of interest in hydropower, the protocol is revised, updated and expanded. In this thesis, this revised version will be used to assess the Kayraktepe Projects in Chapter 5.

3.3 Contents of IHA's Sustainability Assessment Protocols

- Content of IHA's Hydropower Sustainability Assessment Protocol in 2006

The Sustainability Assessment Protocol consists of three main sections. The first section covers general guidance on sustainability issues in order to assess new energy projects. The second section and the third section give sustainability aspects for new hydro projects and for operating hydropower facilities, respectively. These sustainability aspects evaluate relevant economic, social, and environmental issues by scored from 5 through zero. Both process and performance of a project are scored according to these issues. The Criteria of IHA's Sustainability Assessment Protocol (2006) to evaluate new hydro projects are mentioned in Appendix A.

- Content of IHA's Hydropower Sustainability Assessment Protocol in 2010

This revised version consists of four assessment tools which are early stage, preparation, implementation and operation as shown in Figure 3.1. These are stand-alone assessments applied at particular stages before major decision points in the project life cycle (IHA, 2010). For this reason, its application is easier than 2006's Sustainability Assessment Protocol's application. For example, the application of 2006's Sustainability Assessment Protocol on a hydropower project in feasibility study is inconvenient. However, by applying early stage tool in 2010's Sustainability Assessment Protocol, a hydropower project in feasibility stage can be evaluated.

The early stage assessment tool is used to encourage better early stage analysis, to identify knowledge gaps and to choose best alternative solution. Before public announcement about project intentions, this tool can be applied. Therefore, Early Stage Assessment Tool will be used to evaluate the Kayraktepe Projects in Chapter 5. The preparation assessment tool is used when detailed technical, environmental, social and financial feasibility studies are prepared under a strict governmental process. Then, the construction contracts are awarded. During implementation of construction, resettlement, environmental and other management plans and commitments, the implementation assessment tool is taken into account. Finally, the project is commissioned and the operation assessment tool can be used for evaluating monitoring, compliance and continuous improvement. Thus, during project life cycle, continuous improvement measures could be supplied with the 2010's Sustainability Assessment Protocol (IHA, 2010).

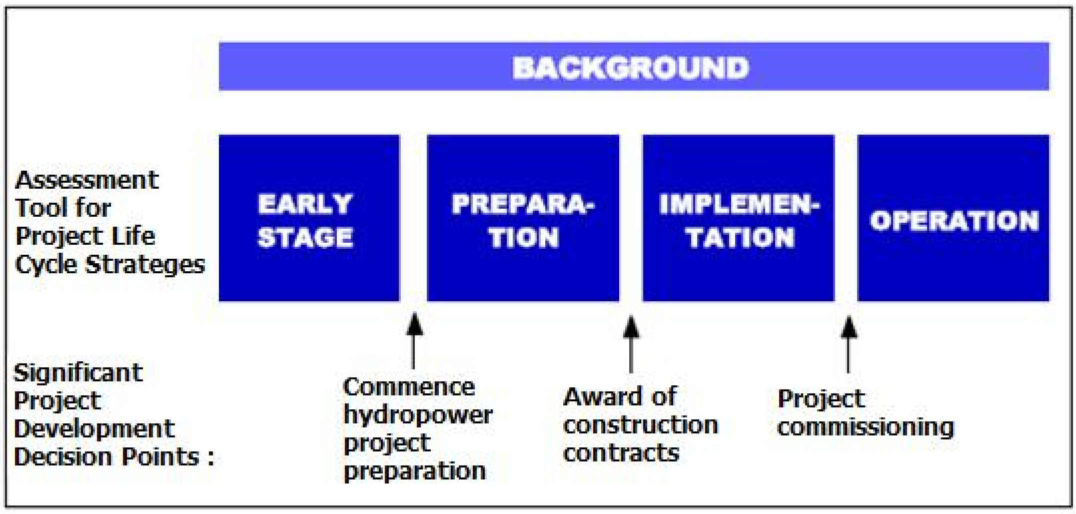

Figure 3.1 Protocol Assessment Tools and Major Decision Points (IHA, 2010)

During project life cycle, there might be overlap between stages. When the project is in transition between stages, assessment tool is chosen according to the purpose of the assessment. Table 3.1 illustrates hydropower sustainability assessment protocol topics for each stage.

Table 3.1 Hydropower Sustainability Assessment Protocol Topics According to Stages (IHA, 2010)

Early Stage	**Preparation**	**Implementation**	**Operation**
Demonstrated Need	Communications & Consultation	Communications & Consultation	Communications & Consultation
Options Assessment	Governance	Governance	Governance
Policies & Plans	Demonstrated Need & Strategic Fit	Environmental & Social Issues Mgmt	Environmental & Social Issues Mgmt
Political Risks	Siting & Design	Integrated Project Management	Hydrological Resource
Institutional Capacity	Environmental & Social Impact Assessment & Mgmt	Infrastructure Safety	Asset Reliability & Efficiency
Technical Issues & Risks	Integrated Project Management	Financial Viability	Infrastructure Safety
Social Issues & Risks	Hydrological Resource	Project Benefits	Financial Viability
Environmental Issues & Risks	Infrastructure Safety	Procurement	Project Benefits
Economic & Financial Issues & Risks	Financial Viability	Project Affected Communities & Livelihoods	Project Affected Communities & Livelihoods
	Project Benefits	Resettlement	Resettlement
	Economic Viability	Indigenous Peoples	Indigenous Peoples
	Procurement	Labor & Working Conditions	Labor & Working Conditions
	Project Affected Communities & Livelihoods	Cultural Heritage	Cultural Heritage
	Resettlement	Public Health	Public Health
	Indigenous Peoples	Biodiversity & Invasive Species	Biodiversity & Invasive Species
	Labour & Working Conditions	Erosion & Sedimentation	Erosion & Sedimentation
	Cultural Heritage	Water Quality	Water Quality
	Public Health	Waste, Noise & Air Quality	Reservoir Management
	Biodiversity & Invasive Species	Reservoir Preparation & Filling	Downstream Flow Regime
	Erosion & Sedimentation	Downstream Flow Regimes	
	Water Quality		
	Reservoir Planning		
	Downstream Flow Regimes		

CHAPTER 4

SUSTAINABILITY ASSESSMENT OF HYDROPOWER IN TURKEY

4.1 The Role of Hydropower in Turkey

According to General Directorate of State Hydraulic Works' 2009 Annual Report (DSİ, 2009), in Turkey, annual energy consumption is about 1,906 kWh. The average energy consumption in the developed countries, in the USA and in the world is around 8900 kWh, 12,322 kWh and 2,500 kWh respectively. One of the main targets of Turkey is industrialization. Thus, it is essential to supply reliable and sustainable energy to the industry and consumer for improvement of economic and social development. Today, total energy generation in Turkey raised about 195,000 GWh/year (DSİ, 2009). According to Table 4.1, in 2009, Turkey's installed capacity was 44,781 MW and 14,553 MW of this capacity was supplied by hydroelectric Power. Although average annual generation capacity of hydroelectric power was 52,348 GWh, actual annual generation was 35,880 GWh because of maintenance and repair activities, economic recession, low demand, operation policy, failures, drought, etc. Therefore, its capacity utilization was 69% in 2009. Hydroelectric power supplied 18% of Turkey's annual total energy generation (DSİ, 2009).

The majority of Turkey's total energy generation is derived from thermal energy. Therefore, in order to supply its energy needs, Turkey has to import natural gas and oil resources.

Turkey's energy consumption rises 8~10% in each year. Figure, 4.1 shows that if alternative energy sources are not used, Turkey may not be able to meet this growing demand in the near future.

Table 4.1 Installed Capacity, Generation Capacity and Capacity Utilization Rate of Power Plants in Turkey According to Type of Energy (DSİ, 2009)

INSTALLED CAPACITY, GENERATION CAPACITY, CAPACITY UTILIZATION RATE OF POWER PLANTS IN TURKEY ACCORDING TO TYPE OF ENERGY									
INSTALLED CAPACITY AND ANNUAL PRODUCTION		in 2008				in 2009			
		CAPACITY		CAPACITY UTILIZATION		CAPACITY		CAPACITY UTILIZATION	
		Installed Capacity (MW)	Average Generation (GWh)	Actual Generation (GWh)	Rate (%)	Installed Capacity (MW)	Average Generation (GWh)	Actual Generation (GWh)	Rate (%)
THERMAL ENERGY	COAL	10.207	66.919	57.716	86	10.612	69.576	54.985	79
	FUEL	2.274	15.243	7.519	49	2.310	15.485	6.604	43
	NATURAL GAS	15.055	112.043	98.685	88	16.345	121.648	94.396	78
	OTHER	60	448	220	49	81	609	255	42
TOTAL THERMAL		**27.596**	**194.653**	**164.140**	**84**	**29.348**	**207.318**	**156.240**	**75**
GEOTHERMAL AND WIND ENERGY		394	1.451	1.009	70	880	3.246	1.940	60
HYDROELECTRIC ENERGY		13.829	49.741	33.270	67	14.553	52.348	35.880	69
TOTAL AMOUNT		**41.819**	**245.845**	**198.419**	**81**	**44.781**	**262.912**	**194.060**	**74**

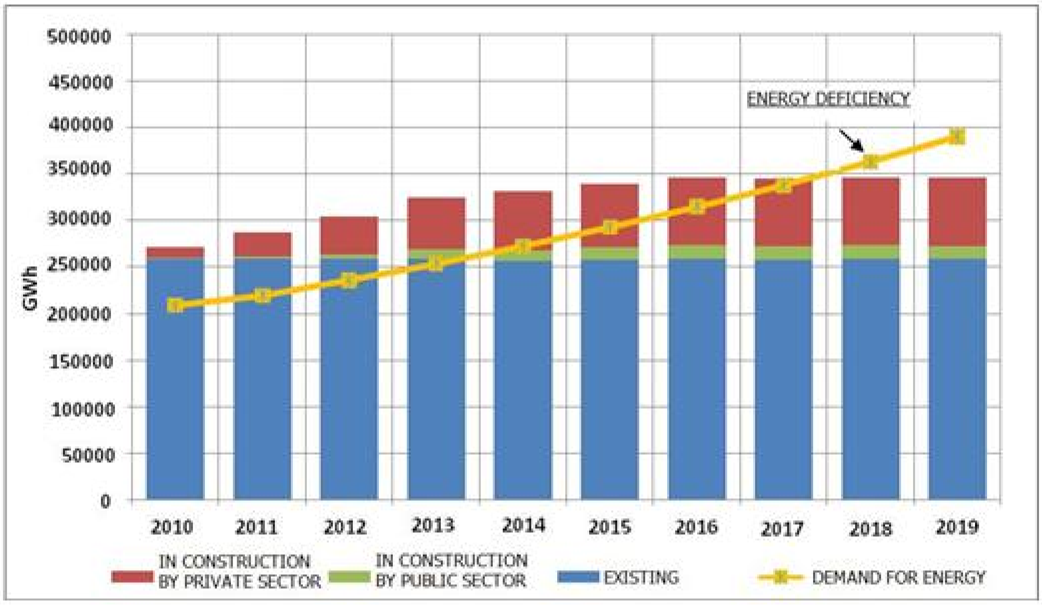

Figure 4.1 Turkey’s Energy Supply-Demand Relationship (TEİAŞ, 2010)

Nowadays, European energy policy focuses on green energy. A common example of green power is hydropower which is clean, environment–friendly, renewable energy sources. In addition, it has high efficiency, long-lifetime, low operational costs and ability to supply peak demands. It can recover its investment costs quickly. Moreover, it is an independent energy resource. Turkey's geographical location provides lots of advantages for extensive use of renewable energy resources, especially hydropower energy. It is important to increase the percentage of hydroelectric power in total energy generation so as to harmony European energy policy with the Turkish energy policy and meet its future energy needs.

If all natural flows could be used with 100% efficiency, Turkey's hydroelectric potential would be 433 billion kWh. By using existing technologies, 216 billion kWh can be generated. However, only 140 billion kWh of this amount is both economically and technically viable (DSİ, 2009).

According to DSİ's annual report in 2009, there are 213 hydroelectric power plants in operation with total installed capacity of 143000 MW in Turkey. It generates nearly 50,000 GWh/year. This means Turkey reaches approximately 36% of its economically viable hydroelectric potential. There are 145 hydroelectric power plants under construction with 7,286 MW installed capacity and 23,770 GWh average annual generation. Turkey has 1300 hydroelectric power projects in plan. Their total installed capacities are 22,614 MW. Their average annual generation will be about 66,230 GWh. As a result of these projects, a total of 1,658 hydroelectric power plants will generate 140,000 GWh/year. This represents that Turkey will reach its economically viable hydropower potential.

In addition to energy supply, dams have a role in flood control, municipal water supply and irrigation. According to DSİ, in Turkey, 8.5 million hectare farm lands might be irrigated economically. However, Turkey could utilize almost 63.8% of them. In order to meet demands of rapidly increasing population, 3.08 million hectare area should also be irrigated (DSİ's annual report, 2009).

4.2 Turkish Laws and Legislations Concerning Hydropower Projects

The Electrical Power Resources Planning and Survey Administration (EIE) were established in 1935 by Law No 2819. Its duties are the estimation of Turkey's electricity demand, making surveys and investigations of all energy sources especially renewable energy resources such as hydropower, wind, geothermal, biomass and solar energy to supply Turkey's energy demand.

General Directorate of State Hydraulic Works (DSİ) was established by Law No. 6200 in 1953. It concerns about planning, designing, constructing and operating water works including hydropower generation, irrigation, municipal water supply, flood control and environmental issues (WATER and DSİ, 2009).

After understanding requirement of clean and renewable energy, in order to increase the weight of hydropower energy rapidly, DSİ requested from the Grand National Assembly of Turkey to prepare a law so that private sector can invest in hydropower.

First of all, in 2001, "4628 Electricity Market Law" came into effect. The aim of this law is to supply electricity continuously and compatible with the environment to the users in adequate quantity and high quality. Moreover, it provides financially strong stable, transparent and competitive electricity market. The procedures and principles of water uses together with the other user's rights are defined by this law. Then in 2003, Water Use Right Agreement for production activities in electricity market was prepared. By this agreement, private sector took place for energy generation (Turkey Water Report, 2009).

In total 1524 hydroelectric power projects with 22360 MW installed capacity has been implemented until the 22th January 2009. However, 426 projects have been granted with licensing, and out of this number, construction of 135 projects has been started (Turkey Water Report, 2009).

It is aimed that hydropower projects will be completed in a short time with the participation of private sectors. By this way, energy deficiency in the near future can be prevented with the usage of national resources. Furthermore, competition ambiance in private sector will cause falling in energy price. This results in economic energy supply in the industries. Therefore, industrialization and employment will develop. Among its benefits, the dependency of the other countries will decrease in spite of a sharp increase in the cost of natural gas and oil (DSİ, 2006).

In 2004, there was a modification in Water Use Right Agreement. By this regulation, private sectors could also involve in hydropower projects at the construction phase.

The Law no 5346 on utilization of renewable energy resources for the purpose of generating electrical energy became effective in 2005. The purpose of this law can be listed as (EIE, 2011);

- Expand the utilization of renewable energy resources for generating electrical energy,
- Benefit from these resources in secure, economic and qualified manner,
- Increase the diversification of energy resources,
- Reduce greenhouse gas emissions,
- Assess waste products,
- Protect the environment,
- Develop the related manufacturing sector for realizing these objectives.

After this law, the number of HEPP projects prepared by private sectors including their credits went up tremendously. The aim is to reach total economically viable hydroelectric potential until 2030.

Ministry of Environment and Forest published Environmental Impact Assessment (EIA) Guidebook for Dams and HEPP projects in 2009. According to this guidebook, the laws and legislations that should be considered in the preparation of EIA report are listed in the following pages (ÇOB, 2009).

The Laws:

- Environment Law
- Employment Law
- Fishery Products Law
- Law related to groundwater
- General Hygiene Law
- National Parks Law
- The protection of Cultural and Natural Assets Law
- Coast Law
- Forest Law
- Pasture Law
- Zoning Law
- Improvement of raising or selling olives and inoculation of feral Law
- Municipality Law
- Metropolitan Municipality Law
- Public Works Law
- Encouragement of Tourism law
- Law of National Forestation and Control of Erosion
- Electricity market Law
- Expropriation Law
- Resettlement Law
- Land acquisition Law
- Law of domestic and industrial water supply to cities
- Renewable Energy Law
- Law of Land and Agriculture Reforms
- Civil Law
- Hunting Law
- Aquatic Products Law

The Legislations:

- Environmental Impact Assessment
- Protection of Air Quality
- Control of Air Pollution Due to Warming
- Control of Air Pollution Due to institution of Industry
- Assessment and Management of Environmental Noise
- Control of Water Pollution
- Fishery Products
- Control of Solid Waste
- Control of hazardous waste
- Control of medical waste
- Control of waste oils
- Control of package and waste of package
- Control of waste of battery and accumulator
- Dangerous chemicals
- Control of hazardous chemical material and productions
- Control of construction, wreckage waste and excavation ground
- Control of soil waste
- Application of soil production and land uses law
- Use and protection of agricultural land
- Protection of wetland
- Application of international trade of animals and plant species which have a risk of extinction
- Protection of Game and wild animal and their habitats
- Highway traffic
- Business opening and working license
- Occupational health and labor safety
- Inspection of environmental health and its supervisors
- Application of agriculture reform law in wetland for land arrangement
- National Park Regulation

Turkey became party to the international conventions that should be considered in the preparation of EIA report (ÇOB, 2009). Here is the list of these international conventions;

- The Bern Convention on the Conservation of European Wildlife and Natural Habitats
- The Convention on International Trade in Endangered Species of Wild Fauna and Flora
- The Convention on Wetlands (Ramsar Convention)
- The Convention on Biological Diversity (The Rio Conventions)
- The Convention for the Protection of the Mediterranean Sea against Pollution
- The Convention on the Protection of the Black Sea Against Pollution
- The Convention Concerning the Protection of the World Cultural and Natural Heritage
- The convention on Combating Desertification
- Adaptation on EU Directives related to water issues
- Water Framework Directive 2000/60/AT
- Directive on Prevention of Contamination of Groundwater Caused by Certain Hazardous Substances
- Directive on Protection of Groundwater Against Contamination and Degradation
- Directive on Assessment and Management of Flood Risk
- Directive on Quality of Surface Waters which are Intended to be used for Obtaining Drinking Water
- Directive on Measurement Methods and Sampling and Analysis Frequencies of Surface Waters Which are Intended to be Used for Obtaining Drinking Water

For sustainable environmental development, Integrated Water Management is essential to protect all water resources. The Water Framework Directive Project is one of the adaptation regulations for Europe. Turkey tries to enact the "Framework Water Act" until 2013 (DSİ, 2009). It covers;

- Protecting surface and groundwater by integrated approach,
- Achieving the determined water quality target for year 2015,
- Integrated river basin management,
- Integration of Emission Control and Water Quality approaches,
- Economical tools; economical analysis, providing accurate pricing for reasonable and fair water use,
- Public participation: including public and stakeholders.
- "Capacity Building Support in Water Sector for Turkey"

As can be seen, Ministry of Environment and Forest declare lots of laws and legislations that should be considered in the preparation of EIA report for dam and HEPP projects. On the other hand, there were several environmental and social problems resulting from these projects. For this reason, hydropower projects' development procedures and formalities in Turkey were examined and illustrated in Figures 4.2 and 4.3 in order to find where these problems come from.

According to Figure 4.2, EIA process starts after a company prepared final designs of the projects. This means, DSİ had already approved the feasibility studies and Energy Market Regulatory Authority had already given license to the company. For this reason, in final design, the company might face with lots of environmental and social problems with EIA report. Sometimes, due to these problems, the company should redesign the projects and should develop alternative solutions and sometimes the project is stopped by the Court decision. However, if there were initial EIA report that the company should have prepared in feasibility process and should have received approval from the Ministry of Environment and Forest, the environmental and social problems related to the projects would be determined already. If DSİ assessed the feasibility studies with this initial EIA report, so many environmental and social problems resulting from the project would not occur. The EIA process will be examined particularly in the following section.

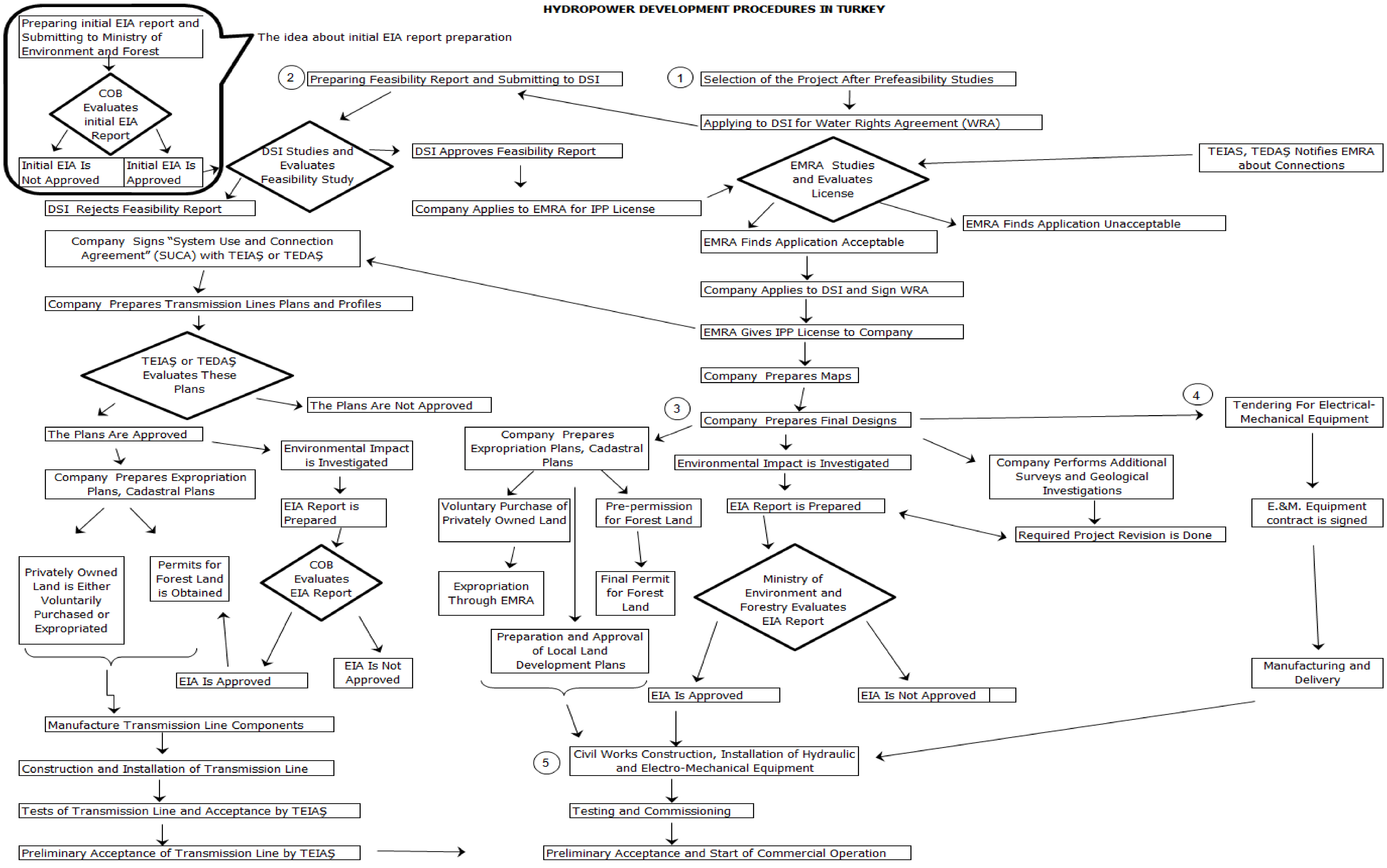

Figure 4.2 Hydropower Projects Development Procedures in Turkey

(1) Selection of the Project, Prefeasibility, Investment Decision

RECONNAİSSANCE INVESTIGATIONS
- Identification of purpose
- Data Collection and market survey
- Desk Studies of Water Resources, Storage and Power Potential
- Field Surveys to Verify Desk Studies
- Evaluation of Water Resources
- Investigation Program

RECONNAİSSANCE STUDY
- Basin Planning
- Priorities
- Individual Project

PRELIMINARY INVESTIGATIONS
- Collection and Evaluation of Basic Data
- Power Market
- Hydrology
- Meteorology
- Sediments
- Topography
- Geology
- Seismicity
- Environment
- Infrastructure
- Socio-economy
- Field Investigations
- Gauging, measurements

PREFEASIBILITY STUDY
- Screening of Projects, Selection
- Project Formulation
- Investigation of Alternatives
- Preliminary Layouts and Project Plan
- Basic Designs
- Costs
- Investigation Program

PREFEASIBILITY REPORT

FIELD INVESTIGATIONS
- Power Market Survey and Demand Forecast
- Hydrology – Evaporation, Water Quality, Meteorology, Water Rights and Water Management
- Topography – Serial Photography, Ground Surveys, Map Construction
- Geology and Geomorphology – Soils and Materials, Seismicity
- Ecology – Survey and Inventory
- Multipurpose Uses
- Inventory of Infrastructures

INVESTIGATION REPORT and DATA BOOKS

(2) Preparing Feasibility Report and Submitting to DSI (3/6 months)

FEASIBILITY STUDY
- Review of Prefeasibility Study, Project Summary
- Selection of Alternatives
- Water and Power Studies, Regulation, Storage
- Layout and Project Plans
- Optimization and Preliminary design
- Development Stages, Installation Program
- Future Project Considerations
- Implementation Schedules
- Cost Estimates
- Development of Cash Flow Tables
- Economic and Financial Analyses
- Environmental Impact Assessment

FEASIBILTY STUDY REPORT
DETAILED FIELD INVESTIGATIONS
LOAN APPLICATION (DEBT FINANCING) REPORT
INFORMATION
MEMORANDUM
APPRAISAL REPORT BY FINANCE INSTITUTIONS

(4) Tendering E-M Equipment

TENDERING and CONTRACTING
- Tender Administration
- Prequalification of Tenderers
- Tendering
- Tender Evaluation
- Contract Negotiations and Bargaining
- Signing Contracts for Works and Supply - Civil Works, Electro-mechanical Equipment, Transmission Lines Penstock, Road Relocations, Gates, Trash Racks, Other Subcontractors

OPERATION & MAINTENANCE
- Operation
- Coordination with Load Dispatch Center
- Maintenance
- Periodic Cleaning and Repairs
- Operation Optimization

(3) Company Prepares Final Designs

FINAL DESIGN and REPORT
- Review of Feasibility Study
- Final Design of Scheme and Tender Drawings
- Specifications and Bills of Quantities
- Road or Railroad Relocation Designs, etc.
- Tender and Contract Documents, Civil Engineering Works, Electro-Mechanical Works, Transmission Works
- Engineering Estimates
- Construction, Supply, Erection and Commissioning Schedule
- Model Tests
- Financing Plan
- FINAL DESIGN and REPORT

(5) Civil Works Construction, Installation of Hydraulic and Electro-Mechanical Equipment

CONSTRUCTION (Owner Side)
- Contract management
- Detailed Design and Workshop Drawings
- Material and Production Controls and Monitoring
- Construction Management
- Site Management, Construction Supervision
- Commissioning
- As-built Drawings, Operation and Maintenance Manuals, Spares
- Operation Personnel Training

CONSTRUCTION (Contractor Side)
- Civil Engineering Works
  - Diversion, Cofferdams
  - Infrastructure Relocations
  - Dams, Weirs, Water Intake, Spillways
  - Tunnels, Channels, Stilling Basins
  - Head Ponds , Surge Tanks
  - Penstock
  - Gates, Valves, Trash Racks
  - Power House
- Mechanical Equipment
- Turbines, Pumps, Hydraulic System
- Electrical Equipment
- Generators
- Operation and Control System
- LV, MV, HV Switchgear
- Transformers and Switchyard
- Transmission Lines
- Erection, Testing, Commissioning

Figure 4.3 Hydropower Projects Development Formalities in Turkey

4.3 Environmental Impact Assessment Process in Turkey

One of the main fundamental components of sustainability is environmental protection. In 1983 the environmental law was enacted. This law brought with lots of regulations. One of these regulations is by-law on environmental impact assessment (EIA) published on the 7th February 1993. The Turkish Ministry of Environment and Forest published the last version of this by-law in the official gazette on the 17th July 2008. The regulation of administrative and technical principles and procedures for the process of Environmental Impact Assessment are the aims of this regulation (ÇOB, 2008). It includes;

- Monitoring and inspection of the projects before, during, and after operational period
- The type and contents of projects for which the Environmental Impact Assessment Application File, Environmental Impact Assessment Report, and Project Introduction File will be required
- Administrative and technical principles and procedures to be complied with during Environmental Impact Assessment process
- The studies to be conducted in order to constitute a Scoping and Examining & Evaluation Commission for Environmental Impact Assessment,
- Training studies required for effective and extensive implementation of Environmental Impact Assessment system and for strengthening its institutional capacity.

Administrative and technical principles and procedures for the process of Environmental Impact Assessment are illustrated on the Figure 4.4. Briefly; first of all, whether the Environmental Impact Assessment Report is required or not, is determined according to the criteria in Annex List 1 and List 2 shown in Table 4.2. If it is required, the project owner send Environmental Impact Assessment Application file to the Ministry. Then the Ministry establishes the Scoping, Examining and Evaluation Commission in order to decide the scope and criteria of the special format given to a project and to examine and assess the Environmental Impact

Assessment Report. This commission consists of representatives of relevant institutions and organizations, officials of the Ministry, and project owner and/or representatives. If the Ministry deemed necessary by taking into consideration the subject and type of project and the characteristics of the location assigned for the project, the representatives of universities, institutions, research and expert bodies, professional associations, trade unions, associations and non-governmental organizations may be invited as members to the commission meetings (ÇOB, 2006).

The members who represent the institutions and organizations in the Commission should have sufficient professional knowledge and experience and should be authorized to give opinions on the subjects limited with the task field of the institutions and bodies which they represent (ÇOB, 2006).

Then public participation meeting is performed. In the meeting, the public which consist of the citizens of Republic of Turkey, foreign citizens residing in Turkey, and associations, organizations or groups constituting one or more such legal persons in accordance with national legislation are informed about the project and shall be able to communicate their opinions, questions, and recommendations regarding the project. The scope and special format determination meeting follows public participation meeting. By paying attention to these meetings, the Environmental Impact Assessment Report is prepared and opened by the Provincial Directorate of Environment and Forestry and Ministry of Environment and Forestry to receive the opinions and recommendations of the public. If the commission admits that EIA report is sufficient at the examination and assessment meeting, the project owner submits that Report as Final Environmental Impact Assessment Report to the Ministry. Finally the ministry decides that the Environmental Impact Assessment is negative or positive. The Governorate shall announce to the public the content of the decision, the reasons constituting the basis for the decision, and the opinions and recommendations of the public which have been reflected in the Final Environmental Impact Assessment Report.

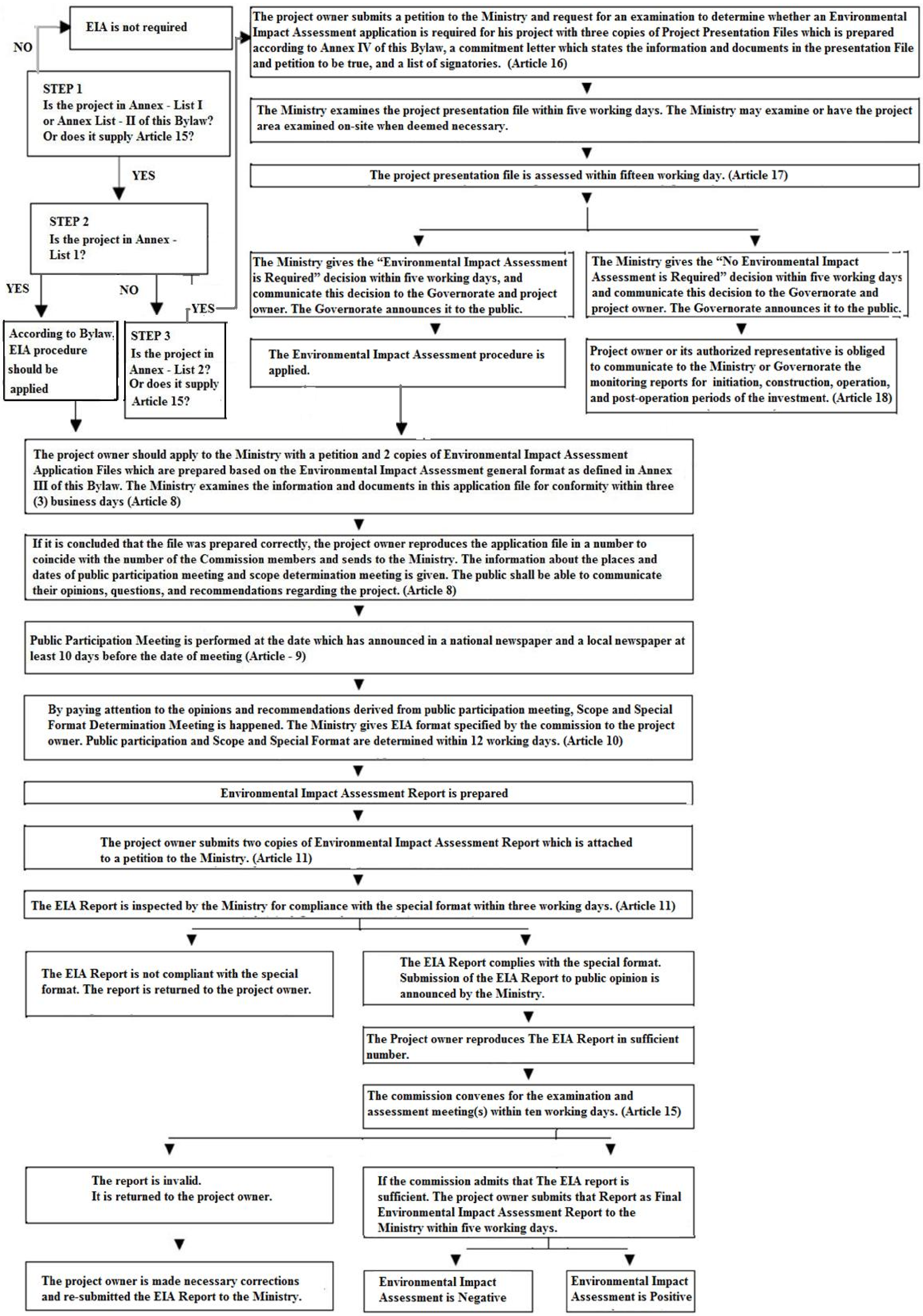

Figure 4.4 Administrative and Technical Principles and Procedures for the Process of Environmental Impact Assessment

For hydropower cases, the conditions while deciding whether the EIA Report is required are illustrated in the following table.

Table 4.2 The Conditions While Deciding Whether the EIA Report is Required

ANNEX – 1 LIST THE LIST OF PROJECTS TO WHICH ENVIRONMENTAL IMPACT ASSESSMENT SHOULD BE APPLIED
Water storage facilities (Dams and lakes with a reservoir volume of 10 million m^3 and over). (Item -15) River type power plants with an installed capacity of 25 MW or more. (Item -16)

ANNEX – II LIST LIST OF THE PROJECTS TO WHICH SELECTION AND ELIMINATION CRITERIA ARE APPLICABLE (The Lower Bounds in Annex I List are Accepted as the Upper Bound in This List)
Water storage facilities (Dams and lakes with a reservoir capacity of 5 million m^3 or more) (Item -27/m) River type power plants having 0.5 MW or more installed capacity. (Item -28)

4.4 Social Impact Assessment Process in Turkey

There is no by-law on social impact assessment in Turkey. Land properties are derived by DSİ for water and land resources development. The value assessment commissions were established with Expropriation Law No. 2942 (Amended Law No. 4650). According to this law, unless there is sufficient price, expropriation cannot be started. The value assessment commissions were established with this law to evaluate value and invite landowners for a compromise. If there is an agreement on the expropriation price, the payment is done within 45 days, in advance and in cash. Otherwise, the Court determines this price then DSİ has to pay it within 15 days to the landowners. DSİ's statistics in 2007 shows that, the rate of agreement for expropriation is about 80% (DSİ's Annual Report, 2009).

DSİ expropriates the necessary land properties, whereas General Directorate of Disaster Affairs (GDDA) (pursuant to Resettlement Code 5543) implements the resettlement of people affected by Dam projects who prefer to be resettled by the State. People not wishing for resettlement by the State, derive expropriation money and settle wherever they choose. When project affected families choose resettlement by the State, they can prefer rural or urban resettlement instead of receiving expropriation money. One of the other solutions is in the form of "movement inside the village boundaries". In this case, families may receive both the expropriation money and a loan for the plot of land and housing construction (Water and DSİ, 2009).

There are approximately 350,000 people affected by DSİ's projects. Almost 250,000 more people will be supposed to be affected in the future (Water and DSİ, 2009).

4.5 Debates on HEPP Projects and Opinions of Dam Opponents

River-type HEPP can be considered as renewable alternative energy source. However, rules of construction and operation phases and related control mechanisms should be determined completely and accurately. If hydroelectric power generation is considered only and its negative aspects, especially on nature, are not taken into account, HEPP leads to irreparable destruction and national mistakes. There are approximately 2000 the river type HEPP projects planned by DSİ and private sector. Total installed capacity of these projects area about 25,000 MW and the annual average production is expected to be 125,000 GWh. Predicted value of this production is equal to 60% of Turkey's total amount of electrical energy consumption in 2008. However, these HEPP projects expected to be completed in 2023 will meet approximately 5% of 2023's electricity demand (TEMA, 2009).

In the following subsections, debates on HEPP projects and general opinion of Dam opponents including some NGOs, Public Concern Organizations, Environmental Organizations and Scientific Communities are mentioned according to process and legislations related to hydropower projects, environmental and social effects of hydropower projects (OECD, 2008; DOKÇEP, 2009; TEMA, 2009; Gülşen, 2011; Serter, 2006; Akyürek, 2005).

4.5.1 Opinions Related to Process and Legislation of Hydropower

There are lots of legislations and laws related to hydropower projects, their applications, inspections and intimidating punishments are essential for sustainable development. After application of the Law No 4628 under Electricity Market Law which is related to the idea of water usage right, there is an excessive increase in the number of HEPP in construction with participations of private sector. Therefore, the problems related to Environmental Impact Assessment also arise. According to Organization for Economic Co-operation and Development's Environmental Performance Reviews in Turkey (OECD, 2008), not only there is a deficiency in application of by-law on Environmental Impact Assessment but also, their inspections are insufficient.

According to the EIA legislation, HEPP projects under 0.5 MW is not subject to the EIA process. 0.5 to 25 MW power installed HEPP projects taking place in Annex II are only subjected to project identification file process (pre-EIA). However, when the entire HEPPs are considered in the project area, total impact on this area will be very large. Many of the current projects are under 10 MW and have been licensed without being subjected to the EIA process. When these projects are constructed, the size of this destruction will increase rapidly. For this reason, river basin based planning with an overall impact assessment on the basin and throughout the country should be prepared to sustain the continuity of ecological systems (TEMA, 2009). Although the projects are evaluated particularly, they are inextricable. Some projects which were taken to the court by the local environmental groups were stopped. For example, as a result of environmentalists' judicial struggle, İkizdere Valley in Rize was declared as a natural protected area in 2010. Thus, 22 hydroelectric power plant projects in İkizdere, Anzer and Ovit region were stopped by court order. In order to satisfy sustainable water usage and integrated river basin management, a water council including the Ministries of Foreign Affairs, Energy and Natural Resources, Environment and Forest, and the State Hydraulic Works, sectoral representatives, various professional disciplines and civil society organizations might be established for future plans (DOKÇEP, 2009). For the adoption of EU's Water Framework Directive, Framework Water Law might be enacted as soon as possible.

The EIA process should begin with feasibility studies of the project. While assessing alternative dam sites, the technical and economic conditions, as well as environmental conditions should be examined. In this regard, the EIA studies began at the right time allow sufficient environmental data collection and evaluation about the location of the dam. Thus, the environmental sensitivity of these areas can be determined as early as possible and it can be taken into consideration during project planning studies. Therefore, the environmental conditions related to the project site and cost and vulnerabilities about its effects can be considered while assessing alternative options. The problems and costs that may arise later can be prevented with the selection of the right place.

The most critical issues for all planned HEPP projects are the amount of water used and the determination of water amount that should be released to downstream for the ecological water requirement so that aquatic life and other ecosystems can survive and the people living in the region can meet their water needs.

While signing Water Usage Agreement, the amount of ecological water, irrigation water, drinking water, and water uses needs for fish production farms are not clear. Flow rates does not specified monthly and daily. Therefore, the amount of released water is not specified in the agreements (TEMA, 2009).

Many projects has been prepared with releasing 100-150 lt/sec water to downstream as ecological water requirement. In recent years, the ecological water requirement was determined as at least 10% of the average flow in last 10 years. This amount may not be the same for each river basin. It should be determined by ensuring the protection of other water rights and the natural balance of basin for each river (TEMA, 2009).

A scientific method might be developed for the amount of released water into downstream to maintain existence of ecological life. While determining this method, the river’s own characteristics and the properties of ecosystem around the river might be considered. Which institution controls releasing ecological water and its time and its enforcement mechanisms might be clarified. The relevant institutions and provincial organization may be appointed by authorized with regulations. Local people and NGOs should also be included in this process (TEMA, 2009).

According to new regulation prepared by Ministry of Environment and Forest in 2010, the instructors attending at least Ph.D. program from hydrobiology, hydrogeology and ecology departments will designate the amount of environmental flow separately by using different ecological methods.

Furthermore, the HEPP projects under construction might destruct the land surfaces greatly. In order to derive Certificate of Environmental Impact Assessment and to prepare final project and reconstruction plan, drilling site and drilling access roads may be allowed by the Forestry Administration. After giving permission, the Forestry Administration cut trees in this route, and the investor can construct the roads. Later, the development plan is prepared and EIA is derived. In some cases, there are some troubles related to the development plan and EIA. Therefore, the land surfaces are being destroyed unnecessarily (TEMA, 2009).

Moreover, the various wildlife areas under protection by national and international conventions such as Land Hunting Law, the Berne Convention, CITES Convention, will be destructed due to the construction of a large number of HEPP. This causes the action contrary to national and international law.

For successful Environmental Impact Assessment, the main criteria are administrative capacity, objective decision process, explanation of decision to the public, accomplished scoping, efficient public participation, successful Scoping and Examining and Evaluation Commission, Environmental Impact Assessment Report of good quality, specialized adviser staff, an effective, scientific monitoring and control process (Serter, 2006).

EMRA (Energy Market Regulatory Authority) gives very short construction period (maximum 40 months) to investor institutions. This time is not sufficient for taking approvals of the EIA Certificate, Master Plan, Property issues, building permits. In addition, many HEPP Projects are in over 1000 m altitude. The investors have to challenge with this short construction period. For these reasons, investors can start construction without the required zoning and building permit. This also leads to an application outside the limited control (TEMA, 2009). Moreover, there is no intimidating punishment. Related companies under HEPP construction may take every measure on time and the relevant institutions might control them. The implementation of the necessary mechanisms is required so that investor companies completely carry out its responsibilities mentioned in Water Use Rights Agreements.

In addition, for the licensing application of the rivers, EMRA gives licenses without taking opinions of local institutions, organizations and people. For this reason, the local authorities face with social and technical insoluble problems about to the construction of HEPP plant projects (TEMA, 2009).

4.5.2 Opinions Related to Environmental Issues

Due to changing environmental figures in the region, the extinction of many specific flora and fauna might have critical results for future generations. Hence, the negative effects of the projects on environment, cultural skin, and social structure can be minimized by implementing scientific studies with necessary experts. Furthermore, historical, cultural and natural assets affected by HEPP projects might be determined and reported to Regional Cultural and Natural Heritage Protection Councils (TEMA, 2009).

Even though the percentage of sensitive areas in Turkey is only 3.8%, a HEPP can be constructed at these areas (Gülşen, 2011). It is essential that the sensitive areas should be protected. These projects must not have a negative influence on these areas.

Cuts opened in the highland to transfer water with the tunnel or channel and to maintain these facilities and to control these facilities cause the evaporation of groundwater. Therefore, the forest trees using this water and the sources feeding with this water might disappear. In addition, the direction of water flow might change (TEMA, 2009).

The changes of the ecological water demand, quality of water used and the negative effects of these changes on natural water ecosystems have not be mentioned enough.

In the river where HEPP project will be constructed, water detection should be done and the amount of local people's seasonal water use should be determined. These amounts should be compared with the amount of ecological water requirement. The adequacy of planned water releases should be investigated (TEMA, 2009). In addition, water quality management plan can be prepared in river basin to determine possible effects of planned projects on water quality in the future.

Constructions such as channel, road, and tunnel disturb the integrity of the forest. For this reason, wild animal's living areas, natural habitats, breeding, feeding and migration paths might be destroyed.

In addition, energy transmission lines are considered separately after the end of the project. Location of transmission lines and forest destruction due to the transmission lines in this area are not included in the projects. However, up to the area where the lines connected to the national grid would create a very high level of forest destruction. If high-voltage lines are forced through the residential areas in the narrow valleys, it will be adverse effects on human life (TEMA, 2009).

Projects will destroy thousands of trees. Amount of cut trees for the project and ecosystem destruction costs are not considered. The integrity of the forest will be disrupted. Particularly, destruction of forest and grassland areas leads to precipitation turning into flooding waters and to soil erosion and transportation. Erosion and sediment control are required for water and land sources sustainability. For this reason, proper investigations related to these issues might be done especially in the dam areas. Forestation work and creation of recreation areas could facilitate to avoid erosion, decrease the sediment amount deposited in dams through rivers, restore the environment of dam basins and their catchments, and establish natural balance between water, plant and land. Moreover, public can benefit from these green areas for promenade and picnic. By this way, a more green country with water and soil resources will be inherited to young generations.

Project areas might be sensitive to disasters such as floods and landslide. The nature interference, destruction of vegetation (especially in the steep slopes), construction of roads on steep slopes, the tremors caused by blasting in stone quarries will adversely affect or destruct slope / bedrock / soil and water balance in the basin (TEMA, 2009).

There might be no storage area for excavation materials especially owing to the geographical structure of construction area. Therefore, these materials might be thrown from hillside involuntarily or voluntarily and fill the river valley which should be protected actually.

Control principles and inspection organizations for the problems arising during the construction and operation are not prescribed clearly. Therefore it is impossible to control the activities. To protect the natural environment and life by minimizing the negative effects of HEPP implementations, ecological planning, effective control and monitoring works might be considered.

4.5.3 Opinions Related to Social Issues

It is a major problem that the policy and implementation principles of HEPP projects are determined without taking the opinion of the people affected by projects and social society organizations. It causes public to deprecate some of these hydroelectric power plant projects. Sometimes, during inspection of the project, an exclusion of public can be seen in order to avoid these complaints (Serter, 2006). In addition, this regulation does not cover the procedure of judgment application for people who have complaints about the projects (Gülşen, 2011). Energy Market Regulatory Authority, the General Directorate of State Hydraulic Works and Ministry of Environment and Forest might inform relevant authorities, local institutions, NGOs and people affected by projects and can request their opinions before giving the necessary permissions. Their opinions might be considered during all parts of a project.

The expropriation and resettlement are also important issues underlined by HEPP's critics. Social dimension takes place in expropriation actions. Therefore, it is important to make plans to minimize socio-economic influences on people who have to abandon their land for these projects. A resettlement plan is not enough to solve the problem. To minimize the negative effects of resettlement and expropriations on the local people and to satisfy social and economical development in these regions, applicable and realistic rehabilitation programs should be prepared and monitoring the level of self sustainability should be done. This rehabilitation should include not only stakeholders whose lives have been affected directly from dam constructions, but also, women, children, adolescents, children working in streets, the urban poors, landless peasants, small farmers and nomadic communities (Akyürek, 2005).

Living standards in the region may be improved so as to satisfy the public acceptance easily, to attract and keep qualified personnel in the region and to decrease the emigration. The development programs might be organized including irrigation, industry, agriculture, rural and urban infrastructure, mobilization, transportation, communication network, domestic water use, hygiene, sewerage systems, forestry, fishery, education, health services, tourism and social services. If these social supports are not satisfied, the new lives of these people affected by the project will become unknown. Probably, they will not keep their life standards as in their previous level. Some supportive education programs and institutional activities can help the people to adapt faster and easier.

The negative influences on the region's fast-growing eco-tourism potential and local people's socio-economic lives are ignored. There might be intense alternative tourism activities due to biological, aesthetic and recreational wealth in the region. The structure of natural landscape of the region with all assets might become corrupted. Moreover, the amount of water needs for local residents' agricultural activities for their own needs and irrigated agriculture's today and future needs are not taken into account (TEMA, 2009).

One of the other problems is the long term uncertainties in the resettlement of those people. The people who were paid cash compensation should be monitored on the issues of proper management of their compensations or standards of their lives, etc. Moreover, the compensation payment schedule sometimes fails due to improper budget organizations of related institutions, the underestimated cost of some items resulted from insufficient the social and technical surveys and lack of proper institutional and legal mechanisms. To avoid such failures, scientific study methods should be included on the land acquisition and resettlement processes by the experienced agencies. Therefore, the important items for proper implementation of resettlement processes are the experience of implementing agencies, the quality of staff including multi sectoral experts, the budget constraints and the successful cost estimation (Akyürek, 2005). Besides inaccurately prepared property assessment, land and forest areas' cadastral work sometimes is not finished yet. Thus, both citizens and treasury will incur losses (TEMA, 2009).

Unfortunately, the social impacts are limited to the expropriation and resettlement concept in Turkey. Land consolidation, population change, education, health, gender issues and cultural heritage are important issues that might be considered.

CHAPTER 5

SCRUTINIZATION OF KAYRAKTEPE PROJECT BY USING IHA'S SUSTAINABILITY ASSESSMENT PROTOCOL

5.1 Introduction

In this chapter, the Kayraktepe Project will be evaluated by using Early Stage Assessment Tool in IHA's Hydropower Sustainability Assessment Protocol. For this reason, first of all, brief information about the Kayraktepe Projects will be given. Then, the measurements of Early Stage Assessment Tools will be explained. Finally, Early Stage Assessment Tool will be applied to the Kayraktepe Project and the results will be discussed.

5.2 Information about the Kayraktepe Projects

In 1982, Kayraktepe Dam was firstly designed as a 125 m high large dam on the Göksu River so as to supply reliable energy resource, permanent discharge, and to provide flood control. Although the investment program of the project was started in 1986 under finance from the World Bank, the implementation and the commencement of the construction except for preliminary works such as camp facilities and access roads were postponed because of various circumstances in Turkey. Moreover, during the time when the project has been postponed, there has been remarkable development of social infrastructures and private properties in the project area (Feasibility Study Final Report, 1997). In 1997, Kayraktepe Dam and HEPP Project was revised by reducing the height of dam. However, the implementation and the commencement of the construction did not start.

In 2003, by Water Use Right Agreement, private sector took in place for energy generation. In 2008, Kayraktepe Dam and HEPP Project was awarded to a private company for large scale dam formulation. Finally, Kayraktepe project has redesigned by the private company in 2010 by changing the formulation to one medium dam and five regulators instead of a large scale dam (Sever, 2010).

The chronology of Göksu Basin and Kayraktepe Dam Projects are listed in Appendix B. In this chapter, the Kayraktepe Projects prepared in 1982, 1997 and 2010 will be explained in detail in chronological order.

5.2.1 The Kayraktepe Dam and HEPP Projects in 1982 and 1997

General Directorate of Electrical Power Resources Survey and Development Administration (EİE) identified the Kayraktepe Dam Project while investigating Göksu River Basin. The main aims of Kayraktepe project were energy production, flood control and water supply for the downstream irrigation projects. After results of international competitive bidding between 1977 and 1997, a consortium of EPDC, Su-İş, Su-Yapı, and TMB dealt with Kayraktepe Project. Four different dam locations were studied. According to this consortium, Dam site No.3 shown in Figure 5.1 was preferred and the rockfill dam with vertical clay core was optimal. By excavating alluvial deposit down to the sound rock foundation, dam safety and satisfactory foundation treatment was provided.

As mentioned before, there has been remarkable development of social infrastructures and private properties in the project area due to delay on the implementation and the commencement of the construction. Under such circumstances, in order to decide whether smaller scale scheme of this project is feasible or not, EPDC and Su-İş prepared revised feasibility study report in 1997. According to this revised feasibility study report, only dam height was lowered 35.50 meters. Basic idea and typical section of the dam were not changed. The locations of Kayraktepe Dam are illustrated in Figures 5.1. and 5.2. The comparisons of these projects characteristics are shown in Table 5.1 (Feasibility Study Report, 1982 and 1997).

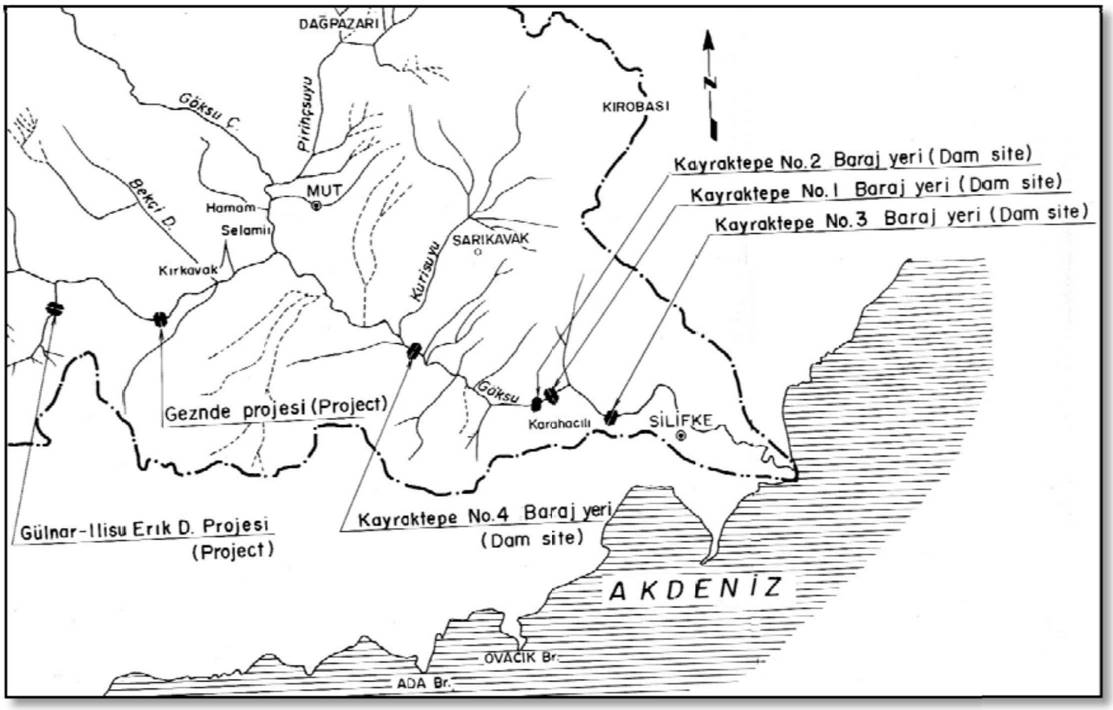

Figure 5.1 Location of Kayraktepe Dam Site No.3 (Feasibility Report, 1982)

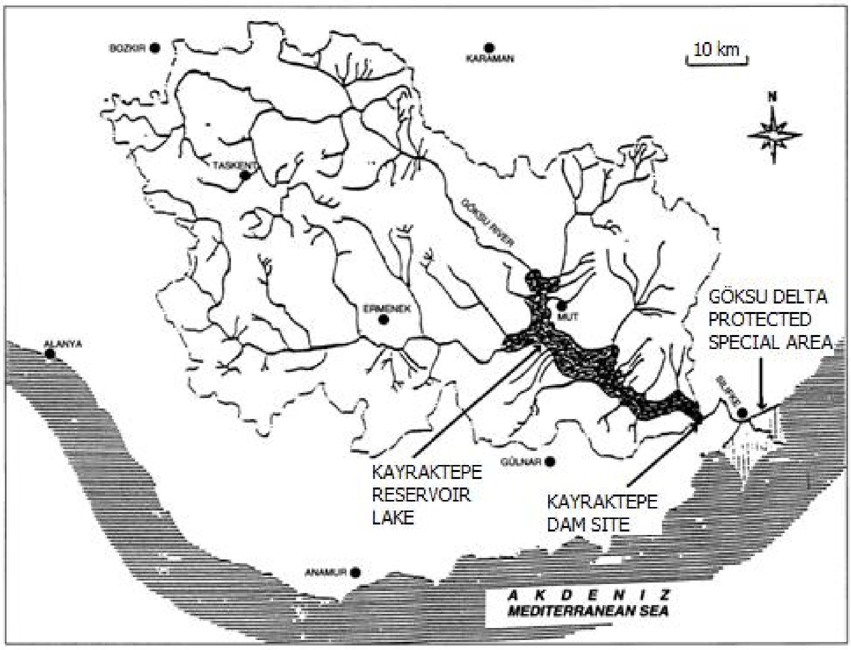

Figure 5.2 Location of Kayraktepe Dam and Its Reservoir Lake (Biro, 1998)

Table 5.1 The Comparisons of the Kayraktepe Projects' Characteristics

Project	Name:	Feasibility Study	Revised Feasibility Study
	Date:	1982	1997
River	Name:	Göksu	Göksu
	Catchment Area:	10,069 km^2	10,069 km^2
	Annual Inflow:	3,546 x 10^6	3,671 x 10^6
Reservoir	Flood Water Level:	158.00 m	122.50 m
	High Water Level:	157.00 m	120.00 m
	Low Water Level:	127.50 m	110.00 m
	Available Drawdown Depth:	29.50 m	10.00 m
	Gross Storage Capacity:	4,800.00 x 10^6 m^3	1,726.90 x 10^6 m^3
	Flood Control Capacity:	160.00 x 10^6 m^3	160.00 x 10^6 m^3
	Active Storage Capacity:	2,800.00 x 10^6 m^3	524.80 x 10^6 m^3
	Reservoir Area:	133.00 km^2	65.25 km^2
Dam	Type:	Rockfill Dam with Center Core	Rockfill Dam with Center Core
	Elevation of Dam Crest:	161.00 m	125.50 m
	Height of Dam:	196.00 m	160.00 m
	Length of Dam Crest:	580 m	460 m
	Volume of Dam:	17,000 10^3 m^3	7,747 x 10^3 m^3
Diversion Tunnel	Number:	2	2
	Inner Diameter:	9.0 m	9.5 m
	Length:	807.70 m / 857.30 m	710 m / 770 m

Table 5.1 (Continued) The Comparisons of the Kayraktepe Projects' Characteristics

Spillway	Design Flood:	9,875 m^3/s	9,875 m^3/s
	Type:	Gate Chute	Gate Chute
	Over Flow Crest Elevation:	143.00 m	107.5 m
	Width of Overflow Crest:	97.8 m	97.8 m
	Energy Dissipating System:	Flip Bucket	Flip Bucket
	Type of Gate:	Tainer Gate	Tainer Gate
	Number of Gate:	6	6
	Size of Gate:	13.80 m x 15.00 m	13.80 m x 15.00 m
Power Intake	Type:	Inclined	Inclined
	Number:	2	2
	Inlet Elevation:	105.00 m	87.5 m
	Type of Gate:	Caterpillar Gate	Caterpillar Gate
	Number of Gate:	2	2
Headrace Tunnel	Type:	Circular Pressure	Circular Pressure
	Number:	2	2
	Discharge Capacity:	198.00 m^3/s	195.00 m^3/s
	Inner Diameter:	8.40 m	8.00 m
	Length:	170.80 m	213.46 / 254.47 m
Penstock	Type:	Steel Embedded	Steel Embedded
	Number:	2	2
	Diameter:	7.20 m ~ 5.20 m	6.80 m ~ 5.20 m
	Length:	315.20 m / 283.80 m	172.85 m / 166.69 m

Table 5.1 (Continued) The Comparisons of the Kayraktepe Projects' Characteristics

Development Plan	Effective Head:	116.00 m	86.00 m
	Maximum Discharge:	198m^3/s (main)/20 m^3/s (sub unit)	390.00 m3/s
	Unit Capacity:	200 / 20 MW	145 MW
	Number of Unit:	3	2
	Installed Capacity:	420 MW	290 MW
Turbine	Type:	Vertical Shaft Francis Turbine	Vertical Shaft Francis Turbine
	Number:	3	2
	Max. Discharge:	198.00 m^3/s / 20.00 m^3/s	195 m^3/s
	Turbine Output:	206,000 / 21,000 kW	149,000 kW
	Revolving Speed:	150 / 429 rpm	150 rpm
	Installed Capacity:	206.00 MW	149.00 MW
Generator	Number:	3	2
	Rated Output:	224,000 / 24,400 kVA	171,000 kVA
	Power Factor:	0.9	0.9
Main Transformer	Number:	3	2
	Capacity:	224,000 / 24,000 kVA	171,000 kVA
	Voltage:	14.4 kV;380 kV / 6.3 kV;334.5 kV	11.0 kV;154 kV
Switchyard	Voltage:	380 kV / 34.50 kV	154.00 kV
Annual Energy Production	Average Energy:	991.00 GWh	767.97 GWh
	Firm Energy:	639.00 GWh	407.08 GWh
Economic Evaluation	Benefit-Cost Ratio:	11.9	1.09
Construction Period:		7 years	6 years
Investment Cost:		548,656 x 103 US$	968,132 x 103 US$

5.2.2 The Kayraktepe Dam and HEPP Projects in 2010

In spite of the revised feasibility study of Kayraktepe Project, there were still essential social and environmental problems. For this reason, Kayraktepe Dam could not have been constructed yet.

After private sector took in place for energy generation by Water Use Right Agreement, Kayraktepe Dam and HEPP was redesigned by BM Holding in 2008. Instead of a large scale dam, one medium dam and five run-of-river type hydropower stations were recommended. With this new formulation, the total installed capacity shall be 253.55 MW, with 588.23 GWh/year expected annual energy generation. BM holding claims that this new project formulation provides the additional benefits. These are listed below (BM, 2011).

- Fully retaining the flood control benefit of the original project shall be satisfied.
- A dramatic reduction in expropriation area by %95 (down to %5 of original) has been attained, where original 5000 ha have been reduced to approximately 820 ha.
- Very large area containing numerous villages and valuable agricultural areas that were originally marked for expropriation and flooding will be preserved.
- The citizens living in the region will not be affected owing to significantly reduced expropriation.
- The Wild Life Protection Area to be flooded will be retained as at the original project.
- Göksu River Delta to be deprived of natural sediment inflow under the original formulation will now be completely preserved.

Figure 5.3 illustrates the locations of Kayraktepe Dam and HEPPs. Their schematic profile view is in Figure 5.4. The characteristics of BM’s Kayraktepe project are listed in Table 5.2.

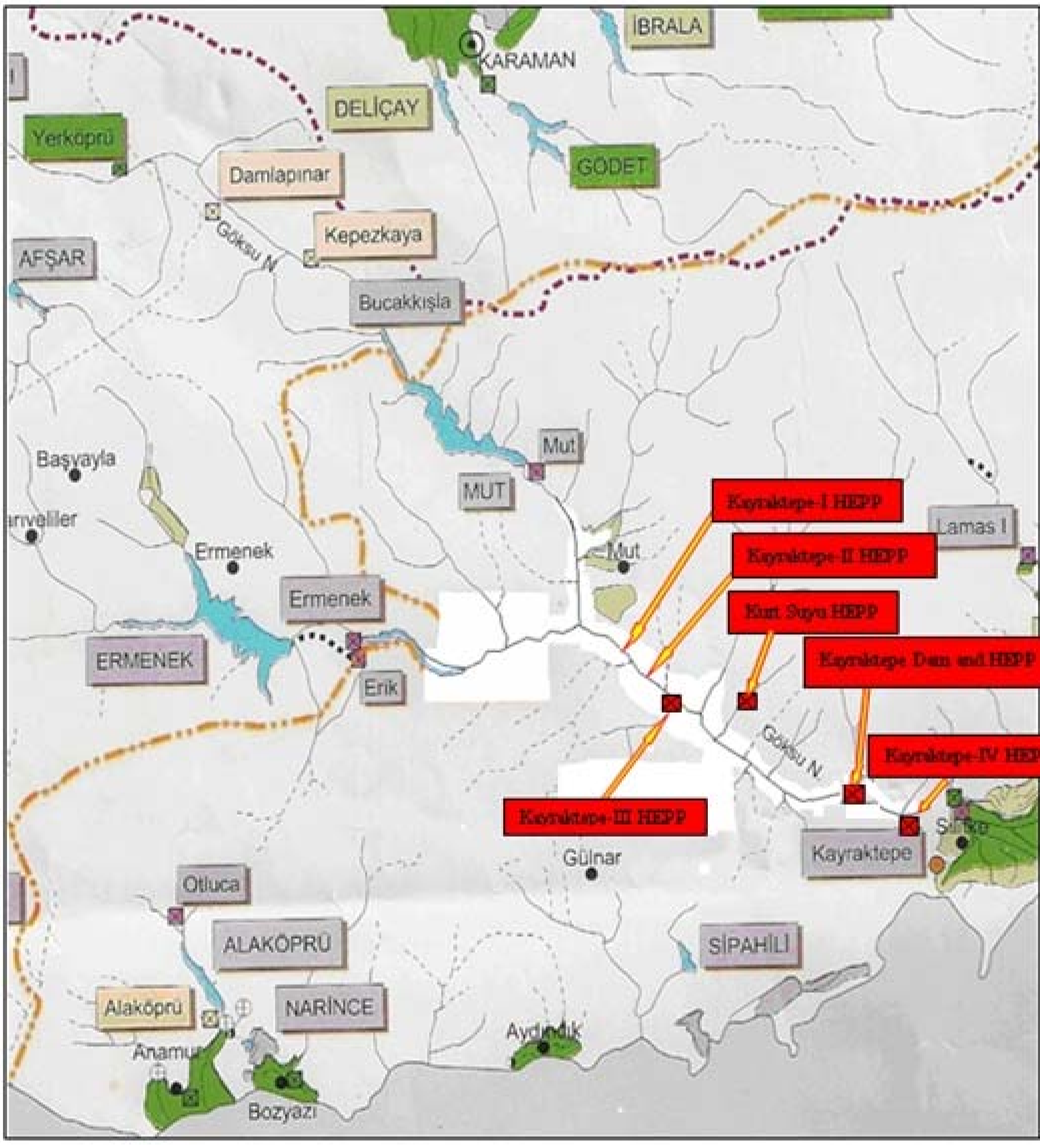

Figure 5.3 Location of Kayraktepe Dam and HEPP Project Designed in 2010 (Sever, 2010)

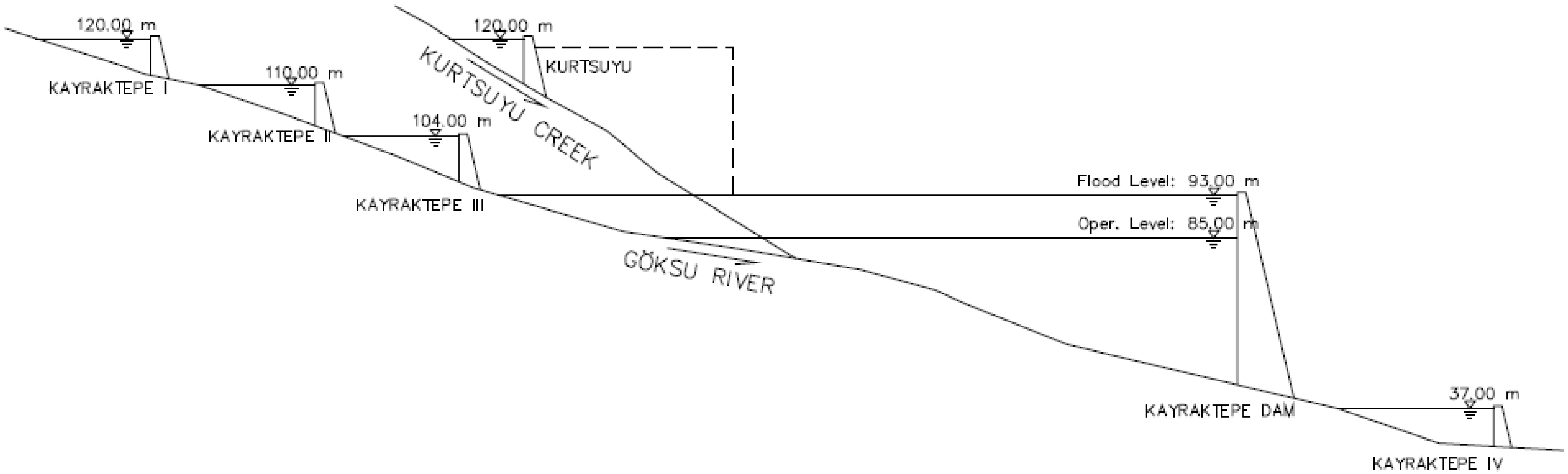

Figure 5.1 The Schematic Profile View of Kayraktepe Dam and HEPP Project Designed in 2010 (Sever, 2010)

Table 5.2 The Characteristics of Kayraktepe Dam and HEPP Project Designed in 2010 (Sever, 2010)

Name:	Kayraktepe I Diversion weir and HEPP	Kayraktepe II Diversion weir and HEPP	Kayraktepe III Diversion weir and HEPP	Kurtsuyu Diversion Weir and HEPP	Kayraktepe Dam and HEPP	Kayraktepe IV Diversion weir and HEPP
Location:	Göksu River and Ermenek Creek	Göksu River	Göksu River	Kurtsuyu Creek	Göksu River	Göksu River
Type of weir:	RCC	RCC	RCC	RCC	-	RCC
Thalweg elevation :	117.00 m	106.00 m	95.50 m	115.00 m	41.50 m	27.00 m
Operating Elevation:	120.00 m	110.00 m	104.00 m	120.00 m	85.00 m	37.00 m
Flood Level:	-	-	-	-	93.00 m	-
Dam Crest Elevation:	-	-	-	-	94.50 m	-
Tailwater Elevation:	110.00 m	104.00 m	85.00 m	85.00 m	37.00 m	28.30 m
Design Discharge:	227.00 m^3/s	232.00 m^3/s	237.00 m^3/s	8.00 m^3/s	369.22 m^3/s	369.30 m^3/s
Installed Power:	20.53 MW	12.53 MW	36.53 MW	2.48 MW	152.13 MW	29.35 MW
Energy Production:	58.80 GWh	39.37 GWh	114.40 GWh	9.68 GWh	308.58 GWh	57.40 GWh
Length of Canal:	-	-	5,925.00 m	2,285.00 m	-	-
Length of Tunnel:	-	-	513.95 m	-	-	-
Type of spillway:	uncontrolled spillways	uncontrolled spillway	uncontrolled spillway	uncontrolled spillway	controlled spillway	uncontrolled spillway
Head pond:	-	-	+	+	-	-

Today, negotiations with DSİ for this new formulation of Kayraktepe Dam and HEPP project still continue. For this reason, Early Stage Assessment Tool will be used to evaluate Kayraktepe Dam and HEPP.

5.3 Information about IHA's Early Stage Assessment Tool

The main aims of Early Stage Assessment Tool are identification of project risks, knowledge gaps and opportunities at an early stage by encouraging better early stage analysis. The process identifies consistencies and conflicts relating to energy and water needs and opportunities to improve the sustainability context of hydropower investments (IHA, 2010).

The Early Stage assessment tool is different from the other three assessment tools in IHA's Hydropower Assessment Protocol described in chapter 3. Contrast other assessment tools; it is not a scoring protocol. There is not strong basis of information to give sustainability scores at feasibility stage. The project owners have not decided yet whether to invest in more detailed studies, or to study other potential project possibilities. As long as no public announcement about project intentions has been made, this Early Stage assessment tool can be used for early stage analysis and identification of knowledge gaps. After detailed technical, environmental, social and financial feasibility studies are undertaken, the Preparation assessment tool can be used to evaluate the project (IHA, 2010).

The Early Stage assessment tool includes nine key topics relating to assess hydropower project which are existing needs, options, policies, political situation, institutional capacities, technical, social, environmental and economic risks. The expectations and assessment guidance for each key topic are described in the following subsections (IHA, 2010).

5.3.1 Demonstrated Need

Basic expectation of this topic is to decide whether there are needs for water and energy services in local, national, and regional development objectives, policies and plans or not. Needs for energy and water service projects should be demonstrated. In addition to basic expectations, the assessment may try to achieve that the project can make a significant contribution to demonstrated needs by considering environmental and social dimensions.

Here is the list of some examples of evidence;
- Energy Master Plan
- Water Development Plan
- Country or regional development report
- Analysis of project fit with demonstrated needs
- Regional land use and infrastructure development plans

5.3.2 Options Assessment

Basic expectation of this topic is to illustrate that the project is one of the priority options to meet demonstrated energy and water needs. This topic is important because it compares hydropower options with other options such as other resources types and/or energy and water conservation with comparing economic, technical, environmental and social factors. The absence of any available options assessment represents a significant risk for the developer which could be addressed in close collaboration with national authorities and financing agencies.

While planning dam and hydro-electric power plant projects, choosing the most suitable alternative project is the most important decision in the planning process. The issues that should be compared with the alternative projects are listed below.

- Energy production, investment and operating costs
- Environmental impacts (impacts on air, water, soil, biological resources and socio-economic environment)
- Areas that will be under water and its possible effects, physical losses, resettlement
- Benefits on regional/national development

Analysis and comparison of the alternatives can be done with respect to the qualitative and/or quantitative evaluation depending on available information, the sensitivity, scope and impacts of the project.

While comparing hydropower alternatives, site selection, dam type, dam size and operating conditions should be evaluated by considering economic, financial, environmental and socio-economic issues. Furthermore, it should minimize disturbance to existing features and activities.

Here is the list of some issues that can be considered in this topic;

- Energy options (energy efficiency measures, increased efficiency in generation, the full range of types of energy, and the option of no development)
- Water options (a range of infrastructure options as well as conservation, policies, distribution mechanisms, demographic and land use issues)
- Criteria or principles for analysis of alternatives (sitting on tributary streams rather than mainstream rivers, avoidance of high value biodiversity areas, avoidance of resettlement, increasing the effectiveness of existing water and energy infrastructure etc.)

5.3.3 Policies and Plans

Basic expectations of this topic are to investigate:
- Whether the project fits with existing national and/or regional policies and plans for hydropower project planning, implementation and operations,
- Whether shortfalls, gaps or complexities in national and regional policies and plans can be managed with respect to development and operation of a particular hydropower project under consideration.

This topic is important because the sustainability of hydropower development can be influenced by the quality of integrated planning for resource development

Here is the list of some issues that can be considered in this aspect;

- National and regional policies and plans
- Evaluation of project fit with policies and plans
- Evaluation of status of river basin plans and river basin sustainability issues (social and environmental related policies and plans, for example, protection of high value sites e.g. national parks, World Heritage sites, Ramsar wetlands, sites of cultural significance, recognized significant landscapes)

5.3.4 Political Risks

Basic expectation of this topic is to analyze whether there are any political risks influencing development and management of a hydropower project under consideration or not. It is important for long term sustainability of the project.

Here is the list of some issues that can be considered in this aspect;

- Political risk (a risk of financial loss or inability to conduct business faced by investors, corporations, and governments due to government policy changes, government action preventing entry of goods, expropriation or confiscation, currency inconvertibility, politically-motivated interference, government instability, or war)
- Transboundary issues (institutional arrangements upstream and downstream of the project and basin-wide sharing of resources)
- Reduction or mitigation of political risks (energy sector reform, transboundary agreements, anti-corruption strategies)
- Agreements of institutions
- Records of meetings with representatives from governments, transboundary institutions and other key stakeholder groups

5.3.5 Institutional Capacity

Basic expectation of this topic is to evaluate the capacities of the institutions that have a role in the development and operation of hydropower projects. The risk of shortfalls, gaps or complexities in the project due to lack of institutional capacity are researched.

Institutional capacity is the capacity of a given national institutional framework to handle the administration of the planning, implementing and operation of hydropower projects in a predictable, responsible and timely manner with appropriate human resources both in term of quantity and competences.

5.3.6 Technical Issues and Risks

Basic expectation of this topic is to identify and analyze technical issues and risks at an early stage before making significant investments into project preparation.

These technical issues and risks can include;
- Availability and reliability of the hydrological resource,
- Seismic stability
- Other natural hazards
- Geotechnical stability
- Access to construction materials
- Asset safety, etc.

5.3.7 Social Issues and Risks

Basic expectation of this topic is to identify and analyze social issues and risks most relevant to the project at an early stage before making significant investments into project preparation. The aim is to minimize and manage negative social impacts and to deliver net benefits to project-affected communities.

Here is the list of some social issues and risks;

- Potential land and water use conflicts
- Project affected community composition
- Socio-economic status and livelihoods

- Likelihood of resettlement requirements
- Labor and workforce capacity
- Community safety
- Public health
- Cultural heritage
- Likelihood of community acceptance
- Communication and consultation needs and issues
- Legacy issues
- Cumulative impacts
- Social unrest.

The opinions of experts, representatives from government, NGOs, potential project affected communities, local communities and other key stakeholder groups are important for this topic.

5.3.8 Environmental Issues and Risks

Basic expectation of this topic is to identify and analyze environmental issues and risks most relevant to the project at an early stage before making significant investments into project preparation. The aim is to minimize and manage negative environmental impacts.

Here is the list of some environmental issues and risks;

- Biodiversity
- Migration of aquatic species
- Threatened species
- Wetlands of significance
- Critical habitats
- Weeds
- Pest species
- Greenhouse gas emissions from the reservoir
- Erosion

- Sedimentation
- Water quality
- Air quality
- Legacy issues
- Cumulative impacts.

The opinions of experts, representatives from government, NGOs, local and other key stakeholder groups are important for this topic.

5.3.9 Economic, Financial Issues and Risks

Basic expectation of this topic is to identify and analyze economic and financial issues and risks opportunities most relevant to the project, and likely costs and benefits at an early stage before making significant investments into project preparation. The aim is to minimize and manage negative environmental impacts. Besides basic expectations, potential costs and benefits including social and environmental externalities can be considered and strengths, weaknesses, opportunities and threats of the project can be analyzed.

Here is the list of some examples of evidence;
- Evaluation of financial issues and risks
- Early stage cost-benefit analysis
- Identification of sources of finance
- Economic and finance issues and risk assessment
- Records of meetings with representatives from government
- Financial institutions
- Development banks
- Key stakeholder groups

5.4 Asse ssment of t he Ka yraktepe Dam and HEPP Project accordin g t o Early Sta ge Asses sment To ol in IH A's H ydropower Su stainability Assessment Protocol

5.4.1 Evaluation of Demonstrated Need

In this section, needs for water and energy services are evaluated under environmental, social and economic considerations.

There is a rapid social and economical development in our country, in parallel with this development, electrical energy needs should be supplied by an uninterrupted, high quality, reliable and economical way without affecting the environment adversely. For this reason, projects might be developed primarily by using domestic energy sources and the necessary investments might be made. Electrical power consumption is one of the most important indicators of economic development and social welfare.

Turkish electricity transmission company (TEİAŞ) published "Turkey's electric energy production - capacity projection for 10 years" in middle of 2009. High and low demand estimations are shown at Table 5.3 and Table 5.4, respectively. Two scenarios were studied considering capacities licensed by EPDK and operated in due time. For first scenario, totally 11188.8 MW and for second scenario, totally 9047.MW is considered to be added into system. According to these scenarios' project and reliable production capacities, supply–demand balance was prepared by using high demand and low demand estimations. The results are illustrated at Table 5.5. After 2013, energy deficiency might occur.

Table 5.3 High Demand Estimation (TEİAŞ, 2009)

	Peak Demand		Energy Demand	
Year	MW	increase (%)	GWh	increase (%)
2009	29900		194000	
2010	31246	4.5	202730	4.5
2011	33276	6.5	215907	6.5
2012	35772	7.5	232101	7.5
2013	38455	7.5	249508	7.5
2014	41339	7.5	268221	7.5
2015	44440	7.5	288338	7.5
2016	47728	7.4	309675	7.4
2017	51260	7.4	332591	7.4
2018	55053	7.4	357202	7.4

Table 5.4 Low Demand Estimation (TEİAŞ, 2009)

	Peak Demand		Energy Demand	
Year	MW	increase (%)	GWh	increase (%)
2009	29900		194000	
2010	31246	4.5	202730	4.5
2011	32964	5.5	213880	5.5
2012	35173	6.7	228210	6.7
2013	37529	6.7	243500	6.7
2014	40044	6.7	259815	6.7
2015	42727	6.7	277222	6.7
2016	45546	6.6	295519	6.6
2017	48553	6.6	315023	6.6
2018	51757	6.6	335815	6.6

Table 5.5 Energy Deficiency Estimation (TEİAŞ, 2009)

	According to demand	According to capacity	Energy deficiency will happen in
Scenario #1	High Demand	Project production capacity	2017
	Low Demand	Project production capacity	2018
	High Demand	Reliable production capacity	2015
	Low Demand	Reliable production capacity	2016
Scenario #2	High Demand	Project production capacity	2016
	Low Demand	Project production capacity	2017
	High Demand	Reliable production capacity	2014
	Low Demand	Reliable production capacity	2015

DSİ's activity report in 2009 indicates that annual available water quantity per capita is 1652 m^3 in Turkey. Less than 1000 m^3 annual available water quantity per capita describes water poorness. State Institute of Statistics (DİE) estimates population will be approximately 100 million in 2030. Therefore, annual available water quantity per capita will decrease to about 1120 m^3/year. For this reason, sustainability of water resources is essential for future generations.

Turkey has 8.5 million hectare agricultural area that can be irrigated economically. However, only 64% of them are irrigated. According to DSİ's activity report in 2009, in order to irrigate remaining agricultural areas, it is essential that the construction of irrigation facilities should be started immediately.

Each year, electricity consumption in Turkey increases 6-8%. One of the Turkey's main aims is to reach 140 billion kWh economical hydroelectric potential as soon as possible because of preventing energy deficiency, supplying water for drinking and irrigation purposes, providing clean, reliable, national energy sources and maintaining economic independency. The State Hydraulic Works and Ministry of Environment and Forest about this issue diligently. Therefore, feasible, environment-friendly, economical hydropower projects are supported by government.

The State Hydraulic Works' (DSİ) 2010-2014 strategic plans were determined. DSİ's targets related to hydropower are listed below;

- The master plans of 10 basins will be revised.
- In order to use water resources efficiently, investigation, feasibility and final project works will be focused.
- Hydro electric potential uses will be increased with HEPP projects.
- In Turkey, the irrigation area will be 4 million hectares.
- The quality and quantity of water will be preserved and/or developed.
- Drinking, usage and industrial water requirements demanding from municipality will be supplied.
- Flood prediction systems and the equipments will be graded and flood damages will be prevented.
- Erosion and debris controls will be supplied in all basins, especially dam's and lagoon's basins.

To sum up, Turkey needs energy and water services. Therefore, national objectives and plans include planning energy and water services. The purposes of Kayraktepe Project prepared in 1982 were energy production, flood control and flow regulation due to irrigation. A high dam with large storage capacity could supply both water and energy needs. Whereas, the purposes of Kayraktepe Project prepared in 2010 are only energy production and flood control.

5.4.2 Options Assessment

In this section, while comparing alternative options, the project is assessed whether it is one of the priority options for demonstrating energy and water needs or not.

During the planning of the project, the most important issue that should be considered is the selection of energy production type. In order to supply water and energy demands, hydroelectric power plant projects are essential as one of the renewable and clean energy sources. In this thesis, only hydropower alternatives are evaluated by comparing large scale dams with small scale dam and HEPPs because hydropower come forward in the developing country due to economical issues. According to Figure 5.5, total costs of other energy projects are higher than total costs of hydropower project. Therefore, the government supports dam and HEPP projects and does not require the comparison of hydropower project with other energy projects in general. However, it can be compared with different energy sources. For example, greenhouse gas emission caused by nuclear, solar and wind energy sources are less than greenhouse gas emission caused by hydropower energy source as can be seen in Figure 5.6. Unfortunately, there are not enough regional investigations of other alternative energy resources. For example, wind power in the region is not known. If available wind energy source is determined, it will be used because of country's energy deficiency. Moreover, inactivation alternative can be considered. When the project is not implemented, which benefits provided by the project and which negative effects caused by the project will disappear can be observed with this alternative.

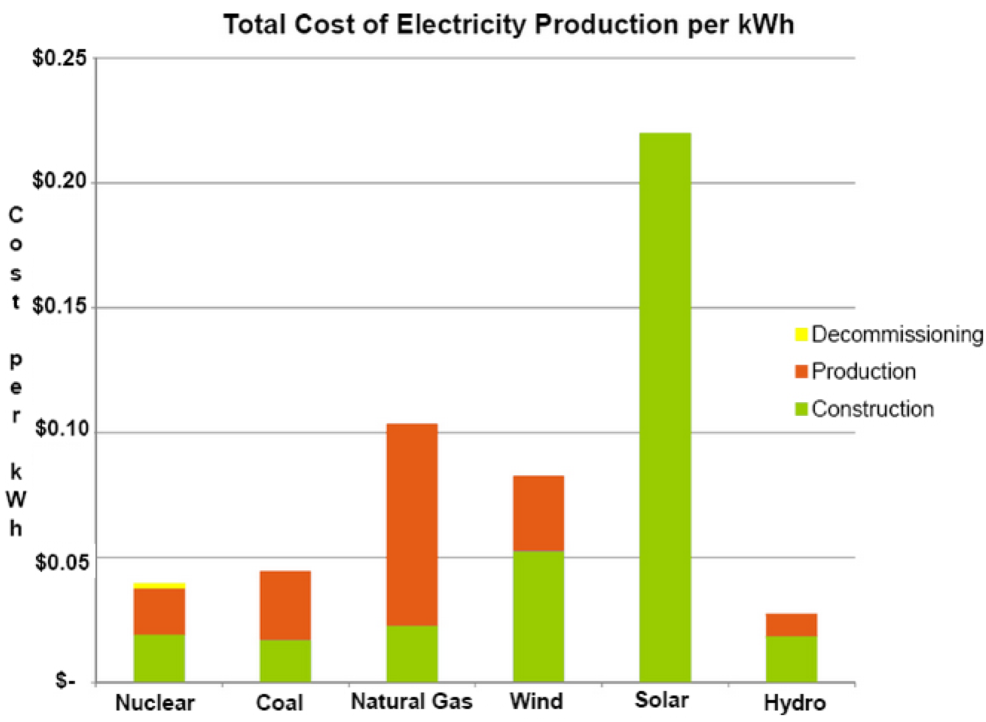

Figure 5.5 Total Cost of Electricity Production's Comparison of Energy Sources (Morgan, 2010)

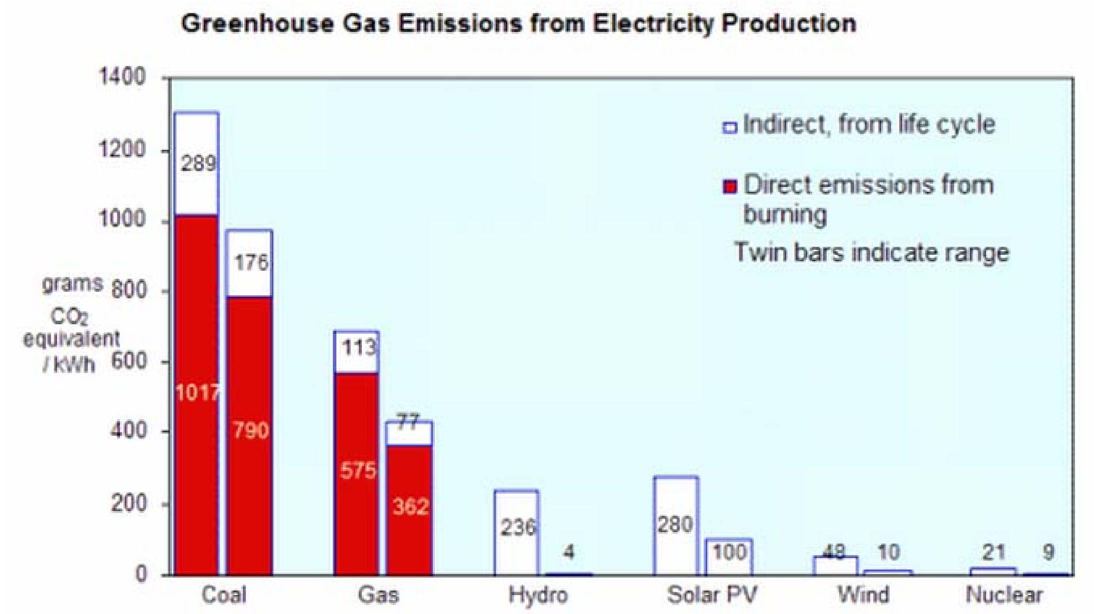

Figure 5.6 Greenhouse Gas Emission’s Comparison of Energy Sources (WNA, 2011)

There are not any flood control systems in the project area. Therefore, flood damages occur in every two years. Therefore, since 1982, the Kayraktepe Dam and HEPP projects have designed in order to not only provide flood control but also supply energy, water, permanent discharge for irrigation purposes. Previously, Kayraktepe Dam was designed as a large scale reservoir type hydroelectric power plant. After the implementation and the commencement of the construction had been postponed, the cost of land acquisition and resettlement increased tremendously due to remarkable development of social infrastructures and private properties in the project area. In addition, there is a vulnerable Turkish wetland called Göksu Delta Plain protected by Ramsar Convention. Ministry of Environment and Forest did not approve Environmental Impact Assessment Report because dam would cut sediment transportation to the downstream. For this reason, loss of fertility and coastal erosion would occur (Feasibility Report, 1997). Therefore, large dam construction in this area sounds to be infeasible owing to social, environmental and economical problems. In order to solve social, economical and environmental problems, instead of constructing a large dam, construction of one medium dam and five run-of-river type hydropower stations are proposed. In this way, flooded areas will be decreased.

With this new formulation, the total installed capacity shall be 253.55 MW, with 588,23 GWh/year expected annual energy generation. The developer of the project claims that this new project formulation provides the additional benefits. Fully retaining the flood control benefit of the original project shall be satisfied. A dramatic reduction in expropriation area by %95 (down to %5 of original) has been attained, where original 5000 ha have been reduced to approximately 820 ha. Therefore, a very large area containing numerous villages and valuable agricultural areas that were originally marked for expropriation and flooding will be preserved. The citizens living in the region will not be affected owing to significantly reduced expropriation. The Wild Life Protection Area to be flooded will be retained as at the original project. Göksu River Delta to be deprived of natural sediment inflow under the original formulation will now be completely preserved (Sever, 2010).

In conclusion, this new formulation seems to be best alternative option among three feasibility studies because of reducing social, environmental and economical problems coming from large area remaining under water due to large dam construction.

5.4.3 Evaluation of Policies and Plans

In this section, the project is assessed whether it fits existing policies and plans, or not.

Systematic water resource development started in the 1950s with the establishment of the General Directorate of State Hydraulic Works. DSİ and EIE have developed the river basins according to their hydropower and water capacity. From this point of view the whole river basins have been planned in order to get maximum energy or maximum water and sometimes both of them. Until today, the river basin development plans have been only considered as the components of water and energy. This cannot be accepted as integrated river basin development as described today. According to EU-WFD, besides water and energy issues, the river basin should be planned by including the following components; river basin properties, human activities, protected areas, monitoring maps, environmental targets, economical analysis, precautions programs, public information and consultation, list of competent authorities, etc (IMO, 2010).

Today, it is already accepted that sustainable projects should be developed for the sake of future generation. However, the future development will be more difficult than in the past since there are new challenges like global climate change, environmental considerations, social reactions, adaptations of new technologies, and replacements of demolished structures. In order to develop sustainable structures, the projects should be carried out with a multi-disciplinary manner. This can be achieved by assuming integrated river basin management as described by EU-WFD. In order to realize this goal, both institutional and legal framework should be adopted accordingly (IMO, 2010).

In 1971, the Ramsar Convention that is an intergovernmental treaty for the conservation and wise use of wetlands and their resources was accepted. Even though there is a vulnerable Turkish wetland called Göksu Delta Plain protected by Ramsar Convention, integrated river basin development of this region does not comply with the Ramsar Convention. If Kayraktepe Project designed in 1982 or 1997 was constructed, dam would cut sediment transportation to the downstream by causing loss of fertility and coastal erosion in Göksu Delta Plain. However, according to new formulation for Kayraktepe Project, Göksu River Delta can continue to derive natural sediment inflow.

5.4.4 Evaluation of Political Risks

In this section, the project is evaluated whether political risk influences on development and management of the hydropower project or not.

After application of the Law No 4628 under Electricity Market Law which is related to the idea of water usage right, there is an excessive increase in the number of

HEPPs in construction with participations of private sector. Therefore, the problems related to environmental and social issues also arise. Although some HEPP projects' feasibility studies reports had been accepted by DSİ, some of these projects were taken to the court by NGOs, potential project affected communities, local communities and other key stakeholder groups due to debates on hydropower projects described in Chapter 4. Their implementation and the commencement of the construction were stopped by the court. In recent years, there are lots of opponent opinions about hydropower projects. Both of Kayraktepe Projects can be subjected to deprecation by social and environmental organizations as in the Black Sea Region after it is decided to be constructed.

Moreover, this project is designed by the private sector. For this reason, the risk arising from this issue may occur. In 2008, DSİ preferred this private sector among other private sectors while considering only the feasibility studies for a large dam. After becoming preferred bidder for Kayraktepe Project, the formulation was changed to smaller dam and several HEPPs. For this reason, DSİ has a right to disapprove this project. However, if DSİ changes its opinion and decides to construct large dam, the financial problems about finding viable credit can occur. While constructing the large scale reservoir type hydroelectric power plant in 1982, World Bank cancelled the loan due to low profit-earning capacity, environmental and social problems. This may happen again.

To conclude, both projects have a political risk.

5.4.5 Evaluation of Institutional Capacity

In this section, the capacities of institutions related to hydropower project are assessed. All institutional information written in this section was derived from BM Holding's web site.

> BM Group has a role in hydropower project development and implementation since 1986. BM has dealt with HEPP operation since 2007 and electricity import, brokerage and trade since 2008.

Here is the list of BM's area of expertise;

- Dams and hydroelectric power plants (all aspects)
- Power generation, transmission, and distribution
- River basin development
- International electricity trade and brokerage
- Large-scale infrastructure construction projects
- Geothermal and Hot Dry Rock exploration and power generation
- Waste to Energy and Solar Thermal power generation
- Alternative renewable energies R&D and project development
- Project development, financing and multi-national partnerships

In line with BM's commitment to efficiency and innovation, technical and environmental aspects of each project are reviewed and investigated far beyond legal requirements starting from feasibility studies to the commercial operation stage.

Some of the novelties devised are listed below:

- Construction of a large dam in full swamp (Büyükçekmece Dam, İstanbul - by perimeter-sealed pan dewatering method enabling 6 months early project completion),
- Conversion of a large dam into a multi-level cascade system with %90 reduced expropriation (Kayraktepe Dam and HEPP (Mersin), with savings for 4500 ha agricultural land, wildlife protection area and Göksu Delta. Similar conversion was also applied to its first stage Azmak HEPP Project, Mersin),
- Rubber spillways and flush power house design for reduced environmental impact,
- Conversion of numerous HEPP surface water transmission lines to underground for reduced environmental impact, expropriation area and easier operation,
- Integration of numerous cascade hydropower projects into single more efficient plants with significantly improved benefit / cost ratios.

BM's current hydropower portfolio holds numerous hydropower projects throughout Turkey, with a total installed power of approximately 500 MW. The Dam, regulator and HEPP projects that BM Group works;

- Kayraktepe DAM and HEPP
- Tahta Regulator and HEPP (located on Tahta Creek in Osmaniye and Kahramanmaraş)
- Azmak 1 and 2 Regulators and HEPPs (located on the Ermenek River within the boundaries of Mut City)
- Kirpilik Regulator and HEPP (located on the Ermenek River within the boundaries of Mut City)
- Paşa Regulator and HEPP (located on Bolu River, 6 km west of Gökçesu Village of Mengen Town in Bolu)
- Arpa Regulator and HEPP (located on the Arpa River in Borçka Town, Artvin City within the Çoruh Basin)
- Devecikonağı DAM and HEPP (located on between 80 m and 65 m elevation of the Emet River)
- Manavgat-1 Regulator and HEPP (located on the Manavgat River main artery of the West Mediterranean Basin, in Akseki Town, Antalya City)
- Menteşbey Regulator and HEPP (located on the main artery of Manavgat River, in Akseki Town of Antalya City)
- Hemşin 1 and 2 Regulators and HEPPs (located on Pazar Stream of Hemşin River of the Eastern Blacksea Basin, in Hemşin Town, Rize City)

All projects considered by BM's group are illustrated in Figure 5.7.

BM Group has developed a guideline approach towards its project areas, which comprises:

- Optimizing each project beyond regulatory requirements, for the highest attainable level of environmental compliancy,
- Improving local environmental awareness and life standards through educational programs,

– Regional natural enhancement and forestation projects,
– Socio-economic improvement projects and facilities,
– Realizing low-return renewable energy projects through voluntary carbon credit trading.

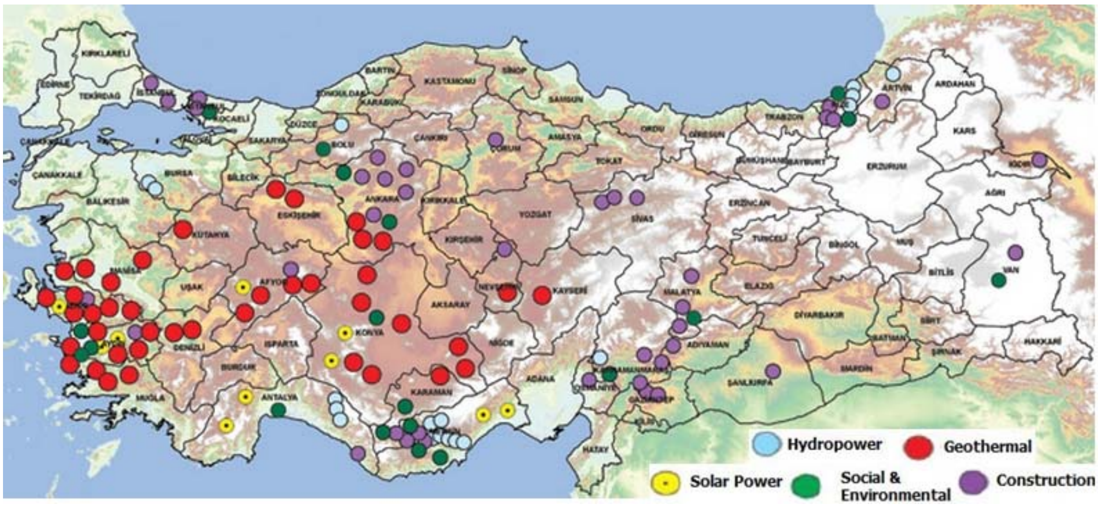

Figure 5.7 BM’s Projects in Turkey (BM’s web site, 2011)

Many courtesy projects have been completed along these guidelines including numerous large forestation projects, construction of mosques, student dormitories, guesthouses, ski facilities and health centers, where studies for new projects are in progress.

BM Group gives importance to the experienced workforce with motivation and development under a balanced educational improvement program. In realization of this fact, BM has adapted the following guidelines in its approach to employee satisfaction:

- Multi-disciplinary educational improvement programs totaling over 10,000 hours, (Includes diversified career training, ISO, OHSAS and other standards, first-aid, fire protection, hygiene)
- Progressive delegation of responsibility,
- Access to networked updated information with know-how transfer at different levels,
- Opportunities for maintaining an active involvement in the sector,
- Multi-disciplinary exposure to corporate matters through inter-departmental teamwork,
- Social integration through corporate social activities and gatherings.

BM Group is also committed to health and safety with its comprehensive health and safety program that is implemented at each project site (BM's web site, 2011).

As can be seen, BM Group has institutional capacity related to hydropower project.

5.4.6 Evaluation of Technical Issues and Risks

In this section, technical issues and risk for the project are assessed.

The Current Status of Flood Protection of Silifke Plain

Göksu River overflows, covers large areas under water and causes the flood damage with the addition of abnormal rains in the snow melting season particularly. The most important Göksu floods occur on the Silifke town and Silifke plain. These floods have been followed by the DSİ since 1955. According to DSİ's data, the flood damage occurs in every two years. Until today, there is not any effective flood control facility. In this respect, Kayraktepe project will be the first and most effective flood control facility (Feasibility Report, 2008).

The main technical issues in new Kayraktepe project formulation are to achieve flood control and natural sediment inflow protection for Göksu River Delta. In 2010, Sever studied these issues in his thesis with Dr. Tiğrek in METU Civil Engineering Department. The results of their study show that, a smaller dam (like the dam in the newly developed formulation) is also enough to limit the outflow peak. By using this newly developed formulation, the outflow peak discharge could be decreased to 1200 m^3/s for a 500 year return period flood. This discharge can flow through Silifke District harmlessly.

The hydrology of the whole basin was revised. Firstly, the flow data were revised. In Kayraktepe 1997 report, flow data till 1989 were used.

However in the thesis, flow data till 2007 were used. Then, the characteristics of the projects within the basin were updated. In Kayraktepe 1997 report, Ermenek Dam characteristics were taken from the feasibility report (1990). In this report, Ermenek Dam flood storage was given as 160.68 hm^3. But actually, Ermenek Dam was constructed with flood storage of 298.85 hm^3. The differences are listed below briefly.

Table 5.6 Comparison Table of the Studies Related to the Flood Calculations (Sever, 2010)

<table>
<tr><th>Kayraktepe 1997 Report</th><th>Sever's Thesis (2010)</th></tr>
<tr><td>Flow data (SGS) till 1989 were used.</td><td>Hydrology of the basin was revised.
Flow data (SGS) till 2007 were used.</td></tr>
<tr><td>Ermenek Dam information was taken from the feasibility report (1990). In this report, Ermenek Dam flood storage was given as 160.68 hm^3.</td><td>Ermenek Dam information was revised (according to the real state). Ermenek Dam flood storage is 298.85 hm^3.</td></tr>
<tr><td>The permissible outflow peak discharge of the dam was given 800 m^3/s. In that report, a 160 hm^3 storage was found to be adequate.</td><td rowspan="2">The permissible outflow peak discharge of the dam is accepted as 1200 m^3/s. This value was taken from DSİ - Adana Region. This value is also confirmed by calculating the water surface profile (HEC-RAS) in Silifke District.</td></tr>
<tr><td>But, according to the revised hydrology, this storage is adequate to decrease the peak outflow just to 1110 m^3/s (Q500, In case Mut Dam is in operation).</td></tr>
</table>

The newly developed formulation was also analyzed whether the dam is adequate for flushing or not in his thesis. Flushing is a sediment removal technique. The increases in flow velocity might cause deposited sediment to be scoured from reservoir and to be transported through low level outlets. According to this analysis, it was determined that the new dam is adequate for flushing. Thus, the sediment supply of Göksu Delta will also continue. It means Göksu Delta will be preserved against erosion. But, Kayraktepe 1997 formulation was analyzed also and found out that Kayraktepe 1997 formulation is not adequate for flushing. Therefore, erosion of Göksu Delta will continue.

According to the results of the sediment calculations, the annual sediment amount at Kayraktepe Dam axis is about 1.13×10^6 m^3.

The dead volume of Kayraktepe Dam Project is planned as 49.71×10^6 m^3. This volume is sufficient to store the sediment load approximately 44 years.

Sediments are mostly transported in floods. During the flood periods, by means of the bottom outlets, the transported sediments can be transferred to downstream before subsiding and solidifying. Therefore, by flushing the reservoir during the flood periods, the dead volume will be adequate for more than 50 years (the economic life of the dam).

The suitability of flushing was examined by using Basson's Diagram (Sever, 2010). According to this study:

- Kayraktepe – 1997 alternative is not suitable for flushing.
- Kayraktepe – 2010 alternative is suitable for flushing.

The results show that the newly developed formulation (Kayraktepe – 2010) is suitable for flushing, thus sediment supply of Göksu Delta will continue. Moreover, flood control will be provided in the project area.

Earthquake

Seismicity of the project area, the risk of earthquakes, dam safety risks and an increased risk of earthquake due to dam construction might be researched. The number and size of the earthquake in the region, and their statistical analysis might be indicated if necessary. This information can be considered during the construction of the units.

Turkey is situated on the Alpine – Himalayan Earthquake Belt, and influenced the Alpine structure of Mediterranean Europe, a fair amount of earthquake activity is observed, it is interesting to note that most of the project area is situated within the earthquake free or less important zone.

The project area is in 5 degrees seismic zone according to Turkey earthquake zones maps (Ministry of Development and Housing, 2006). It means earthquake intensity is lower than 6 with respect to Marcalli's intensity scale. By the connection between earthquake intensity and horizontal acceleration, the horizontal acceleration is lower than 0.04g. Moreover, maximum possible ground acceleration value is less than 0.10 g (Dad, 1996). In order to be on the safe side, in project calculations the horizontal acceleration is assumed as 0.10 g. Figures 5.8, 5.9 and 5.10 illustrates earthquake zone in the project areas.

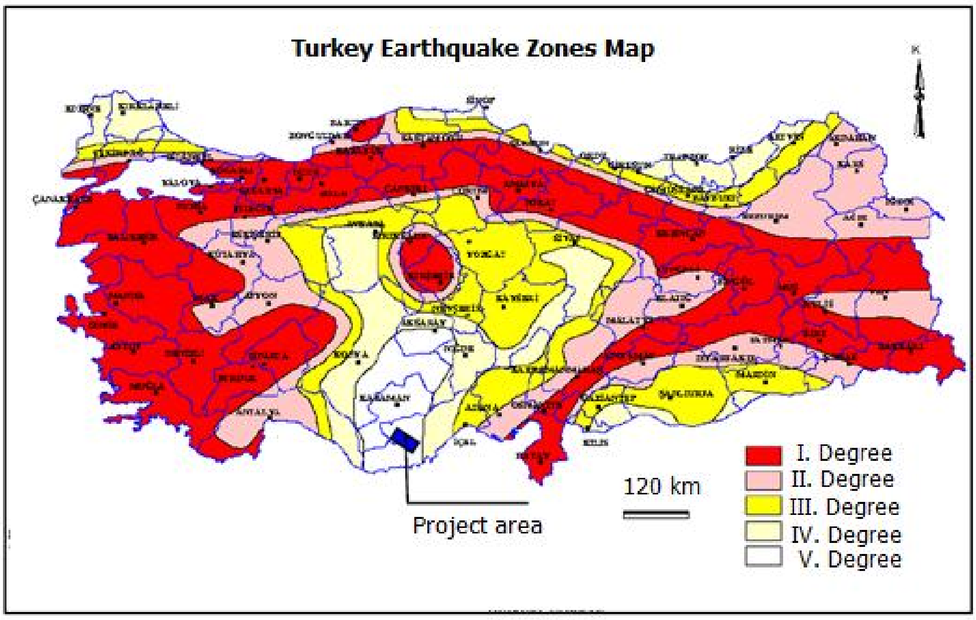

Figure 5.8 Turkey Earthquake Zones Maps (Feasibility Report, 2008)

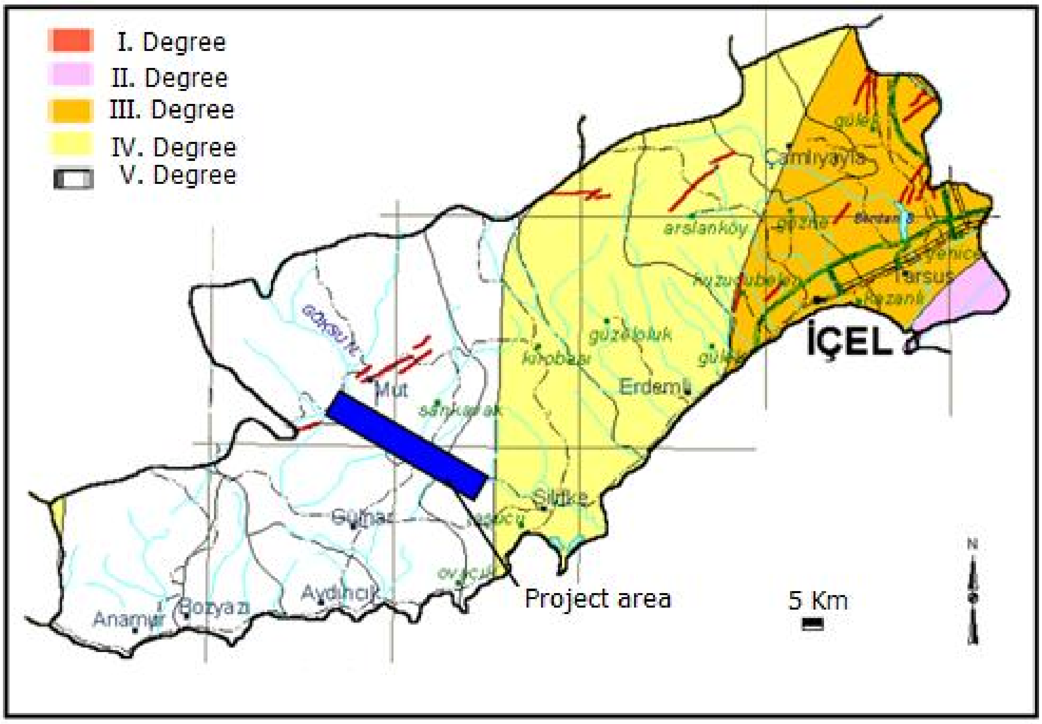

Figure 5.9 Mersin Province’s Earthquake Zones Maps (Feasibility Report, 2008)

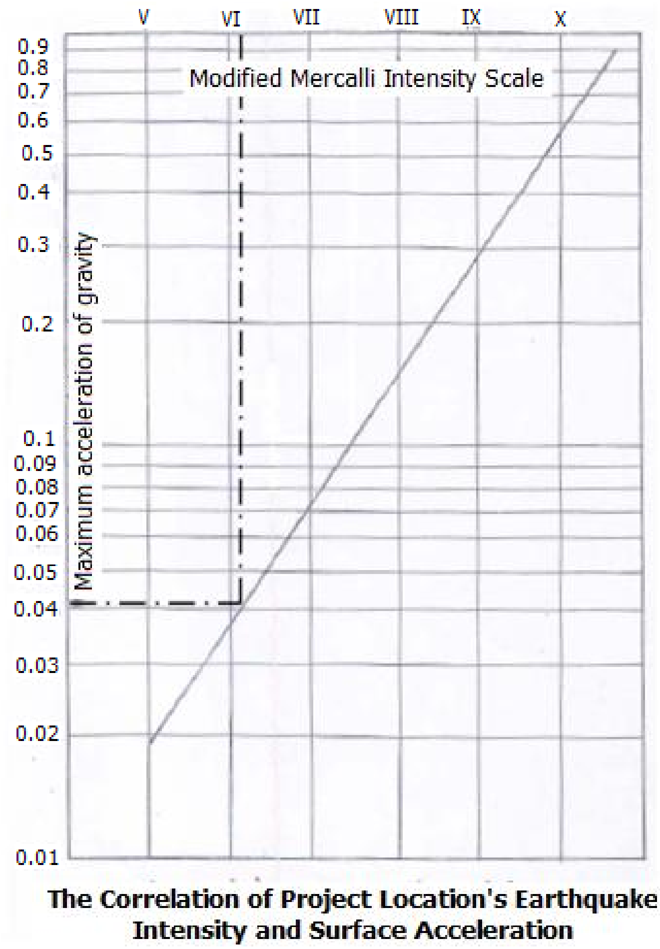

Figure 5.10 Marcalli's Intensity Scale (Feasibility Report, 2008)

Effects on Hydrology and Water Use

The dam projects can cause significant changes in river regime. The flow rate released to downstream of the dam can vary significantly depending on the type of reservoir operation in especially water retention and operation stages. Possible environmental effects, operation conditions and specific conditions to be applied in extreme situations might be determined separately for rainy, dry and normal years. The effects on the downstream might be evaluated by considering parameters such as deepening of the river bed, drying or alteration of fresh-water habitats and the possible flood on downstream.

The effects of project on downstream water uses (domestic purposes, irrigation and industrial purposes) might be evaluated. The existing facilities especially established on the basis of streams, (recreation facilities, tourist facilities, sports facilities, etc.) and their effects on the local economy might also be considered.

Existing Facilities on the Göksu River Basin

- Konya-Yerköprü Hydroelectric Power Plants
- Ermenek-Merazpoli Hydroelectric Power Plants
- Mut Hydroelectric Power Plants
- Gezende Dam and Hydroelectric Power Plants
- Silifke irrigation project
- Mut irrigation project
- Ermenek Dam and Hydroelectric Power Plants
- Erik diversion project

Existing Facilities in the Project Area and the Water Needs

Through the years in Konya plain, the risk of drying occurred due to excessive use of groundwater. Therefore, in 2006, the construction of water transmission line from Göksu River to Konya Plain (Blue Tunnel) was started (Sever, 2010). There is a risk that such situation will occur again in the future. However, today, except for Mut irrigation and Blue Tunnel, none of the existing facilities on the Göksu River reduces water.

In addition, due to all the existing hydroelectric power stations on the upstream of Kayraktepe Project, Kayraktepe project will not affect the production of these hydropower plants.

Water need estimations prepared by DSİ for Silifke irrigation project located downstream of the Kayraktepe Project are illustrated on Table 5.7.

Table 5.7 Water Need Estimations for Silifke Irrigation Project (Feasibility Report, 2008)

Months	For Plants (mm)	For Farm Lands (mm)	For Derivations (mm)	Irrigation Module m3/sn/ha
March	1.64	2.74	3.04 64.83 213.56	0.01
April	35.01	58.35	227.69 308.75	0.25
May	115.32	192.20	269.52 30.69	0,80
June	122.95	204.92 277.87	178.06	0.88
July	166.72	242.56 160.26		1.15
August	145.54	27.62		1.01
September	96.15			0.69
October	16.57			0.11
Total	699.92	1,166.53	1,296.14	

Nowadays, the water needs around Silifke are very difficult to predict except for irrigation. In this field, there is no industrial development plans. For this reason, the Kayraktepe project’s downstream water needs including irrigation was estimated as 33 m^3/s. This amount has been accepted as the minimum flow rate given from Kayraktepe power plant to Göksu river bed. However, more detailed investigations and analysis should be made to decide to whether this discharge is sufficient or not.

Transportation and Communication

Transportation and communication problems are not expected in the project area.

Geological Features

The dam site is characterized geologically by the following features.

- thick alluvium in the riverbed
- high permeability of conglomerate, especially of the right abutment

– major fault and sheared zone at the bedrock

Optimal dam type might be selected considering consistency with adequate measures against the above-mentioned geological features.

According to the permeability test carried out at the dam site, the limestone and the conglomerate are highly permeable. Therefore foundation treatment by grout injection will be indispensable irrelevantly to the dam type. On the other hand, as for mechanical properties such as deformability and strength, the rock foundation seems to be unsuitable to sustain the structure under high stresses.

Natural Construction Materials and Industrial Materials, such as Iron, Cement Supplying Places

Sand and gravel materials can be provided from alluvial fields in the downstream of the projects. Cement and iron can be provided from Mersin or Konya, İskenderun, respectively.

Enhancement of Public Health and Safety, Minimization of Public Health Risk

During construction, laws, rules and regulations related to health care measurements should be implemented carefully.

Safety planning should correspond to appropriate national and international standards and comparable industry practice.

5.4.7 Evaluation of Social Issues and Risks

In this section, social issues and risk related to the hydropower project are assessed.

5.4.7.1 Land Acquisition, Resettlement and Land Usage

After the implementation and the commencement of the construction of large scale dam had been postponed in 1986, there has been remarkable development of social infrastructures and private properties in the project area. If this large scale dam was constructed, the agricultural areas under the dam lake would be 1886 ha. Moreover, this dam lake would include the boundaries of numerous villages. This results in increasing the cost of land acquisition and resettlement tremendously. For this reason, large scale dam could not have been constructed until now.

Instead of a large scale dam, in 2010, the Kayraktepe Project was redesigned as one medium dam and five run-of-river type hydropower stations. Therefore, by decreasing height of dam, flooded area will be reduced. A dramatic reduction in expropriation area by %95 (down to %5 of original) has been attained, where original 5000 ha are reduced to approximately 820 ha. Therefore, a very large area containing numerous villages and valuable agricultural areas that were originally marked for expropriation and flooding can be preserved. The reservoir areas of the Kayraktepe Projects prepared in 1997 and in 2010 are shown in Figure 5.11. The citizens living in the region will be less affected owing to significantly reduced expropriation (Sever, 2010).

In Silifke region, serious floods occurred especially in the downstream. Both government and DSİ stated that if large scale dam was constructed, flood control would be satisfied. Inspite of public response, DSİ insists on the construction of large dam. However, as explained in the evaluation of technical issues and risk, the Kayraktepe Project prepared in 2010 can also satisfy flood control. Unfortunately, in Turkey, settlements can be observed in the flooding areas. There is a limitation for settlement in the Delta region but it is not controlled. For this reason, Kayraktepe Project will be constructed and numerous villages and valuable agricultural areas in the upstream will remain under water or the resettlements will occur in downstream for flood protection. Therefore, both of Kayraktepe projects have social risks.

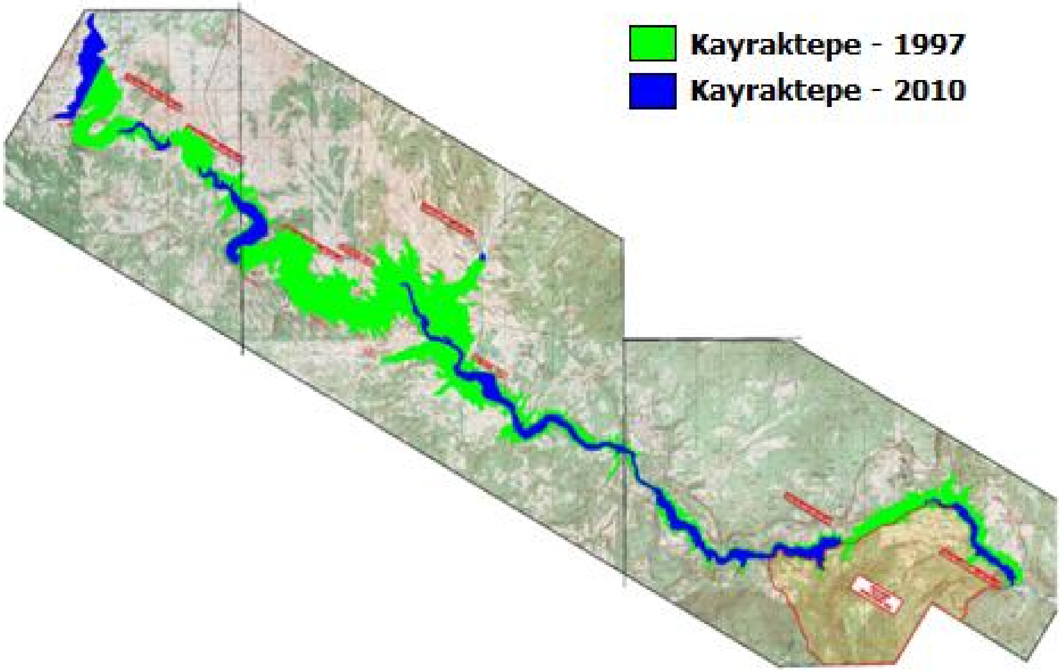

Figure 5.11 Kayraktepe Projects' Reservoir Areas Comparisons (Sever, 2010)

According to EIA Guide for dams and HEPPs prepared by Ministry of Environment and Forestry, the expropriation and resettlement issues in the flooded area might be solved before water retention starts in dam's reservoir. The payment of the immovable costs and demands for resettlement might be determined by pre-interview survey with public whose lands will remain under water. During expropriation studies, not only immovable assets remaining under water but also the integrity of the land can be observed. Informational meetings and training programs might be organized for these people. The new residential areas might be selected properly so that social relations, economic activities, and living standards of these people can be maintained. People who live in the project area might be resettled in a particular plan and program consisting of resettlement project to survive under similar conditions and to keep the negative effect on the environment in minimum level. For this purpose, an alternative irrigable land might be prepared instead of agricultural lands that will be under the dam and its reservoir. The settlers can establish new businesses and strengthen their social relationships in these areas without reducing the existing living standards. Fair and sufficient facilities might be provided to the people who have to resettle due to their lands remaining under water. The infrastructure of new residential area might be built or improved.

5.4.7.2 Impacts on the Socio-Economic Environment

According to the EIA Guide for dams and HEPPs, generally, in the region the dam and hydroelectric power plants projects increase services in the region (eg, new industries, new roads, electricity), change population structure in this region. The importance of this change will increase depending on the size of the project. The project might provide the revival of local economic activity and an increase in job opportunities during construction of the project for local people. The majority of people who do not migrate to the cities can work as a seasonal worker. When facilities constructions begin, people have an opportunity to work in construction zone. When operation of the project starts, a certain number of staff can have also opportunity to employ. The employment policies can be applied for the local, regional, provincial people and other groups are willing to employ in order of geographical priority. In the region, development of new economic activities might be encouraged. The other benefits the project can deliver to directly affected stakeholders and the broader community might be education, transfer of knowledge, capacity building, improved health care, national development, recreational area and infrastructure.

On the other hand, the effects on local people exposed to physical losses due to homes, revenue generating assets (e.g., agricultural lands, orchards, shops) and public assets (forest lands, cultural values, public infrastructure) to remaining under water might be considered. The social deterioration and changes of people's living standards after resettlement might be considered in terms of quality of life, social integration and economic activities.

5.4.7.3 Social Conditions in the Project Area

- Risks Related to Health Conditions

The risks of diseases resulting from the water, and conditions that may cause an increase in the formation of disease vectors due to reservoir can be considered.

- Relocation of Roads

If large dam was constructed, part of the route No.715 (Konya-Silifke) about 40 km would be inundated by the dam reservoir. Therefore the route would be relocated. In addition to this road, route No.33-59 about 6 km with a bridge and local village road about 15 km would be also relocated. The cost of the relocation of the roads should be considered in the cost of the Kayraktepe project.

- Agriculture

Agriculture is the main activity within the project area, and most of them are dry-farming. There are some small scale irrigation practice along the valley of the Göksu River and its tributaries. But major irrigation system in 15 km downstream of the project area which is developed by DSİ is in the Silifke Plain. The ultimate size of this system is 12,000 ha, and 5,000 ha out of this are irrigated at present.

Over 80% of people living in the delta work in agriculture. Although the delta supply abundant agricultural products, the farmer in the delta has been suffered from frequent floods of the Göksu River.

Most of the Mut plain, will be inundated by the Kayraktepe reservoir, therefore, necessary measures might be taken by the government authority in order to find new jobs or settlement area for the local people who live on that area.

- Fishing

Including the section related to the project area, fishing is carried out for only the recreational purposes in Göksu River. There are no fishery cooperatives in this area. Fishing in Dam Lake can contribute to the economic development and balanced nutrition of the people living in the project area.

- Livestock Production

In the area related to the project, livestock is usually just for the families' own consumption. The animals kept in the region are mainly sheep and goat. There are no pasture lands that will be inundated.

- Industry

There are no facilities for industry around the dam site and reservoir area.

- Mining

There is no mining operation considered as economic in the project area.

- Tourism

There is no touristic site for tourist around the dam site and in the planned reservoir. Tourism is developed in the delta.

To sum up, both of the Kayraktepe projects have social risks due to resettlement problems resulting from the area remaining under water by dam reservoir or floods.

5.4.8 Evaluation of Environmental Issues and Risks

In this section, environmental issues and risk related to the hydropower project are assessed.

5.4.8.1 Protected Area

In 1989 the main wetland areas in the delta were declared a Permanent Wildlife Reserve 4,350 ha by the General Directorate of Forestry, National Parks Department, in 1990 the delta and offshore area, totally 23,600 ha, was declared a Specially Protected Area by the decision of the Ministers' Council. The aim of this decision was to protect the region against environmental pollution and ecological degradation and to ensure the transition of the area's natural heritage and historical remains to future generations. In 1991 the Authority for the Protection of Special Areas (APSA), Ministry of Environment, declared the area covering Akgöl, Paradeniz, Incekum Cape and an area east of Göksu River as Sensitive Zone. In 1994 the Göksu Delta Plain was declared one of the first five Turkish Ramsar sites which aim to conserve wetlands and their flora and fauna by farsighted national policy and coordinated international action. Ministry of Environment and Forest did not approve Environmental Impact Assessment Report of large scale dam because it would cut sediment transportation to the downstream by causing loss of fertility and coastal erosion in Göksu Delta. Moreover, some part of the Wild Life Protection Area in near the town of Mut and Cyprus Peace Cemetery on the road to Silifke-Gulnar would be flooded due to dam construction. Therefore, World Bank cancelled the loan owing to low profit-earning capacity, environmental and social problems (Göksu – Kayraktepe Dam and HEPP's Revised Feasibility Study Report, 1997).

According to Kayraktepe Project prepared in 2010, the Wild Life Protection Area located on Kayraktepe Dam reservoir area will be excluded from the project area. As can be explained in the evaluation of technical issues and risk part, sediment inflow will be satisfied in the Göksu River Delta. Therefore, Göksu Delta Plain will be protected from erosion. Moreover, flood control will be supplied (Sever, 2010).

5.4.8.2 Impacts on Biological Environment

In the dam projects, the most significant and irreversible impact on biological resources usually comes from the land changes due to remain under water. Terrestrial habitats remaining under water cause habitat loss and changes in the properties of existing aquatic habitats. Therefore, the effects of project on ecosystem, natural resources, biodiversity and sensitive habitats (especially the habitats used by the endangered animal and plant species) might be considered.

- Flora and Fauna

There are not any endemic flora and fauna species under protection in the planned dam lake (Kayraktepe Project's EIA Report, 1994).

Natural vegetations in dam lake and its surrounding area are pine and the primary types of shrubs. There are no endemic plant species in the region of the dam. They must be cleared away before filling the reservoir. In addition, wet biotopes of the Göksu valley have occurred in many years. If these biotopes will remain under water, it will be a great loss for water-dependent fauna living that region. After construction of the dam, studies might be done to re-establish the lost biotopes. These losses need to be repaired as soon as possible (Kayraktepe Project's EIA Report, 1994).

According to "Göksu-Kayraktepe Environmental Development Plan" prepared by Agriculture Department of Cukurova University in 1985, the fish species observed in the Göksu River at the project area are Silurous Glanis, Gobio sp., Anguilla anguilla, Varicorhinus sp., Clarias tazera, Aiburnus alburnus, Salmo trutta magrostigama, Barbus sp., Bufo Vulgaris, Tripoclonatis sp. and Lutra Lutra. They have no commercial value (Kayraktepe Project's EIA Report, 1994).

According to the DHKD report, the fish species found in Lake Akgöl and in the drainage canals are carp (Cyprinus carpio), blackfish (Clarias iazera), grey mullet {Mugil cephalus), eels (Anguilla), and occasionally sea bass (Dicentrachus labrax) and gilt-head bream (Spams aurata).

Dam body forms a barrier on the river. Therefore, it prevents the migration of fish species due to ovulation purposes to upstream of the dam. This causes changes of fish species in river system and the amount of fish. The necessary structures, such as fish passages and stairways can be constructed in the dam body.

The animal species observed at the project area are Urus arctos, Cants lupus, Musteta fonia. Canis aureus, Sus scrofa, Cinis vulpus, Hyanea hyanea, Lepus Europeus, Capreolus capreolus and Rupicapre lupicare (Kayraktepe Project's EIA Report, 1994).

Some important bird species living in the project area are Glariola sp., Anap sp., Grus grus, Ciconia ciconia, Anser anser, Streptopelia sp., Sciopax rusticola, Otis tarde, Alectoria sp., Francolinus francolinus, Tetve ogallus caspius, Cotunnix

cotunnix, Ardea Cinerea, Meropa Apiaster, Anthus trivalis, Locustella iusciniodes, Turdus Merula and Sturnus vulgaris(Kayraktepe Project's EIA Report, 1994).

5.4.8.3 The Impacts on Water Quality

The organic load increases in the reservoir lake and downstream of the project as a result of decomposition of biomass in the area remaining under water, especially areas with high organic content (wetlands, agricultural fields, forests etc.). In the areas planned to remain under water, collection of agricultural products, cutting down trees in forest lands, clearing of vegetation are some of the methods can be applied to reduce the amount of organic loads. This process is important particularly for applications if there are high nutrient loads in reservoir and eutrophication may occur. Eutrophication can be evaluated by determining entrance of pollution sources into the reservoir (point/diffuse, domestic/industrial pollution sources, etc.) and increased organic load. In addition, in order to prevent eutrophication, reservoir operating conditions can be adjusted to limit the duration of water retention in reservoir.

According to the research by DSİ, as far as concern only about nitrogen and phosphorous, the water quality of the Göksu river belongs to Water Quality Class I or II at both upstream and downstream from Silifke town in 1994 through 1996.

According to the data observed by DSI, groundwater in the delta is found relatively shallow depth below 1-2 m from the surface. Saltification of groundwater is observed only in the southern and northern parts of the delta adjacent to the sea.

The ground water level fed by the river bed in Göksu Delta can reduce due to a decrease of flow in the river bed. Nevertheless, resources feeding the wetlands in the delta could prevent creating any negative impact on wetlands. Furthermore, irrigation and the widespread use of fertilizer in the region cause flowing nutrients towards to wetland areas (Kayraktepe Project's EIA Report, 1994).

According to the measurement and the assessment made by looking at the existing water quality, eutrophication will not be expected to occur in the dam lake (Kayraktepe Project's EIA Report, 1994). In the upstream of the dam, a significant polluting source that can alter Göksu River's water quality adversely does not exist.

It is observed that there is no pollution in the project area. However, in downstream of the dam, Göksu River is polluted with Silifke town's domestic waste and liquid wastes from the manufacturing industry. In addition, various pollutants caused by SEKA Mediterranean paper factory located in Taşucu affect Göksu River negatively.

The minimum flow rate released from the reservoir in all situation (even if hydroelectric power plant does not produce energy) might be determined to prevent drying of the river bed in downstream of the project, to prevent affecting fish habitat negatively, to ensure sufficient water flow for downstream users. Minimum flow rate should be sufficient to maintain an aquatic life (e.g., spawning, fish fry's development) and the existing pollution assimilation capacity. In addition, appropriate structures providing migration ability of aquatic life can be added to the project.

5.4.8.4 Effects on Soil, and Sediment Accumulation in Reservoir

Sediment transported to the downstream by the Göksu River strongly depends on the amount of river discharge. The component of the sediment is silt and sand. Sediments are mostly transported in floods. During the flood periods, by means of the bottom outlets, the transported sediments can be transferred to downstream before subsiding and solidifying. Therefore, by flushing the reservoir during the flood periods, the dead volume will be adequate for more than 50 years (the economic life of the dam).

As mentioned before, the newly developed formulation was analyzed whether the dam is adequate for flushing or not in Sever's thesis (2010). According to his calculations, the annual sediment amount at Kayraktepe Dam axis is about 1.13 x

10^6 m^3. The dead volume of Kayraktepe Dam Project is planned as 49.71 x 10^6 m^3. This volume is sufficient to store the sediment load approximately 44 years. According to this analyze, it was determined that the new dam is adequate for flushing. Thus, the sediment supply of Göksu Delta will also continue. It means Göksu Delta will be preserved against erosion. But, Kayraktepe 1997 formulation was analyzed also and found out that Kayraktepe 1997 formulation is not adequate for flushing. Therefore, erosion of Göksu Delta will continue. Moreover, as a result of sediment retention, there will be decrease in storage capacity of the dam. This is a factor taken into account in determining the plant's project lifetime.

If dam does not have the facilities to supply sediment transportation, the amount of suspended solid material in the downstream of dams usually decreases because of sediment retention in the dam. If there are agricultural areas in the downstream of the projects, the efficiency of these areas might be reduced due to a significant decrease in high nutrient sediment transportation.

5.4.8.5 Impacts on Climate

The operation of large-scale dams may cause the changes in micro-climate conditions (such as the rate of change on humidity as a result of evaporation, the local fog formation, and increased wind speed). In addition, greenhouse gas emissions can be considered for the fields remaining under water where high organic degradation is expected to form. Clearing of vegetation in the flooded area might reduce greenhouse gas emissions resulting from reservoir.

5.4.8.6 The Effects on Historical and Cultural Assets

Depending on the project area, water retention in the reservoir may cause some of the cultural and historical assets remaining under water. Moreover, transportation to these areas may be affected adversely due to the realization of the project.

Cultural Ministry registered three important historical assets in the reservoir area of Kayraktepe Project prepared in 1982, Maltepe, Cingentepe and Attepe, which are from the prehistoric age. These assets were determined as the most important ones in term of exposing some unknown issues in very old history by Silifke Archeology Museum Directorate and English Archeology Institute (Kayraktepe Project's EIA Report, 1994). These assets might have been replaced. An excavation project could have been prepared to rescue these assets that would be under the Dam Lake. Its cost should have also been added to total project cost. There is no information about this issue at the Kayraktepe Project redesigned in 2010.

According to Biro's studies, the local villagers were deeply attached to their natural environment, poorly informed about the project, and willing to participate in a study concerning the environmental impacts of the Kayraktepe Project (Biro, 1998).

In conclusion, large dam with reservoir has more environmental problems and risks than small dam and HEPPs have due to water retention and sediment cut.

5.4.9 Evaluation of Economic, Financial Issues and Risks

In this section, economic and financial issues and risk related to the hydropower project are assessed.

For the realization of the Kayraktepe project in 1985, World Bank provided loans amounting to USD $200x10^6$. After joining World Bank, the Japanese, European and Arab commercial banks also provided loans amounting to USD 350×10^6. Unfortunately, the cost of land acquisition and resettlement increased tremendously due to various circumstances in Turkey. Thus, World Bank cancelled the loan due to low profit-earning capacity, environmental and social problems. According to the study in 1993; costs for land acquisition and resettlement for the Kayraktepe hydroelectric plant increased from approximately $30 million in 1986 to more than $180 million in late 1993 (Kammen and Pacca, 2004). A more complete and informed economical analysis of the project shows that when the Kayraktepe Project's external costs are internalized, its benefit cost ratio falls from 1.35 to 0.84 (Biro,1998). It indicates that the project is economically undesirable and the decision of construction needs to be considered.

In order to reduce the cost of land acquisition and resettlement, instead of a large scale dam, one medium dam and five run-of-river type hydropower stations were recommended in 2010.

Benefits for large dam formulation of Kayraktepe project and for new formulation of Kayraktepe project are shown in Table 5.8 and Table 5.9 respectively.

Table 5.8 Benefits for Large Dam Formulation of Kayraktepe Dam (Sever, 2010)

Project Name	Kayraktepe Dam and HEPP (Original project)
Firm Energy (Gwh)	401.3
Seconder Energy (Gwh)	254.4
Total Energy (Gwh)	655.7
Investment Cost (TL)	999,119,575
Annual Income ($/yr)	61,504,660
Annual Outcome ($/yr)	103,789,001
Income / Outcome ratio	0.59

Table 5.9 Benefits for New Formulation of Kayraktepe Project (Sever, 2010)

Project Name	Kayraktepe I Diversion Weir and HEPP
Firm Energy (Gwh)	38.67
Seconder Energy (Gwh)	20.13
Total Energy (Gwh)	58.8
Investment Cost (TL)	55,487,250

Table 5.9 (Continued) Benefits for New Formulation of Kayraktepe Project

Project Name	Kayraktepe II Diversion Weir and HEPP
Firm Energy (Gwh)	24.11
Seconder Energy (Gwh)	15.26
Total Energy (Gwh)	39.37
Investment Cost (TL)	51,910,656

Project Name	Kayraktepe III Diversion Weir and HEPP
Firm Energy (Gwh)	69.573
Seconder Energy (Gwh)	44.823
Total Energy (Gwh)	114.395
Investment Cost (TL)	95,304,591

Project Name	Kurt Suyu Diversion Weir and HEPP
Firm Energy (Gwh)	
Seconder Energy (Gwh)	9.683
Total Energy (Gwh)	9.683
Investment Cost (TL)	8,083,085

Project Name	Kayraktepe Dam and HEPP
Firm Energy (Gwh)	160.07
Seconder Energy (Gwh)	148.51
Total Energy (Gwh)	308.58
Investment Cost (TL)	274,540,344

Project Name	Kayraktepe IV Diversion Weir and HEPP
Firm Energy (Gwh)	36.62
Seconder Energy (Gwh)	20.78
Total Energy (Gwh)	57.4
Investment Cost (TL)	56,503,123

Table 5.9 (Continued) Benefits for New Formulation of Kayraktepe Project

Project Name	Total Project
Firm Energy (Gwh)	329.043
Seconder Energy (Gwh)	259.186
Total Energy (Gwh)	588.228
Investment Cost (TL)	541,829,049
Annual Income ($/yr)	55,175,786
Annual Outcome ($/yr)	38,896,343
Income / Outcome ratio	1.42

Environmental damage has not been included in cost-benefit analysis of hydroelectric power projects because the value of nature is difficult to determine since there are no markets for all environmental goods and services and, therefore, prices are not available. However, the fact that nature does not have a market price does not necessarily mean that it has no value.

Biro (1998) studied the first formulation of Kayraktepe Project's cost estimations with a more complete and informed economic analysis in 1998 so as to estimate some of the local environmental and social costs of the Kayraktepe Project, and to incorporate these values into the project's cost-benefit analysis.

In upstream, a dam's reservoir may inundate human settlements, as well as wildlife habitats and natural resources. In downstream, by changing flows of water, sediment, nutrients, energy, and biota, a dam can interrupt and alter most of a river's important hydrological processes, leading to dramatic ecological and economic losses. The official economic analysis for the Kayraktepe Project does not account for such impacts and, thus, favors the decision to construct the dam. Moreover, although the local people are immediately affected by the project's construction, they were not consulted or given an opportunity to participate in the decision-making process concerning the project's design, feasibility and desirability.

This study concentrates on three major external costs associated with the Kayraktepe Project, the loss of agricultural income from the existing fields and trees in the reservoir area; the loss of value from the national forests which will be inundated; and the non-use values placed on the environment by the local people. The use values of agricultural land and forests were estimated using current market prices while the non-use values were estimated using Contingent Valuation Method (CVM).

The official cost-benefit analyses carried out for the Kayraktepe Project ignore the project's external costs and only include construction and operation costs. When its external costs are internalized, the net present value of the project falls below zero and the benefit-cost ratio decreases from 1.35 to 0.84, indicating that the project is economically undesirable and the decision for its construction needs to be reconsidered. The results are illustrated in Table 5.10.

Table 5.10 Cost-benefit Analyses for the Kayraktepe Project by Internalizing the Project's Local Environmental and Social Costs

Cost-Benefit Analysis for The Kayraktepe Project

				Gender-bias corrected	
	Official Analysis	Alternative Analysis I	Alternative Analysis II	Alternative Analysis III	Alternative Analysis VI
		Using WTP for total population	Using WTP for adult population	Using WTP for total population	Using WTP for adult population
Discount rate	0.095	0.095	0.095	0.095	0.095
WTP for environment (million USD yr^{-1})	0	8.89	3.55	10.02	4.01
Loss of agricultural income (million USD yr^{-1})	0	11.45	11.45	11.45	11.45
Loss of forestry value (million USD yr^{-1})	0	1.21	1.21	1.21	1.21
Total external costs (million USD yr^{-1})	0	21.55	16.21	22.68	16.67
Net present value (million USD yr^{-1})	137.97	-87.59	-31.70	-99.42	-36.51
Benefit-cost ratio	1.35	0.86	0.94	0.84	0.94

Although it was not possible to take all the external costs, i.e. resettlement of villagers, loss of coastal fisheries, etc., of the project into account, internalizing even some of the externalities associated with the Kayraktepe Project made a significant difference in the desirability of the project. Clearly, if the economic cost of all the other impacts were also incorporated into the analysis, the benefit-cost ratio would be much lower.

Consequently, the final result is that when environmental externalities are added, the first formulation of Kayraktepe Project becomes economically undesirable and it should not be constructed before thorough economic, environmental and social evaluations are conducted and all alternatives are considered. Dam builders and project developers can be held responsible for undertaking such evaluations. There may be several alternatives for this project including small- scale hydroelectric projects like new formulation of Kayraktepe Project. Even if economical analyses of small–scale HEPP are prepared, the local environmental and social costs estimations of the Project should be considered.

5.4.10 Summary of the Results of Early Stag e Asse ssment Too l's Applications

The comparisons of the results of Early Stage Assessment Tool's application on large dam and medium dam with five run-of-river type hydropower stations are illustrated in Table 5.11.

Table 5.11 Comparisons of the Results of Early Stage Assessment Tool's Application on Large Dam and Medium Dam with Five Regulators

Early Stage Assessment Tool	Large Dam	Medium Dam and 5 Regulators	Explanations
Demonstrated Need	+	+	Turkey needs energy and water services. A high dam with large storage capacity could supply energy production, flood control and irrigation facilities. Whereas, the purposes of Kayraktepe Project prepared in 2010 are only energy production and flood control.
Options Assessment	-	+	Hydropower projects can supply water and energy demands. Moreover, Their investment and generation costs are lower than costs of other energy projects. Kayraktepe Project prepared in 2010 seems to be best alternative option among three feasibility studies because of reducing social, environmental and economical problems resulting from large area remaining under water due to large dam construction.
Policies and Plans	-	+	The government supports hydropower projects because of preventing energy deficiency, supplying water service, providing clean, reliable, national energy sources and maintaining economic independency. River basins have been planned in order to get maximum energy and water. Large dam cuts sediment transportation to the downstream by causing loss of fertility and coastal erosion in Göksu Delta Plain. Therefore, integrated river basin development of this region does not overlap with the Ramsar Convention.
Political Risks	-	-	Both of Kayraktepe Projects can be subjected to deprecation by social and environmental organizations after it is decided to construct. DSİ has a right to disapprove Kayraktepe Project prepared in 2010 due to the formulation changed after bidding. However, if DSİ changes its opinion and decides to construct large dam, the financial problems about finding viable credit can occur. Therefore, both projects have a political risk.
Institutional Capacity	+	+	BM Group's current hydropower portfolio holds numerous hydropower projects throughout Turkey, with a total installed power of approximately 500 MW. BM has institutional capacity related to hydropower project.
Technical Issues and Risk	+	+	Both projects are technically feasible. However, large scale dam cuts sediment transportation whereas Kayraktepe Project designed in 2010 is suitable for flushing, thus sediment supply of Göksu Delta will continue.

Table 5.11 (Continued) Comparisons of the Results of Early Stage Assessment Tool's Application on Large Dam and Medium Dam with Five Regulators

Early Stage Assessment Tool	Large Dam	Medium Dam and 5 Regulators	Explanations
Social Issues and Risk	-	-	In Turkey, settlements can be observed in the flooding areas. There is a limitation for settlement in the Delta region but it is not controlled. For this reason, if large dam is constructed, numerous villages and valuable agricultural areas in the upstream will remain under water else the resettlements will occur in downstream for flood. Therefore, both of Kayraktepe projects have social risks.
Environmental Issues and Risk	-	+	Large dam with reservoir has more environmental problems and risks than medium dam and regulators have, with respect to water retention and sediment cut.
Economic, Financial Issues and Risk	-	+	When environmental externalities are accounted for, high dam with large storage capacity becomes economically undesirable. New Project reduces the cost of land acquisition and resettlement. Moreover, environmental externalities are also reduced. Hence, its income/outcome ratio is higher. Even if economical analyses of small–scale HEPP are prepared, the local environmental and social costs estimations of the Project should be considered.

5.5 Discussions

5.5.1 Discussions about Turkish Laws and Legislations Concerning HEPP Projects

In order to deal with the world's most conspicuous challenges including lack of electricity access, water scarcity, climate change and global warming, sustainability should be satisfied on the environmental, social and economical issues.

There is a rapid social and economical development in Turkey, in parallel with this development, electrical energy needs should be supplied by an uninterrupted, high quality, reliable and economical way without affecting the environment adversely. For this reason, projects can be developed primarily by using domestic energy sources.

Hydropower projects, as a national energy resource, supply the equity between present and future generations by leaving a cleaner world and natural resources to future generations and by providing electricity source with long viability and low maintenance. However, the sustainability development of these projects on environmental, social and economical considerations is very curios and significant issue. If the feasibility studies of these projects are not prepared accurately, instead of being beneficial, these projects may be harmful.

Unfortunately, there are some curious problems related to Turkish laws and legislations' applications and inspections which can be listed as;

- While planning the projects, local people can be informed and their opinions can be gathered. However, public's opinions are not obtained during entire parts of a project.
- Project Introduction Files and EIA studies can be done based on the measurement, and applicable precautions can be placed. The negative effects of the projects on environment, culture and social structure do not usually depend on scientific studies. The opinions of necessary experts on the influences of a project can be taken in order to minimize negative effects.
- The rehabilitation of people affected from dam constructions and monitoring the level of sustainability are the other essential works that have to be done.
- The EIA process can begin with feasibility studies of the project. While assessing alternative dam sites, the technical and economic conditions, as well as environmental conditions can be examined. In this regard, the EIA studies began at the right time allow sufficient environmental data collection

and evaluation about the location of the dam. Thus, the environmental sensitivity of these areas can be determined as early as possible and it can be taken into consideration during project planning studies. Therefore, the environmental conditions related to the project site and cost and vulnerabilities about its effects can be considered while assessing alternative options. The problems and costs that may arise later can be prevented with the selection of the right place.

- The effects of the projects are considered particularly. However, while assessing the environmental impacts of the HEPP projects, total impacts of all projects planned in the same river, especially ecological impacts can be taken into consideration. Project planning might be based on an integrated river basin-based analysis. Integrated river basin planning might be established by including sectoral representatives, various professional disciplines, local governments and civil society organizations.
- To protect the natural environment and life by minimizing the negative effects of HEPP implementations, ecological planning, effective control and monitoring works might be considered.
- A scientific method can be developed for the amount of released water into downstream. While determining this method, the river's own characteristics and the properties of ecosystem around the river might be considered. In addition, which institution controls releasing ecological water and its time and its enforcement mechanisms might be clarified. The relevant institutions and provincial organization might be appointed by authorized with regulations. Local people and NGOs can also be included in this process.
- In the river where HEPP project will be constructed, Water detection can be done and the amount of local people's seasonal water use can be determined. These amounts might be compared with the amount of ecological water requirement. The adequacy of planned water releases might be investigated.
- Energy Market Regulatory Authority, the General Directorate of State Hydraulic Works and General Directorate of Forestry can inform relevant authorities and local institutions and can request their opinions before

giving the necessary permissions. The opinions of relevant authorities, local institutions, local public and NGOs might be considered.

- Related companies under HEPP construction might take every measure on time and the relevant institutions might control them. The implementation of the necessary mechanisms is required so that investor companies completely carry out their responsibilities mentioned in Water Use Rights Agreements. Moreover, there might be intimidating punishment.
- Historical, cultural and natural assets affected by HEPP projects might be determined and reported to Regional Cultural and Natural Heritage Protection Councils.

5.5.2 Discussions about the Kayraktepe Projects

Here are the disadvantages of 1982’s Kayraktepe Project formulation (Biro, 1998).

- The reservoir will inundate 40 villages and their fields, forcing about 21000 people to resettle elsewhere.
- The reservoir lake will change the microclimate of the Göksu Basin, adversely affecting the flora and fauna of the region, including certain rare species.
- The reservoir will destroy instream fish habitats and spawning grounds.
- Fertile farm lands and forests will be flooded, causing economic and ecological damage while wildlife, including possible endemic species will perish.
- Three unexcavated prehistoric archeological sites will be inundated.
- The reservoir lake will destroy a natural and undisturbed landscape that has a potential for eco-tourism development.
- The dam will impede sediment/nutrient flows in the river, resulting in the decline of coastal fisheries.
- Downstream sand and gravel-mining operations in the river bed will be adversely impacted.
- Cessation of sediment flow will cause erosion along Silifke's coastline, resulting in loss of coastal land, buildings and eco-systems in the long term.

- As coastal erosion takes place in the Göksu Delta, seawater will diffuse into coastal fields, threatening agriculture.
- Kayraktepe Dam will alter flow patterns of the Göksu River, adversely affecting underground and the surface-water supplies that feed into the Göksu Delta.

Therefore, large dam construction in this area sounds to be infeasible owing to social, environmental and economical problems.

The advantages and disadvantages of 2010's Kayraktepe Project formulation is summarized below (Sever, 2010).

- Social and environmental impacts were reduced.
    - Expropriation area is decreased from 5000 ha to 820 ha.
    - Resettlement is not required.
    - Wild life protection area is recovered.
- The flood control task has been overcome.
- The energy production reduces about 10%.
- Göksu River Delta to be deprived of natural sediment inflow under the original formulation will now be completely preserved.

In order to decrease social, environmental and economical problems related to Kayraktepe project, instead of large dam construction, construction of smaller dam and regulators can be preferred. The plans for optimal size and the most adequate location of these structures should be prepared by considering negative impact of these structures on social and environment. Moreover, flood control and sediment transport into downstream of dam should be maintained.

There are a wide variety of factors that control the formation of the coast. For any reason, the prevention of sediment transport in the Göksu River causes very significant changes in the delta.

Breakwaters construction or releasing the material taken from lagoons, reservoir or sea-bed area into the delta from time to time may be considered to avoid this erosion. In addition, water releases from bottom outlet of the dam at certain times can assist sediment transport towards the delta because of including low amount of sediment. On the other hand, it is necessary to prevent taking sand and gravel from the river bed in the downstream of the dam. Moreover, a kind of by-pass structure allowing sediment transport could be constructed in the dam (Kayraktepe Project's EIA Report, 1994). Some solutions are listed below.

- Construction of barriers in the delta
- Crater-sink fluidization
- Supplement of sediment by sand, gravel and soil transportation from surrounding areas.
- Construction of wave breaker and marine structure which can manipulate the direction of coastal flow in the sea

However, for such preventions, both the initial investment as well as operation and maintenance costs are very high. Therefore, when the costs of these structures are added into the total investment cost of the project, the economical feasibility of the project disappears.

Almost all debris carried by the river bed in the dam reservoir can pass the dam lake with crater-sink fluidization method (Kayraktepe Project's EIA Report, 1994). When comparing with other method, it is less dependent on human labor. It causes to protect natural balance with natural methods. One another advantage is that economical feasibility and technical feasibility was tested in practice.

Planned dam lake area is in an active landslide region. While designing dead volume of the dam, landslides should be taken into account. For this reason, in order to provide the desired energy production, sufficient active volume of the dam is designed in high value. However, if sediment carried by the river bed and mass piled as a result of landslides in the dam reservoir are transported into downstream of the dam with the methods described before, additional dead volume capacity could be greatly reduced. Therefore, the height of the dam could be decreased. This causes reduction of the dam reservoir area. Some fertile agricultural lands and some archaeological values (mounds) could be saved. Moreover, the cost of expropriation, initial investment cost of the dam and expenses for the relocation of road could be reduced.

On the other hand, economic life of the project of Kayraktepe Dam project is planned by depending on how long the dead volume of the dam will be filled with sediments. When by-pass methods are used, sediment filling the dead volume of the dam will be released into downstream of the dam. Therefore, calculated dead volume will not be filled with sediments. The economic life of the dam will increase. Significant economical benefits will be provided.

However, more detailed studies should be done to measure positive or negative changes of water quality in the Delta due to application of these methods.

CHAPTER 6

CONCLUSIONS AND RECOMENDATIONS

After understanding requirement of clean and renewable energy, in order to increase the weight of hydropower energy rapidly with the participation of private sectors, the Electricity Market Law related to water usage right was enacted. In this way, there was an excessive increase in the number of HEPPs in construction with participations of private sector. However, this increase brings about lots of social and environmental problems. Due to these problems, there is an increase in the number of hydropower opponents including NGOs, potential project affected communities and local communities. In this thesis, their opinions were investigated in order to find the origin of these problems. It was determined that there was a deficiency in hydropower projects' development process.

Environmental Impact Assessment enters into the hydropower projects' procedure after final projects are designed as can be seen in Figure 4.2. This means, DSİ had already approved feasibility study of the project and EMRA had already given license to the company. After EIA is included into the process, the company might face with environmental and social problems most of the time. However, during the time, the company has made significant investments into project preparations. After this stage, it may be difficult to consider an alternative project. To avoid this problem, EIA can start with feasibility studies. As illustrated in Figure 4.2, if there were initial EIA report that the company should have prepared in feasibility process and should have received approval from the Ministry of Environment and Forest, the environmental and social problems related to the projects would be determined already. If DSİ assessed the feasibility studies with this initial EIA report, so many environmental and social problems resulting from the project would not occur. For this reason, as an example, International Hydropower Association's Early Stage

Sustainability Assessment Tool was chosen to show how to determine social, environmental and economical impacts of the project at the feasibility stage.

In this thesis, this Early Stage Tool was applied to the Kayraktepe Projects which have more than 30 years of history. The aim is to decide best option among the projects while considering social, environmental and economical effects at the feasibility stage. The effects of dam construction with a large scale reservoir were compared with the effects of construction of medium dam and several regulators. As a conclusion, Kayraktepe Project prepared in 2010 has less social, environmental and economical problems than Kayraktepe Projects prepared in 1982 and 1997. This is because instead of the dam construction with a large scale reservoir, construction of small dam and regulators decrease the problems related to the cost of land acquisition and resettlement tremendously. In addition, wild life protection area will not remain under water. Therefore, people affected from the project and the effects of the project on environment are also reduced. Although the energy production decreases about 10%, sediment transportation can continue with flushing. Therefore, loss of fertility and coastal erosion at the Göksu Delta which is protected by Ramsar Convention might be prevented. Moreover, flood control might also be provided.

Even if small scale hydroelectric facilities seems to be more feasible, a study might be prepared to determine and assess the number of HEPPs, their location and their height while minimizing total negative effects of the entire project on social, environmental and economical issues. Moreover, how the region will be affected when Kayraktepe Projects are not implemented might also be investigated.

During project life cycle, continuous improvement measures might be supplied with IHA's Hydropower Sustainability Assessment Protocol consisting of early stage, preparation, implementation and operation assessment tool. These are stand-alone assessments applied at particular stages before major decision points in the project life cycle. For this reason, whenever DSİ decides Kayraktepe Project formulation and detailed technical, environmental, social and financial studies are prepared, the evaluations might continue with using the preparation assessment tool.

Hydropower projects are considered as renewable, clean, and environmentally friendly energy sources. However, hydropower projects might contribute sustainable development, if and only if social, environmental and economical effects of hydropower projects are taken into account. Conversely, if these effects are not considered, hydropower project might be destructive for country's sustainable development.

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APPENDIX A

IHA'S HYDROPOWER SUSTAINABILITY ASSESSMENT PROTOCOL (2006) TO EVALUATE NEW HYDRO PROJECTS

Summary of Aspects for a New Hydro Project

In this section, there are twenty sustainability aspects related to economic, social and environmental issues in order to assess proposed new hydro project.

Summary of Aspects for a New Hydro Project

1) Political risk and regulatory approval
This section measures the level of sovereign risk and likelihood of regulatory approval. Political instability and sovereign risk issues and a degree of uncertainty about the risks posed to the project are examined.

Examples of Evidence:

- Regulatory agreements
- Interviews with regulators
- Authoritative assessment of political stability / sovereign risk
- Authoritative assessment of likelihood of approval, including timeframes and conditions

2) Economic viability

In this section, economic viability is evaluated. Suitable and adequate plan for future auditing / monitoring of economic performance should be prepared.

Examples of Evidence:

- Business plan
- Business charter
- Agreements with shareholder on planned benchmarks and targets
- Cost / benefit analysis
- Auditing and monitoring plans
- Independent analysis, e.g., by scheme financiers

3) Additional economic benefits

How many benefits the project delivers to directly affected stakeholders and the broader community is determined in this part. These benefits can contain direct and indirect employment, education, transfer of knowledge, capacity building, improved health care, national development, additional economic activities, recreation and infrastructure.

Examples of Evidence:

- Identification of types and range of additional benefits
- Plans to measure effectiveness of additional benefits,
- Evidence of stakeholder support
- Identification of stakeholders
- Assessment of opportunity
- Independent assessment of plans and proposals

4) Planned operational efficiency and reliability

The planned operational efficiency of the project in the context of the broader system and relevant market arrangements are assessed with respect to three specific areas which are planned management of the hydrological resource, design efficiency of the power station assets (e.g., turbines), planned and/or existing efficiency of the network assets. Moreover, the likely reliability of power scheme in the context of the broader system, short-term and long-term reliability of the hydrological resource, power station assets (e.g., turbines and generators), and network assets are evaluated.

Examples of Evidence:

- Assessment of likely asset performance
- Proposed power station asset management strategies
- Emergency / unusual event plans
- Analysis of long-term resource availability
- Contingencies to cope with future changes to resource

5) Project management plan

The aim of this part is to appraise the proponent's ability to design and construct the project. It illustrates whether comprehensive planning for the design and construction phases of the project is supplied or not.
Examples of Evidence:

- Project management plan
- Project risk analysis
- Evidence of resource availability
- Evidence of resource suitability and/or competency

6) Site selection and design optimization

In this part, planning for side selection or implementation of side selection and design optimization is measured. It should avoid exceptional environmental and cultural heritage sites. Furthermore, it should minimize disturbance to existing features and activities (e.g. practicable reduction in flooded area in relation to GWh output). Besides, maximization of economic, social and environmental opportunities should be required.

Examples of Evidence:

- Site selection criteria and assessment
- Design criteria, planning process, verification, and reviews
- Calculation of flooded area in relation to GWh output
- Records of design change to avoid or minimize disturbance and/or maximize opportunities
- Independent assessment of exception environmental and cultural heritage sites
- Interviews with designers

7) Community and stakeholder consultation and support

The likely degree of community support for the project, and the planning for and processes used to gain that support are evaluated.

Examples of Evidence:

- Written agreements with stakeholders or plans for agreements
- Records of interviews
- Results of surveys or polls
- Minutes of meetings with stakeholder groups
- Various process documentations
- Stakeholder and issue identification
- Determining objectives and targets
- Methodologies used or planned, including consultation strategies, resources, timings, information sharing
- Stakeholder input and feedback.

8) Social impact assessment and management plan

It measures community and regulator support for any actual or planned mitigation, compensation, and/or enhancement strategies.

Examples of Evidence:

- Plans for social impact assessment or the actual assessment
- Identification of directly affected stakeholders
- Plans for involvement and/or consultation with directly affected stakeholders during assessment process
- Records of stakeholder involvement
- Interviews with regulators and stakeholders
- Agreements with stakeholders and/or regulators.

9) Predicted extent and severity of economic and social impacts on directly affected stakeholders

The potential extent and severity of economic and social impacts on directly affected stakeholders are investigated. Plans for avoiding impacts and/or mitigate and compensate for those impact and plans for improving present conditions through enhancement programs are evaluated.

Examples of Evidence:

- Independent review of social impact assessment
- Authoritative opinion on the level of social impact
- Mitigation / compensation / enhancement plans or programs
- Agreements with stakeholders and regulators
- Interviews with stakeholders and regulators

10) Enhancement of public health and minimization of public health risk

Public health are evaluated by considering area of risk, measurements to manage risk, opportunities to provide public health benefits such as electricity and water supply, flood mitigation and an increase in employment.

Examples of Evidence:

- Public health risk assessment
- Assessment of public health enhancement opportunities
- Agreements with regulators and stakeholders
- Interviews with regulators and stakeholders
- Public health management plans
- Planned monitoring program

11) Safety

The assessment of safety planning is done with respect to appropriate national and international standards and comparable industry practice.

Examples of Evidence:

- Safety and legal compliance requirements
- Independent review of proposed asset safety plans or measures
- Issue identification and risk assessment
- Determining objectives and targets, safety planning
- Incorporation of standards and other requirements in plans
- Emergency preparedness planning

12) Cultural Heritage

The level of impact and planning for protection and conservation of historic and indigenous heritage values are appraised.

Examples of Evidence:

- Conservations plans
- Heritage impact statements
- Heritage plans and agreements

- Interview with regulators and other stakeholders
- Physical inspection of sites
- Independent assessment of plans and proposals.

13) Environmental impact assessment and management system

It measures community and regulator support for any actual or planned mitigation, compensation, and/or enhancement strategies.

Examples of Evidence:

- Plans for environmental impact assessment or the actual assessment
- Identification and risk assessment of environmental issues
- Interviews with regulators and stakeholders
- Agreements with stakeholders and/or regulators
- Stakeholder and regulatory consultation plans
- Independent expert testimony on EIA plans or content.

14) Threshold and cumulative environmental or social impacts

Threshold impacts mean actions causing a large step change to environmental or social conditions. Cumulative impacts are the sum of total impacts resulting from a series of changes to environmental or social conditions. This section assesses regulated and unregulated river systems in the region.

Examples of Evidence:

- Options assessment in relation to regulated and unregulated rivers in the region
- Environmental and social impact assessment of options
- Assessment of cumulative and threshold impacts of options

15) Construction and associated infrastructure impacts

It evaluates regulatory support for any actual or planned avoidance, mitigation, and/or enhancement strategies and the success of planned construction avoidance, mitigation, and/or enhancement strategies.
Examples of Evidence:

- Construction management plan
- Emergency response program or plans
- Land rehabilitation and restoration plans
- Chemical management plans
- Protocols and agreements with local community
- Protocols and agreements regarding construction workforce
- Social and environmental plans relating to associated infrastructures

16) Land management and rehabilitation

Land management and rehabilitation during the construction process are assessed. The agreements and planning for on-going land or catchment management including management of terrestrial habitat, over the life of scheme are investigated.
Examples of Evidence:

- Design plans for land restoration and rehabilitation
- Construction management plans
- Revegetation program or planning
- Weed control program
- Site sediment controls or planning
- Catchment management agreements or planning
- Land use agreements or planning
- Vegetation retention or protection programs
- High-value terrestrial habitat retention or protection programs.

17) Biodiversity and Pest Species

Ecosystem values, habitat and specific issues such as threatened species, fish passage, and introduced pest species in the catchment, reservoir and downstream areas are assessed. Planned investigations and likelihood of agreement with regulators and stakeholders are evaluated.

Examples of Evidence:

- Research and database on threatened species
- Documented agreements in relation to ecosystem values
- Research on fish passage and pest barriers
- Plans for physical infrastructure, e.g. fish lifts
- Biological monitoring plans
- Interviews with regulators
- Independent assessment by appropriately qualified individuals or groups

18) Environmental flows and reservoir management

The likely effectiveness of the planned environmental flow and reservoir management regimes to meet expected environmental, social and economic outcomes are evaluated.

Examples of Evidence:

- Regulatory agreements
- Documented environmental, social, and economic objectives
- Surveys or other measures of stakeholder opinion
- Investigations and specific reports
- Monitoring plans
- Interviews with stakeholders and regulators

19) Sedimentation and erosion

It measures the risks associated with reservoir and downstream sedimentation and erosion. It illustrates understanding of likely reservoir and downstream sedimentation and erosion issues and risks, and the scheme will meet regulatory requirements and stakeholder expectations.

Examples of Evidence:

- Sedimentation and erosion risk management planning
- Investigations into sedimentation and erosion issues in the reservoir and downstream
- Stakeholder surveys and agreements
- Regulatory license requirements
- Interviews with stakeholders and regulators

20) Water quality

It assesses potential water quality issues in the reservoir and downstream of the power station.

Examples of Evidence:

- Water quality management planning
- Water license and water quality commitments
- Water quality investigations
- Records of negotiations with other water users
- Water quality management agreements with other users
- Interviews with regulators

APPENDIX B

THE CHRONOLOGY OF GÖKSU BASIN AND KAYRAKTEPE DAM PROJECTS (Sever, 2010)

- Some important legislation related to hydropower and critical development stages of Kayraktepe Dam and HEPP projects are listed chronologically below.
- 1936: General Directorate of Electrical Power Resources Survey and Development Administration (EİE) was founded to investigate issueson how rivers in the country could be utilized for energy production.
- 1953: Initial investigation in the basin started; Stream Gauging Stations were installed.
- 1954: State Hydraulic Works (DSİ) was established.
- 1954: The basin scale studies for 26 different basins have been started.
- 1971: Ramsar Convention or the convention of wetlands was accepted. It is an intergovernmental treaty in order to maintain the ecological character of their Wetlands of International Importance and to plan for the "wise use", or sustainable use, of all of the wetlands in their territories. (Ramsar, İran, 1971).
- 1977: The Kayraktepe Dam and HEPP project was identified by EİE.
- 1977: The contract awarded to the consortium of EPDC, Su-İş, Su-Yapı and TMB.
- 1980: The first phase of the engineering service including the feasibility study for the purpose of selecting the optimum dam site and formulating an optimum development scheme of the optimum scale.
- 1979: Construction of Gezende Dam on the Ermenek Creek was started.
- 1982: The feasibility report of Kayraktepe Dam and HEPP project released by the Consortium. Optimum dam site was selecting among four alternative dam sites.
- 1983: the design report and the loan application report were prepared.

- 1984: ACT No: 3096 released: Local and foreign private companiesallowed to generate, transmit distribute and trade electricity by using Built-Operate-Transfer model.
- 1986: The construction of Kayraktepe Dam was awarded by DSİ to EPDC under finance from the World Bank. Small preliminary works such as camp facilities and access roads were constructed.
- 1990: Construction of Gezende Dam was completed.
- 1994: Turkey ratified Ramsar Convention. The Göksu Delta was recognized as Ramsar site.
- 1997: Kayraktepe Dam and HEPP Project was revised.
- 1999: Act No: 4446 released: Legal foundation of "Privatization in the Constitution was defined.
- 2000: The World Commission on Dams published an infamous report as "Dams and Development". It is the biggest victory of environmentalist nongovernmental organizations against large dams. In the report, five core values were identified and 26 guidelines were listed for the construction of large dams. Turkey and some other developing economies put strong critics to the report by claiming that they had the right to development. However, from that time onwards, the construction of large dams became difficult due to action taken from international credit agencies (WCD, 2000).
- 2001: Act No: 4628 released: Aims to form a stable, transparent and competitive electricity market to generate sufficient, sustainable and cheaper electricity.
- 2002: Construction of Ermenek Dam was started.
- 2003: Regulation for increasing involvement of private sector in the electricity market was established.
- 2004: Six on-going HEPP developments were transferred to private sector.
- 2005: Act No: 5346 released: Aims to increase electricity generation from renewable sources.
- 2006: The construction of Blue Tunnel was started (water transmission from the Göksu River to Konya Plain).
- 2008: Kayraktepe Dam and HEPP was awarded to a private company. The company, namely BM holding, decided to revise the project in order to eliminate environmental effects.

- 2009: Construction of Ermenek Dam was completed.
- 2010: Negotiations with DSİ for the new formulation of Kayraktepe Dam and HEPP project has not been settled yet.

APPENDIX C

THE EXAMPLES OF SUSTAINABLE ENVIRONMENTAL SOLUTIONS FOR SEDIMENTATION AND EROSION PROBLEMS FROM AROUND THE WORLD (sustainablehydropower, 2011)

C.1 Dashidaira Dam, Japan

A flushing channel, sediment gates and appropriate operating rules have overcome potential sediment retention impacts at Dashidaira Dam, in a Japanese river system noted for fast flow and very high sediment loads.

Although the Kurobe River catchment is primarily situated in national park, the very high annual rainfall (4000mm/yr average) and low water retentive geology has resulted in approximately 7000 landslip areas. As a result, sediment loads in the river tend to be very high. The construction of a conventional dam would result in:

- Rapid sediment accumulation in the storage, requiring frequent dredging, diversion works or other strategies to maintain the capacity of the storage. These operations would have significant impacts on the downstream environment and would be difficult and expensive due to the inhospitable terrain at the dam site.
- The retention of sediments and bed load that, under natural conditions, would move down the river system and discharge to sea. Strong community opposition to the dam centered on the potential for riverbed and coastal erosion as a result of altered sediment transport regimes.

To overcome these issues, the Dashidaira Dam was designed with a unique flushing channel and sediment gates to enable free flow of water when the lake level is low. This provides the opportunity for the unimpeded passage of floods, the timing of being matched to natural flood events using flow and sediment transport models. The resulting sediment transport patterns closely match natural sediment transport events.

- Monitoring of the downstream environment since construction of the dam has indicated that:
- Turbidity in the downstream environment is declining annually
- Turbidity and organic carbon loads are temporarily high in the vicinity of the river mouth during sediment flushing, but return to background levels within one day of a flushing event
- No changes in the nature of riverbed sediments have been detected subsequent to sediment flushing.
- Aquatic faunal communities downstream of the dam are altered during and immediately after during flushing events, but return to normal after a period of 1 month. This is similar to trends observed during natural flood events.

C.2 Asahi, Japan

Measures have been implemented to prevent sedimentation and turbidity in the reservoir and downstream, including construction of a bypass tunnel and filtering weir immediately downstream of the dam as well as protective works against slope collapses around the regulating reservoir.

C.3 Tarbela, Pakistan

Flushing flows conducted to manage sediment buildup in the dam to maintain a larger live storage volume in the reservoir and prolong the effective life of the scheme.

Furthermore, as can be seen on figure 4.3., environmental impact is investigated after company prepares final design. This means DSİ had already approved its feasibility study and company had already taken IPP license from EMRA. If environmental impact assessment studies were started with the project's feasibility studies and while DSİ approves the feasibility study, the Ministry of Environment and Forest approved initial environmental impact assessment, there would not be such environmental problems related to HEPP projects.