7. ENVIRONMENTAL AND SOCIO-ECONOMICAL ASPECTS

7.1. GENERAL

Hydropower development projects are closely linked to environmental and social factors in the process of project layout and design as well as evaluation. Today environmental considerations are already included from the first stage of work during identification. The number of specialists concerned with environment impacts working in hydropower development is steadily increasing. There are botanists, zoologists, water quality chemists, sociologists and many others evaluating the environmental issues.

The term environment is a broad term that includes physical, biological, and social impacts. Changes in productivity of downstream agricultural fields or fisheries are included, just as the question of population resettlement. Environmental effects may occur upstream, on-site, or downstream of the hydropower project. The following list presents a listing of environmental aspects of hydropower projects. Some impacts are positive, others negative. It should illustrate the complexity of the topic. The listing is taken from the World Bank technical paper no.10 entitled ”Dams and the Environment”. It can be considered as a checklist of environmental aspects in hydropower development.

- Health
  Some water related diseases can increase unless precautions are implemented (e.g. Vector control, prevention) schistosomiasis, onchocerciasis, encephalitis, malaria, etc. Remediation usually impossible; prevention is the only cost-effective approach.
- Resettlement of people is expensive and time-consuming when done acceptably. The people can (and should) be better off afterwards. Can hydropower projects become regional development projects, which integrate rural development for people, with watershed management and irrigation? Resettlement of vulnerable ethnic unacculturated minorities should be avoided; if unavoidable, special precautions are necessary.
- Wildlife extinction can be minimized by siting. Including a wild land management unit, equivalent to the inundated tract in the watershed, can mitigate loss of wildlife. Biotic rescue can assist.
- Fish migrations (if any) will be impaired without passage facilities. Fish promotion in the reservoir can mitigate and produce more than before the project
- Biomass removal
  Related to whatever water quality is needed downstream, to fisheries and navigation. Valuable timbers and fuel should be salvaged; ”opportunity costs” of lost timber and foregone use of inundated land should be internalized
- Water weeds
  Proliferation can increase disease vectors, and transpiration increases water loss and impairs fish and water quality (e.g. Water hyacinth (eichhornia), water lettuce (pistla)). Clogging impairs navigation, recreation and irrigation. Some potential to use weeds for compost, biogas, fodder
- Water quality
  Within reservoir and downstream, saline intrusions, water retention time (i.e. Flow/volume); decrease nutrients in estuary; pollution monitoring (agricultural leachates, Industries).
- Erosion
  upstream leads to sedimentation, which can impair storage; watershed management should be routine. Increased erosion below a dam
- Drawdown strip
  Useful for recession agriculture (with disease and access precautions)
- Cultural property
  Archeological, historic, paleontologic, religious and esthetic or natural unique values or sites should be conserved or salvaged
- Multiple use
  Can be optimized by tourism, irrigation, fisheries, and recreation. Regulation improves seasonal rivers into perennial waterways; advantages for drinking and irrigation.

- Navigation
  may need special provisions such as locks, cleared shipping lanes, and access ramps if drawdown is large. Lake transport may become economically advantageous
- Induced seismicity
  Tectonic movements may increase or decrease; monitoring is becoming routine
- Intact rivers
  Hydropower and other developments are better concentrated on the same rivers in order to preserve
  Representative rivers in their natural states.

There are several common points from the above mentioned aspects that are important: It is needed to re-emphasize that not all environmental effects are negative and entail costs only. They can also generate benefits. It is as important to identify the contributions of environmental factors to the project, as it is to identify the negative impacts and the constraints they may impose. Both environmental costs and benefits must be taken into account. The second important aspect is that the effects and thereby also the environmental aspects of hydropower developments are strongly interconnected as the listing above shows.

7.2. DATA COLLECTION

The data collection concerning environment can be distinguished in three steps:

- Preliminary desk studies in the office
- Data collection in the field
- Establishment of environmental and socio-economic set up

Preliminary office work will gain a considerable amount of data, since low head hydropower developments are usually in areas with more or less existing infrastructure. In case of bigger projects in tributaries, some more information will be available. In recent years mapping of environmental and natural resources is carried out by multistage survey, where tools as satellite data, computer classification, aerial photography, ground sampling and land surface mapping is used. Following image shows the approach of multistage survey.

Major information on the project area can be obtained during a site visit, which is carried out to observe and establish present environmental conditions in the area of influence of the project, to assess the range of possible impacts, on site as well as off-site, which may extend into the catchment and even into the district.

A site inspection and infrastructure survey will be carried out. The purpose is to cover a large cross-section of the inhabitants of the project area and surrounding villages. Inhabitants of villages should be interviewed together with local people of the region and the proposed site should be inspected. Further information on the project area can be obtained from development programs and local authorities.

The fieldwork mainly includes the following information:

- Socio-economic conditions concerning the people and their basic necessities.
- Soil, land, vegetation, farming, irrigation, plantation, forestation and deforestation.
- Ecological conditions concerning fisheries and wild life.
- Climate of the catchment

The irrigation and water supply issue in connection with the determination of residual waters can be considered as a main point of the environmental assessment of high head developments in rural areas. For this purpose it is useful to carry out discharge measurements in the distribution canals and water supply canals during different seasons of the year. It is also recommended to take the historical water demand for irrigation into consideration. This will give some helpful additional information regarding the need for water together with other data taken

in the field.

7.3. DATA PROCESSING AT JINNAH HPP, PAKISTAN

The data collected during the field visit will be processed to establish a set-up of present different environmental and socio-economical data. This should describe the actual stage without any considerations of hydropower development. Later processed data are analyzed by applying it to the proposed hydropower scheme and to find their environmental impacts whether beneficial or harmful. The following example of the proposed hydropower project Jinnah HPP at Indus River describes the set-up with collected data as basis.

7.3.1. PHYSICAL SETTINGS

The physical environment is separated in the project area, topography, climate, regional geology, seismicity, hydrology, erosion, sedimentation and water quality. Since the topics of topography/physiography, climate, regional geology, seismicity and hydrology with sedimentation/erosion are already discussed in detail in the paragraph “data collection and data processing”. Therefore there is no need for repetition in this context. Apart from the description of project area and water quality reference can be given to concerned paragraph.

7.3.1.1. PROJECT AREA

Jinnah HPP is situated on the Indus river approximately 5 km downstream Kalabagh town that is located in Mianwali district. The total area of the Mianwali district is 13,933 km^2. The district can be broadly divided into two parts: a hilly area in the north, northwest and northeast and a sandy plain in the center and the south. The mountain and hills consist of Bhangi Khel and the Khattak Niazi hills in the northwest and the salt range in the northeast. The plains in the center and south consist of a cultivated area between the Indus River and its main banks and a sandy area as Thal.

It is considered that the main area of influence will be in an approximate triangle formed by joining Kalabagh village to the Kurram River where it crosses the Mianwali district boundary and a point just to the southeast of Mianwali. Any area further to the south than the barrage boundaries will be more affected by the Chashma HPP. The triangle pushes outwards at the sides up to the mountain areas and therefore includes such areas as Chapri and Makawal in the west and Musa Khel in the east.

7.3.1.2. WATER QUALITY

Water quality data of measurements show colorless water. It is slightly alkaline and has a ph value of about 8.0 throughout the year. The salt content of Indus River is very low. The typical ranges of major ion (in mg/l) include the following:

Table 7.1: Major ions of Indus water at Jinnah HPP

Ion	Concentration [mg/l]
Ca	1.00 to 2.00
Mg	0.25 to 1.25
Na	0.10 to 1.00
K	0.00 to 0.15
Co_3	0.00 to 2.27
Hco_3	1.20 to 2.44
Cl	0.14 to 0.90
So_4	0.10 to 0.90
No_3	0.01 to 0.06

Electric conductivity (ec x 10^6 at 25°c) fluctuates between 140 and 470. The permissible value of electric conductivity is below 1500 for good quality of water. The amount of dissolved oxygen varies from 4.50 to 13.00 parts per million throughout the year.

7.3.2. BIOLOGICAL ENVIRONMENT

7.3.2.1. WILDLIFE

Although little documentation is available on local sources have stated the presence of human activities on and adjacent to the Indus River have affected local wildlife fauna. These human activities include the construction of the Chashma and Jinnah barrage and the widening irrigation activities. Over the past 50 years, since these projects were constructed there has been reported decreases in certain species such as crocodile but other species appear to have a growing population.

Table 7.2: Mid-winter water fowl in Chashma Reservoir

Sr. No.	Name of Species	
	Common	Scientific
1	Avocet	Recurvirostra avosetta
2	Bar-headed goose	Anser indicus
3	Bar-necked grepe	Podicepa nigricollis
4	**Black-winged stilt**	Himantopus himantopus
5	Bar-crowned night heron	Nyzticorax nycticorax
6	Black-headed gull	Larus ridibundus
7	Brown-headed gull	L brunnicephalus
8	Common shelduck	Tadorna tadorna
9	Common teal	Anas crecca
10	Common pochard	Aythya ferina
11	Common coot	Fulica atra
12	Common snipe	Gallinago gallinago
13	Eurasian wigeon	Anas penepole
14	Ferruginous duck	Ayatha nyroca
15	Great cormorant	Phalacrorax carbo
16	Grey heron	Ardea cinerea
17	Great egret	Egretta alba
18	Great crested grebe	Podiceps cristatus
19	Great black headed gull	Larus ichthyaetus
20	Green sand piper	Actitis hypoleucos
21	Green shank	Tringa nebularia
22	Greylag goose	Anser anser
23	Gadwal	Anas strepera
24	Herring gull	Larus argentatus
25	Indian river turn	Sterna aurantia
26	Indian pond heron	Arodeola gravii
27	Lettle egret	E garzatta
28	Little cormorant	Phalacrocorax niger
29	Little ringed plover	Charadrius dubius
30	Mallard	Anas platyrhynchos
31	Moorhen	Gallinula chloropus
32	Northern pintail	Anas acuta
33	Northern shoveler	A clypeata
34	Northern lapwing	Vanellus vanellus
35	Purple heron	Aredea purpurea
36	Pleasant tail jacana	Hydrophsianus chirugus
37	Red crested pochard	Netta rufina
38	Ruddy shelduck	Tadorna ferruginea
39	Tufted duck	Aythya fuligula
40	White-tailed plover	Vanellus leurecurus

Today the shorelines and wetlands area appear to be stable and have adapted and matured from the changes created years ago when the barrages inundated new properties. Chashma wetlands have become a wild life sanctuary and include a Ramsar site, which is in the list of international conservation unions. Water foul are present in the project area and are given in the Table 7.2. Visiting birds also use some times marshlands near Jinnah barrage for rest.

7.3.2.2. FISH AND AQUATIC LIFE

About 70 species of fish are reported in the river near Jinnah barrage. The fish reported by fisheries at Chashma are given in the Table 7.3. It is also pointed out that with occasional sightings as for north as Jinnah barrage the Indus dolphin is found from Guddu up to Chashma barrage.

Table 7.3: Fish Species occurring in Chashma Reservoir (1991-1992)

Common Species	Predator Species (Commercial)	Non-commercial Species
Labeo rohita	Mystus seengala	Gadusia chapra
Cirrhinus mrigala	Wallago attu	Notopterus notopterus
Cyprinus calhasu	Channa marulius	Notopterus chitala
	Mastacembelus armatus	Labeo gonius
		Labeo dyocheilus
		Cirtrhinus reba
		Puntius arana
		Puntius ticto
		Puntius sophore
		Ostiograma cotio
		Rasbora daniconius
		Chela labuca
		Salmostoma bacaila
		Heteropneuses fossilis
		Ailia coila
		Mystus cavasius
		Mystus tengara
		Xenentodon cancila
		Ambassis ranga
		Amabassis baculus
		Nandus nandus
		Colisa fascciata
		Colisa lalius

7.3.2.2.1. FISH MIGRATION

A number of fish of the Indus River display a migratory nature. Although this migration is widely observed by fisherman, fisheries personnel and other interested government agencies and have not scientifically documented this phenomenon.

Fish ladders are provided and functioning with various degrees of effectiveness at Suleimanki, Panjnad, Balloki, Marala, Kotri, Guddu, Khanki, Trimmu and many other barrages. But to date it has not been possible to trace the biological record pertaining to fish for which these fish ladders were designed and constructed.

Upstream traveling by the fish is mainly for spawning. Although a fish may inhabit a considerable stretch of a river, they usually prefer to travel against the current to places where the high monsoon flows create temporary ponds. The fish lay there eggs in these ponds, where availability of flood, depth of the water and velocities of the flow are better suitable for newly hatched fry than deep and high currents of the main river. Migration is also observed to take

place in cycles, which may range from a few months to several years. This cyclical nature of migration varies by fish species. During certain years, a much higher number of fish are noted to be migrating upstream, than during the same months in other years.

7.3.2.2.2. FISH LADDER

At present there are two fish ladders at Jinnah barrage, one near the right and one near the left bank. Their construction is identical and they are each located alongside a pier in the landward side. Fish are common in this part of the Indus River. The migration season is from February to November.

Larger fish traveling downstream have been observed to follow definite preferred routes, usually along banks. On approaching an obstruction such as a barrage the fish tend to prefer a fish pass, if one is available. The concern at Jinnah HPP will be that they may be drawn through the turbines but the trash racks and the noise omitted by the turbines should discourage fish most from entering the turbine waterways. If available the fish may move towards a fish ladder. Fish passing through the large slow turning/moving bulb or pit type turbines are likely to suffer mortalities of less than 5% (Sithe energy of America has studied fish mortality extensity with the same turbine design and other similar conditions. The results from these studies show mortality rates from 2 to 4%)

The effect of the power station will be to attract fish migrating upstream to the turbine draft tubes but the fast flowing water will prevent their upstream passage. However, the possibility of fish ladders will be examined for their potential effectively for passing fish and they must be kept in full working order.

Thus new fish pass may be required to provide a safe route for migrating fish round the power station. If required, it should stretch from the power station tailrace to the headrace.

7.3.2.3. VEGETATION

The vegetation of the area is generally forest, shrubs and grasses. The salt range at Kalabagh has a flora of its own corresponding to that of the situation on the ranges east of the Indus. The thal sand hills are an extension of the Great Indian Desert. There are separate botanical aspects of three different terrains of the district.

The hills have limited vegetation in the form of trees except for the areas of Shakesar hill in the heart of Bhangi Khel trees are confined to depression and low lying slopes. The common trees are Phulahi, Sanatha, Kangan, Kann or Olive, Dhaman, Kikar, Anar or Pomergranate, Khabari or wild Fig tree, Tut or Mulbery, Bohar and Jl. The hills are, however, rich in plants and shrubs including viven, mastiara, hari, vithaman, ganger and kahir.

In the uplands the common trees are Lulha, Kikar (acacia arabica), Thali (dalhergia sisso), Jand (prosopis aphylla), and Ber (zizyphus jajaha), which is commonly planted on wells. Fruit tress (pillha) can also be found in the district. The important supply of food for grazing camels are Keri, Babbil, Phog, Bohar and different shrubs such as Lana, Khip, Akh thrive in the uplands. Grasses are numerous of which chamber and sain are the most common. These are excellent fodder for cattle and horses.

In the kacha or river tract, the Ban, Lai, Thali, Kikir and Ber are the most common trees. The common garden trees are Mangoes, Oranges, Pomegranates, Mulberries, Lemon, Loquts, Pears and Grapes. The chief grasses are Sarkana, Munykana, Kunder, Talla and Drabh. Among weeds Singi, Maiuna, Jawah, Lihu, Jahdre, Ozi and Kinh are very common.

7.3.2.4. FOREST

In Mianwali district the Rakh Kundian is the most forested area. This is a natural forest. Species found in this forest are Dalbegia Sisso, Accacia Arabica, Marus Alba, Salmalia Malabaricum,

Prosopis Spicigrea, Phosopis Uliflora and many other types of species, which can be considered as common for this region.

7.3.2.5. WETLANDS

There is no censes record available about wetlands of Jinnah barrage. The nearest wetland in the project area is Chashma wetland. The wetlands in the area are associated with the construction of the Chashma reservoir, which cover an area of 480 ha. It supports a number of reptile species, a wide range of waterfowl and various wild mammals. The wetland of the reservoir is only a small part, which comprises the most important wildlife sanctuary.

Table 7-2 shows the bird counts recorded by Punjab wildlife research institute during the critical month of January for a seven-year time period. January is the month when migratory birds pass through or leave Pakistan following the path of internationally important flyway no.4, which is also known as the Indus flyway. The Indus flyway links Siberia and Kazakhstan with indo-Pakistan. Marshlands on the west bank of the Jinnah barrage are not considered good habitat for waterfowl. It is seen as a resting area and not permanent habitat for waterfowl. Any species of waterfowl can use this resting area.

7.3.3. HUMAN ENVIRONMENT

7.3.3.1. POPULATION

The population of the whole Mianwali district was 1.4 million according to the last census in 1981. Of this approximately 60% (i.e. 840,000) live in the survey area. The district population has grown at around 2.7% per annum not including three afghan refugee camps. The population density was stated as 98 persons per sq. Km in 1981. Table given below shows the population growth for Mianwali district since 1951. The largest town is the district capital, Mianwali, with a population of 75,265 (estimated 1988). The labor force in the study area is now estimated to be 320,600, which represents 30% of the total population. This figure excludes the people in the afghan camp near Chapri, which holds another 6000, of which 1800 could be classed as potential labor. The official unemployment rate was stated 1981 as being 1-4% but this figure does not reflect the severe underemployment.

The major occupations are agriculture, forestry, hunting, and south of Mianwali fishing. The activities occupy about 62% of the total labor. Migration is considered to be fairly stable at present with little movement in either direction.

Table 7.4: Population in Mianwali district

Description	1951	1961	1972	1981	1988
Population	550,449	746,733	1,095,632	1,377,413	1,694,044
Intercensal increase [%]	-	35.6	46.7	25.7	23.0
Average annual growth rate [%]	-	3.1	3.3	2.7	3.0

7.3.3.1.1. SOCIAL INFRASTRUCTURE

The total area of the Mianwali district is 13,933 sq. Km and for administration purposes is divided into tehsils, growing circles, patwar, revenue circles and mauzas.

The project is situated in Kalabagh town of the tehsil Isakhel, which lies on the west bank of the Indus River. The remainder of the Mianwali district is on the eastern bank. A deputy commissioner, assistant commissioner, district magistrate and collector control civil administration.

7.3.3.1.2. HEALTH AND NUTRITION

Health facilities are not well developed within the project area. Lack of adequate facilities has affected the incidence of malnutrition, illness, mortality and fertility. Families living in remote areas have less access to health services, minimal disposable incomes and less time to travel to the city to seek these services. However, three basic health units (bhu) are working in the general area of the Jinnah barrage.

Major diseases in the project area are diarrhea, malaria, acute respiratory infections, thyradism, and tuberculosis. In local population m. Vivax is very common but 97% of afghan refugees are saturated with m. fabiciparum. Which has not transferred to the local population.

Mianwali has a vaccination program against the six communicable diseases (whooping cough, tetanus, measles, tuberculosis, mumps and diphtheria). Both programs consistently achieved better vaccination coverage within urban areas.

Malnutrition is frequently linked with poverty. There was prevalence of malnutrition among preschool age children according to verbal discussion with local health officials. In the Mianwali district, less than 25% of children are growing normally by the standards of western countries.

Infant mortality rates are high in Mianwali district. It was reflected by the total deaths of children under the age of five years. The main cause of infant deaths was diarrhea, dysentery, and the six communicable diseases. Very few women attend hospitals for childbirth and births are frequently attended by a midwife.

7.3.3.1.3. LITERACY AND EDUCATION

Pakistan has a young population with 37% of the population being between the ages of 5 and 19 years. Literacy is not evenly distributed within the district and the sexes. Literacy is greater in urban areas than in rural areas. Literacy rate is low in females due to the attitude of the local rural people towards education. But no females are approaching college level education. Some development projects such as the atomic energy power station and the Chashma HPP have changed the attitude and lifestyle of locals to some extent.

7.3.3.1.4. HOUSING

Over 80% of the houses in Mianwali district are owner occupied and majority are made with unbaked bricks with mud baking. However, in urban areas and towns there are pacca/concrete houses.

7.3.3.1.5. ETHNIC GROUPS, CULTURE AND LANGUAGE

The principal tribes of the district are Pathans, Awan, Baloch, Syed, Qureshi, Jat and Rajputs. Other tribes also live in the district.
There are four different tribes of Pathans in the district, the Niazi, Khatak, Balochi and Multani. They come from different places near the Indus River and settled in the project area.

7.3.3.1.6. THE FAMILY STRUCTURE

The family consists of an extended family grouping in which the oldest member is the head of the family. In decision making, the oldest male, normally the father or the eldest son, determines the family interest and makes decisions with regard to the family. In some cases, an elder female or mother may take over the role after the husband’s death.

7.3.3.1.7. MIGRATION

According to the 1981 census, the total immigrants were 106,634 or 77% of the total population. In the rural areas, immigrants amounted to 75.1 percent of the population. The male

and female immigrants were 53.2 and 46.8 percent, respectively. The persons who had migrated into the district during the five-year period of 1976-1981 were 23.4 percent of the population. During the ten-year period of 1971 to 1981, 30,800 persons had left the region. Of these 29,693 were from rural areas with the remainder of 1,107 were from urban areas.

7.3.3.1.8. WOMEN'S ISSUES

Women's issues such as social services and employment opportunities need improvement. Some of the shortcomings that could be addressed in the decreasing order of importance are educational facilities, hospitals, water supplies, vocational training schools and employment opportunities.

Within social culture, the preference of a son over a daughter is predominant mainly for reasons of securing lineage and property. Women are infrequently consulted, usually men have the deciding power and make the purchases for females. Rural women mostly remain inside the home. In any cases men will not tell his wife about his plans to sell an animal or land. Young girls are born to be submissive and have to obey the rules framed by the males in society.

7.3.3.2. LAND USE AND LOCAL ECONOMY

Local economy of the area is based on agriculture and influenced highly by migration of the people to other districts and out side the country. Existing land use of the district is agricultural, forestries and other Industries. The total land area required for the project is 50 hectares including working areas.

At the recommended power station site on the right bank no existing structures will be affected. Much of the land is unused. To the immediate north and south of the existing road towards the Kalabagh town, the land is swampy and a large reedy lagoon lies in the north. A small amount of poor quality wheat is grown near the proposed site area and there is some grazing for goats. Otherwise the land is barren. Apart from the re-routing of the road to Bannu during construction of the scheme the effect on the land usage will be very small.

7.3.3.2.1. INDUSTRY

A number of large Industries already exist in the survey areas most of them using the enormous mineral resources in the hills above Kalabagh town. The list includes:

- Fertilizer factory
- Cement factory
- Dye factory
- Penicillin factory
- Coal mining

Other developments, which are considered realistic in the next 5-10 years include:

- Rock salt processing factory
- Glass Industry
- Furnace brick unit
- Ceramics Industry

Apart from the large Industry mentioned above, there is also a considerable amount of small Industries. The most recently published statistics on small scale Industry in the Mianwali district was issued in 1982. This data was discussed with the small Industries department in Lahore and an estimated growth pattern since 1982 was produced. The information is provided for the whole of the Mianwali district and is subdivided by tehsil. The total electricity requirement in Mianwali district is approximately at 20,000 MWh per annum. This is based on the number of Industrial units and the estimated electricity charges per Industry for 1981-82. It is expected that the future development in the small Industries sector could be very significant in the next 10-15 years. The following Industries have a high potential:

- Leather/footwear
- Saw milling and wooden furniture
- Light engineering
- Metal Industries
- Building materials and bricks
- Oil expelling and wheat and grain milling
- Stone crushing
- Ice factories

New Industrial sub-sectors could be:
- Wool spinning
- Poultry farming
- Pottery
- Tanning
- Chip board and veneering
- Paper and paper board
- Dairy products

7.3.3.2.2. AGRICULTURE AND IRRIGATION

In general the district is in great need of increased irrigation. Irrigation areas have good wheat production whereas non-irrigated areas are barren. The main crops in the Mianwali district are as follows:
- Wheat
- Grain
- Sugar cane
- Cotton
- Oil seed
- Maize

The total production of wheat shows a growth although some of the other crops have declined. Vegetable and fruit crops have also declined. New tubewells should increase crop production but a groundwater study would be needed to assess the number which would be feasible to install.
Mianwali district is also well known for its livestock. The part of the district along the salt range hills is important for cattle breeding, other parts are well suited to buffalo breeding. In 1981-82, the following livestock were being kept within the district:

Table 7.5: Number of different livestock in district

Livestock	No. In thousands
Cattle	414.6
Buffalo	103.7
Sheep	641.7
Goats	419.2
Camels	47.5
Asses	40.1
Horses	9.5
Poultry	478.0
Mules	0.4

7.3.3.2.3. FISHERIES

Punjab fisheries department of Mianwali lease Indus River water at Jinnah barrage for fishing every year. It is stated from official side, that different sections of the Indus from Kalabagh up to

downstream of Chashma barrage are leased to contractors every year. Details should be considered during detailed engineering design.

7.3.3.2.4. TOURISM

With the construction of Jinnah barrage and Chashma reservoir, a major opportunity for recreation development has resulted. Else where in the world, 25 years after creation of huge lake with its blue waters and beaches, mountain backdrop, magnificent climate for several months of the year and proximity to the crowded province of Punjab, this would be a site for unlimited tourist and recreation development. This development however, has not yet been realized. The site is ideal for picnics, bathing, water skiing, sailing, motor boats, wind surfing and just simple relaxation amongst attractive scenery, especially in a country like Pakistan where such opportunities are limited. The tourism department should develop this area for tourism.

7.3.3.3. DRINKING WATER

According to the census, around 80% of the houses had hand pump water for drinking water supply, although the number of diesel powered tube wells for both irrigation and water is increasing significantly. Piped water is used mostly in urban areas.

7.3.3.4. TRANSPORTATION AND COMMUNICATIONS

Metalled roads to Sargodha in the east, Bakhar in the south and Isa Khel on the west bank link Mianwali. There are approximately 796 km of metalled and 856 km of unmetalled roads. Pakistani railways including four routes also serve the district.

There are 1150 telephone connections at the time of 1981 census report with 6 telegraph offices and 209 post offices in the district.

7.4. ENVIRONMENTAL IMPACTS

The environmental impacts of the project will be determined for the physical, biological and human environments with regard to location design, construction and operation.

7.4.1. PHYSICAL AND BIOLOGICAL IMPACTS

Portion of the existing main channel will be used as the power channel and the existing barrage structures will remain unchanged except a part of the right guide bank. A portion of the existing road on the top of right marginal bund will be realigned.

7.4.2. ALTERATION OF FLOW

Main flow of river is diverted into power channel, which rejoins Indus River about 500 m downstream of the barrage. The powerhouse will be located on the downstream of the barrage axis. Flow will be diverted into the power channel for energy generation on a year round basis. The project will operate on a run-of-river basis.

7.4.2.1. DOWNSTREAM AND UPSTREAM IMPACTS OF PROJECT

No serious downstream/upstream impacts are foreseen on river and aquatic life except fish migration, which may be effected during low flow period. Some localized erosion in the riverbed near the off take is likely to occur but this will be further investigated during detailed design phase of the project.

7.4.2.1.1. WATER QUALITY IMPACTS

With the commissioning of the project, the water quality changes will not be pronounced. However, after the construction of the proposed Kalabagh dam water quality will slightly change due to settling of silt and nutrients in the Kalabagh reservoir. There will be some change in water quality due to increased turbidity temporarily during the construction period.

7.4.2.1.2. FLOW RECOVERY BELOW DIVERSION

Flow will resume its original conditions only after 500 m downstream of the barrage. Because of the short length of the project waterways, there is essentially no diversion of water.

7.4.2.1.3. IMPACT ON AQUATIC LIFE

The Indus River is a productive river. The impact due to diversion of the river will not be significant. The fish production and species will not be effected. The Indus dolphin has been reported in the project area, however, no significant impact on the dolphin is expected. No aquatic life study has been done for this project at this stage. However, detailed study for aquatic life (fish species invertebrates, photo plankton and zooplankton) will be carried out during detailed engineering design phase of the project. Table 7.3 shows fish found between Chashma and Jinnah barrage. But no bad impact on fishing is expected because of the type of proposed project.

7.4.2.1.4. IMPACT ON FISH MIGRATION

The Chashma (GTZ/WAPDA) hydropower feasibility report indicated that a number of species present in the Indus are of migratory habit. Fish migrate from downstream to upstream and upstream to downstream for the purpose of food and breeding. Two fish ladders are present at Jinnah barrage. Due to proposed change in flow pattern, efficiency of these fish ladders will likely be affected. However, additional studies and observations are needed prior to any recommendation of a new fish pass along powerhouse. This study should include efficiency of existing fish ladders, aquatic fauna and fish species using fish ladder for migration.

7.4.2.1.5. IMPACT ON SPECIES POPULATION

Because of the relatively small diversion of 500 m, species population will not diminish. There will be no diversion impact on upstream and the species population will not diminish. The impact area is very small and the presence of a fish ladder will maintain the biotic continuity.

7.4.2.1.6. VEGETATION LOSSES

Some loss of trees and natural vegetation is expected on the right bank near the barrage for the purpose of the powerhouse structure. Planting new trees on power canal bank will compensate the loss of trees. The vegetation was inspected and it was concluded that the vegetation at the effected site is very common and well distributed throughout the area. No rare endangered species was identified during the field visit.

Upstream some vegetation and trees will be lost on the right bank of the Indus River at Jinnah barrage. This is required for the clearance of the site for the power channel and powerhouse structure. The cost of tree and tree clearing will be compensated. Planting new trees on both banks of the power canal will compensate the loss of trees.

7.4.2.1.7. WILDLIFE AND WILDLIFE HABITAT LOSSES

No significant wild life and wildlife habitat are expected due to the construction of Jinnah HPP as the wildlife habitat of Chashma barrage is quite far from the project area and the marshland found at the right bank of the barrage is considered as poor habitat by the wildlife department. Habitat of mammals is mainly in the mountainous area.

7.4.3. IMPACTS DURING CONSTRUCTION AND MITIGATION

7.4.3.1. IMPACTS IN CONSTRUCTION AREA

7.4.3.1.1. ACTIVITIES PRODUCING DUST

Control of dust in the generally dry local climate will require that exposed dusty surfaces be sprinkled with water regularly. This is most likely to be necessary on upward access roads in the project area, which are used by heavy traffic. It is unlikely that constraints will have to be imposed on work due to dust, such as stopping work if strong winds prevail from a quarter which would blow dust into residential areas. It is however, important that the construction camp be protected from any nuisance due to dust and, if necessary, construction may have to be curtailed if conditions are particularly adverse.

Workers must also be protected from exposure to dust. Facemasks or other respiratory aids should be provided to workers who may have to work in a dust-laden environment.

7.4.3.1.2. CONSTRUCTION NOISE AND VIBRATION

Like several other potential impacts, this potential problem is significant only at the powerhouse site, due to the proximity of the camp. Activities further away are remote from the camp and from any other settlement so that the noise and vibration should not disturb anyone. Depending on actual levels of the noise and vibration, restrictions may have to be imposed on working hours at the powerhouse site.

At the working sites themselves, workers must be protected from undue exposure to noise or vibrations. To this end, they must be provided with ear muffs when working in any uncomfortably loud environment; and workers should be removed from locations where excessive (uncomfortable) vibrations result from the use of large machinery.

7.4.3.1.3. TREE CLEARING

Tree clearing must be kept to an absolute minimum. Any trees not in the direct way of construction shall be left standing and shall be damaged in any way. Trees which have to be removed to make way for construction, but which would not otherwise disturb subsequent operation of the project, must be replanted upon completion of construction.

7.4.3.1.4. AGRICULTURAL LAND

There will be some loss of agricultural land on the right bank of the Indus near barrage. This is an impact of the completed project itself and not specifically a construction impact. However, in these areas, construction must be confined to strict lines so that no more land is disturbed than is absolutely necessary; and any agricultural land disturbed temporarily for construction must be replanted as soon as possible thereafter and owners/tenants compensated for any loss of agricultural production.

7.4.3.2. CONSTRUCTION SAFETY MEASURES AND PROCEDURES

7.4.3.2.1. SAFETY HAZARDS

Safety hazards are associated with the operating of construction machinery, equipment and tools, transportation, blasting, land cutting, fires etc. The causes of safety hazards are usually complex involving human errors, operational faults of machinery and unforeseen incidences. The majority of the causes are controllable with efficient management, staff training, machinery maintenance and other preventive measures. Accident prevention is essentially an engineering and administrative problem and rests mainly on strict compliance with established safety rules and regulations. Proper management and utilization will minimize the hazards during construction.

Workforce water supply and wastewater
The camp will be supplied with an adequate flow of water to meet all domestic requirements of the camp. The contractor should specify the source of this water in his tender. Surface water is unsuitable for drinking purposes. It must first be boiled and filtered. Bottled spring water suitable for drinking should be made available for purchase in the camp.

All wastewater should be subject to collection and treatment to meet acceptable standards before it is discharged to open watercourses.

7.4.3.3. DISPOSAL OF CONSTRUCTION SITE WASTES

7.4.3.3.1. SOLID WASTES
Refuse disposal areas should be located well away from main roads and open watercourses. A large central septic tank could be provided for sewerage treatment. Solid wastes should be disposed to a sanitary landfill, which, upon completion of construction, can be covered and put to some useful purpose, such as tennis courts for example.

7.4.3.3.2. EXPLOSIVES AND ANY TOXIC OR HAZARDOUS CHEMICALS
These must be stored in secure areas well away from residential areas. The storage sites should be placed under armed guard 24 hours a day. An accurate and up-to-date inventory of material delivered to the store and material used on site must be kept. Upon completion of the project, any unused materials must be returned to the supplier and/or disposed of in a safe and responsible manner. The contractor must produce evidence that all such material brought to site for the project has either been used (without residue) in construction of the project, or removed from site in a safe manner.

Further, the contractor must adhere to any and all locally applicable laws and regulations regarding the transport, storage and use of explosives or hazardous materials.

7.4.3.3.3. DISPOSAL OF EXCAVATED MATERIAL AND LAND RECLAMATION
All excavated material, not subsequently used in construction of the project, must be disposed in such a way that it forms stable slopes and does not enter watercourses. The material must be landscaped to fit into the surrounding countryside; this includes planting grass, shrubs or trees which will enhance both aesthetics of such fill areas and their stability against erosion.

7.4.3.4. OPERATIONAL IMPACTS

7.4.3.4.1. POWERHOUSE RELEASES
Powerhouse releases join Indus River 500 m downstream Jinnah barrage. It will not create any serious erosion problem but slight erosion of riverbed and bela may be expected.

7.4.3.4.2. HEADWATER
Since the Jinnah HPP is considered as run-of-river scheme, there is no head ponding in planning.

7.4.4. CONSTRUCTION IMPACTS
For the construction of the project about 800 staff skilled and unskilled will be employed. Manpower is available in the project area. Despite of this some workers will come from outside

the project area. So in this way there will be a sudden increase in population and subsequently pressure on local consumable resources.

7.4.4.1. ECONOMIC IMPACT

The contractors will set-up his camp near the powerhouse site. The camp area is located near the project. Construction staff residing in the camp will buy the articles of daily use from nearby villages, which will improve the economy of the local people and will also result in development of social links. Proper human resource management will coordinate the use of local workers into the construction program.

7.4.4.2. SOCIAL CONFLICT

The locals are strictly Islamic and females observe “parda” so labor force coming from outside the area should be warned about this tradition.

7.4.4.3. IMPROVED INFRASTRUCTURE

During construction roads, and medical facilities will be provided at the site.

7.4.4.4. IMPACT OF NATURAL RESOURCES

Due to increase in labor force pressure on already scarce trees and vegetation will increase. The contractor should provide housing, fuel and meals to the labor to avoid loss of vegetation and hunting.

7.4.4.5. IMPACTS OF LARGE WORKFORCE ON SMALL LOCAL COMMUNITIES

The nearest center of population is the town of Kalabagh which, compared to the size of the workforce, is not small. Given its size, its existing infrastructure and distance from the construction site, the town of Kalabagh will not be adversely impacted by construction. On the contrary the local economy will improve due to influx of workers and income generated by wages paid during construction of the project.

7.4.4.6. OPPORTUNITIES FOR EMPLOYMENT OF LOCAL WORKERS

Construction will provide abundant employment opportunities for local people. Large numbers of unskilled or semi-skilled laborers will be required, particularly during the first 18 months or so of construction when the powerhouse construction pit will be excavated and mass concrete poured for the foundations of the unit blocks. Preference should be given to employment of local residents rather than importation of workers outside the area.

7.4.4.7. RISKS AND DANGERS TO PUBLIC HEALTH AND ENVIRONMENT

Health hazards arise through many sources. The source of greatest concern during construction is dust. Respiratory diseases may result from the dust generated by excavation and movement of equipment. Other risks and danger to health which construction of the project may have is related to workers’ safety. Regular sprinkling of water can control dust.

Contamination of water sources by pollutants may cause health hazards for the population using that water. For the safety of workers and local population, construction activities will be carried out under strict control. Waste material (liquid and solid wastes) will be disposed off in a safe manner. Moreover, the sanitation of the construction camp and work places will be proper. The workers will be provided with proper protection materials such as goggles, helmets, full boots and gloves.

In addition to the preventive and precautionary measures, the camp will have a dispensary equipped with first-aid material, dressing material and necessary kit of medicines for communicable diseases like cholera, dysentery, typhoid, paratyphoid, hepatitis, malaria, etc.

7.4.5. OPERATION IMPACTS

7.4.5.1. EMPLOYMENT

During operation employment opportunities will reduce because fewer people will be required to run the powerhouse and maintain facilities. The terminated labor and staff could be used in other development projects.

7.4.5.2. SAFETY

Local people are already aware of river problems and they are well acquainted with hazards of electrification so this will not be a problem.

7.4.6. BENEFICIAL SOCIAL IMPACTS

7.4.6.1. CREATION OF ADDITIONAL EMPLOYMENT OPPORTUNITIES

The project will create additional employment opportunities during the project construction and limited job opportunities during operation of the project. About 800 people will be required for the project construction.

7.4.6.2. REGIONAL IMPACTS

By building the Jinnah HPP thermal emissions from an equivalent thermal plant will be avoided which will have a corresponding reduction in pollution. The regional impacts are difficult to determine as are impacts on a global level.

7.4.6.3. REDUCTION IN THERMAL EMISSIONS

With the construction of the project thermal emissions of greenhouse gases will be avoided which will contribute in the reduction of pollution.

7.4.7. NATIONAL IMPACTS

The value of energy derived from Jinnah HPP will be about us$ 833 million annually; a portion of this is also given to the Punjab province as a water fee. The project will save the government of Pakistan from costs involved in the fuel import in foreign exchange.

7.4.8. ENVIRONMENTAL COSTS

Environmental costs are based on the expenditures required to neutralize the impact of pollution, due to the construction and operation of the power station, on the environment and ecology of the surrounding area. The overall environmental cost comprises the mitigation cost, institutional costs and monitoring cost, which are discussed in the following sections.

7.4.8.1. ENVIRONMENTAL IMPACT MITIGATION COST

Major basis of the mitigation cost are for the measures to be taken at the pre-construction, and construction stages. Most of these costs therefore shall be included as a part of the main power project contract costs.

The main components covered in environmental cost are access roads realignment cost, temporary relocation costs, compensation for loss to forest trees and water supply provision costs, costs for disposal of mucking material, channel lining cost etc. The environmental cost also includes afforestation cost.

7.4.8.2. INSTITUTIONAL COST

These include the cost for the running of complete set-up for environmental control and monitoring programs. This cost is included in plant operation cost.

7.4.8.3. MONITORING COST

Monitoring cost mainly consists of the equipment required for the checking and testing water and air quality and noise pollution checking during construction of the project. In addition fisheries management plan, construction activities and socio-economic monitoring costs, are also included. Most of these costs are also included under O&M costs.

7.4.8.4. TOTAL COSTS

The estimated environmental impact mitigation works cost is the sum of all costs minus the institutional and monitoring costs, which are already included in the project O&M costs.

7.4.8.5. PROJECT ENVIRONMENTAL COSTS AT JINNAH HPP

For the above-mentioned measures to protect/rebuild the environment, following direct cost issues are needed for Jinnah HPP:

- Land acquisition costs
- Tree clearing cots
- Replanting cots
- Fish ladder costs if needed
- Environmental costs during construction

A principle example for a cost estimation for land acquisition costs and afforestation costs is given in Table 7.6 to Table 7.8.

7.4.9. PUBLIC INTERVENTION

Community involvement is urgently needed; community level discussions should be taken up during detailed engineering. Government officials such as deputy commissioner, divisional forest officer, district health officer, Executive Engineer Irrigation should be contacted and consulted from the beginning of the project.

Table 7.6: Compensation for trees and cost of afforestation

Name of Structure	Species	Dia (cm)	Unit Costs (Rs)	No Of Trees	Total Cost
A. Road widening					
	SUB-TOTAL				
B. Weir site					
	SUB-TOTAL				
C. In take structure/power channel					
	SUB-TOTAL				
D. Power House-site.					
	SUB-TOTAL				
	GRAND-TOTAL				

Therefore, compensation for trees works comes out to be Rs.169800 equivalent to US$ 4250.

COST OF AFFORESTATION

Particulars	No. Of Plants	Unit of Cost Rs.	TOTAL
Planting of Robina, Poplar Apple and Apricot/Walnut			

Therefore cost of afforestation works comes out to be Rs.75000 equivalent to US$1875.

Table 7.7: Total land required for the project

Item	**Cultivated**		**Uncultivated/Waste**		**Total**	
	land (ha)	**Unit Cost (Million Rs)**	**Land (ha)**	**Unit Cost (Million Rs)**	**Land (ha)**	**Cost (Million Rs)**
Weir intake						
Surge tank						
Power house						
Switch yard						
Staff colony and related structure						
Access road to surge tank						
Realignment and widening of existing tract						
Head race channel						
Total						

Table 7.8: Temporary Requirement of Land for Construction Period of 4 years

Item	Cultivated	Waste	Total land
1. Site installation weir area 2. Site installation power house area 3. Deposition area			
Total			