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147 MW PATRIND HYDROPOWER PROJECT PAKISTAN



FISH STUDY

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EXECUTIVE SUMMARY

1. INTRODUCTION

Kunhar River flows through Kaghan valley. Starting from Naran (2,362 m amsl) in Khyber Pakhtunkhwa, it has a length of 129 km up to weir site (755 m amsl). It is spread over a catchment area of 2,429 Km². The 13 Km reach of the Kunhar River from weir site to its confluence with Jhelum River at Domishahi has a catchment area of 256 Km². Temperatures prevailing at Muzaffarabad are more relevant to the Project area. At Muzaffarabad the months of May to July are the hottest months with temperature ranging between 26°C to 30°C while December to February are coldest with temperature varying between 10°C to 11°C.

2. FISH SAMPLING

Fish culture study was undertaken in the Kunhar River reach of the Project area. Fish fauna survey was conducted at three selected sites to find out the kind, number and quantity of fish available. Fishes consisted of *Schizothorax plagiostomus* (Swati), *Anguilla rostrata* (Eel), Uchali fish (China fish) and Wallago auto (Mallie) were found. The number found was between 0-5 and the weight was less than one Kg in each case.

3. WATER QUALITY SAMPLING

The water samples were also collected at the selected three sites and analyzed for temperature (°C), pH, total dissolved solids (g/l), turbidity, dissolved oxygen (mg/l), total hardness(mg/l as CaCO₃), total alkalinity (mg/l as CaCO₃), BOD, COD, TSS, Ca, Mg, K, Phosphate, Nitrate etc.

Water quality was found conducive to fish culture except for turbidity and critical temperature regime for cold water fish.

4. IMPACTS AND MITIGATION MEASURES

Impacts of construction and operation activities on fishery would be insignificant. Minimum 2 cumecs of water from the head pond will be released as ecological flow throughout the year. This flow (2 cumecs) is in addition to the flow which joins Kunhar River in the form of various large and small streams downstream of the weir thus providing mitigation measures for aquatic flora and fauna in the reach downstream of the weir.

However, the head pond holds a considerable fishery potential after the construction of the Project. With appropriate management of this potential, head pond fishery development during operation phase will substantially enhance the beneficial impact of the Project on the local population.

5. FINDINGS OF LOCAL INTERVIEWS

The netting data and discussion with people indicated that the occasional fishing in the Project area is not an occupation but a hobby due to little availability of fish fauna. The fishing activity was practiced more in winter due to lower turbidity, lesser speed and depth of the river. The same position persists from the head pond area to the confluence of Kunhar River with Jhelum River as far as the availability of fish and angling is concerned according to local people. When asked about the availability of trout, the answer of majority of the public was no with occasional evidences of trout availability in the Project area after many years. They revealed that the Trout was restricted mainly above the Balakot area of KP. The evidence supports the findings of the fish fauna survey.

6. FISH MIGRATION PAST MANGLA DAM

It is acknowledged that the results of the study are not necessarily representative of long term waterway conditions. The lack of long term data on water quality, plankton concentrations and fish populations limits the conclusions that can be made about the aquatic ecology in the Project area. The scope of present study does not require covering of fish fauna present in Jhelum River along with its migration status. There is almost no possibility of upstream migration of fish fauna above Mangla Dam to the Project area as authenticated by the study results and supported by the local information recorded through the interviews. Even then, if some migration occurs that will be compensated by the Neelum river. Thus, it can be safely concluded that the proposed Project will have minimal effects on the available fish fauna as well as the migration of fish species above Mangla dam.

FISH FAUNA STUDY

1. INTRODUCTION

Kunhar River flows through Kaghan valley. Starting from Naran (2,362 m amsl) in Khyber Pakhtunkhwa, it has a length of 129 km down to weir site (755 m amsl). It is spread over a catchment area of 2,429 Km². The 13 Km reach of the river from weir site to its confluence with Jhelum River at Domishahi has a catchment area of 256 Km².

Being a river of cold water, fish fauna in Kunhar River is very limited and does not form a major economical fishery. The following main freshwater fish species are available in the upper and lower portions of Kunhar River (Muslim and Chaudhry, 2004).

- *Schizothorax curvifrons* (Snow Trout)
- *Salmo trutta* (Brown Trout)
- *Salmo gairdneri* (Rainbow Trout)
- *Tor putitora* (Mahasheer)
- *Labeo rohita* (Rohu)

1.1 The Study Area

The physical layout of the Patrind hydropower Project extends from location of its weir on Kunhar River near Patrind village which acts as a boundary between Khyber Pakhtunkhwa and AJK to location of its powerhouse on Jhelum River at Lower Chattar in Muzaffarabad district, (AJK).

1.2 Objectives

The objectives of the study were to:

- Assess aquatic ecology (fish fauna) in Kunhar River between head pond and downstream to Jhelum confluence.
- Describe aquatic ecology (fish fauna) and existing water quality in Kunhar River.
- Describe the overall impact of the Project on aquatic ecology in Kunhar River between head pond and downstream to Jhelum confluence.

2. METHODOLOGY

A survey of Kunhar River (head pond and downstream to Jhelum confluence) regarding aquatic ecology was carried out from 15-25 September, 2010 to assess aquatic biodiversity (fish fauna) and water quality.

Discussion with DFO Wildlife, Mansehra, DFO Jhelum valley, Deputy Director, Fisheries, Abbottabad and other officials of Forest/Fishery Department of AJK and Khyber Pukhtunkhwa were undertaken for collection of information about the Project area for the fish fauna. After discussion, a detailed programme for survey of fish fauna of Kunhar River falling in the Project reach was chalked out. In addition to this, short interviews with community members and fishermen were undertaken to know the method of hunting, types of fishes found in the Project

area, quality and flow of water. Netting for fish catch and sampling for water quality was undertaken at following three sites of Kunhar River namely:

- i) 7 Km length of the proposed submergence area to be created by headpond,
- ii) Weir site near Patrind village, and
- iii) Confluence point of Kunhar with Jhelum River at Domishahi.

2.1 Fish Sampling

Netting was done at three sites for one day each in Kunhar River between Head pond and downstream to Jhelum confluence for gathering details about fish fauna. The fishing methods used were simple and suited to the nature of the river reach. Cast nets, drag nets, bag nets were used. Seasonal variation information was collected through interviews with locals as well as from relevant Fishery Department of the Project area. The weight of all fish collected was recorded.

2.2 Water Quality Sampling

Sampling was done for water temperature (°C), pH, total dissolved solids (g/l), turbidity, dissolved oxygen (mg/l), total hardness(mg/L as CaCO₃), total alkalinity (mg/l as CaCO₃), BOD, COD,TSS, Ca, Mg, K, Phosphate, Nitrate etc., for the mentioned three sites.

3. SAMPLING RESULTS

3.1 Fish Fauna

The results regarding fish fauna are summarized in Table 1 below:

Table 1: Fish Fauna Sampling Results

FISH SPECIES	AREA (HEAD POND)	WEIR SITE (PATRIND)	DOMISHAHI			
	NUMBER	WEIGHT (kg)	NUMBER	WEIGHT (kg)	NUMBER	WEIGHT (kg)
<i>Schizothorax plagiostomus</i> (Swati)	05	3	03	2	04	2.5
<i>Anguilla rostrata</i> (Eel)	03	1	04	1.5	04	2
Uchali fish (China fish)	04	2	05	2.25	03	1.5
<i>Wallago auto</i> (Mallie)	01	1	00	00	01	1.5
<i>Tor putitora</i> , <i>Tor</i> <i>tor</i> (Mahasheer)	00	00	00	00	00	00

All these fish species are localized (having a short term migration pattern only in case of breeding/spawning or shortage of food), therefore the impact of the Project on fish migration is predicted to be low / of little significance given the low number of fish in the lower Kunhar River.

It is to be noted that the number of fish caught is small, varying from zero to five. Also the weight of almost all fish caught is less than 1 kg per fish, indicating that the conditions are not conducive to fish culture in the river reach under consideration.

Apart from the referred study (Muslim and Chaudhary 2004) and the actual fish sampling results, local people say that two more species have been caught very occasionally. The related details for these two fish fauna along with five caught fish fauna is included in the list given below;

i. *Schizothorax curvifrons*

Common Names: Snow trout
Family: Cyprinidae
Order: Cypriniformes
Maximum size: 25-30 cm
Environment: Fresh water
Temperament: Non-aggressive
Water parameter: Sub tropical

ii. *Salmo trutta*

Common Names: Brown trout
Family: Cyprinidae
Order: Cypriniformes
Maximum size: Medium sie
Environment: Fresh water
Temperament: Non-aggressive
Water parameter: Temperature 2°C-16°C

iii. *Salmo gairdneri*

Common Names: Rainbow trout
Family: Cyprinidae
Order: Cypriniformes
Maximum size: 120 cm
Environment: Fresh water
Temperament: Non-aggressive.
Water parameter: Sub tropical, 10°C-24°C

iv. *Tor putitora*

Common Names: Mahasheer
Family: Cyprinidae
Order: Cypriniformes
Maximum size: 183 cm
Environment: Fresh water
Temperament: Non-aggressive.
Water parameter: Subtropical, 13°C-30°C

v. *Labeo rohita*

Common Names: Rohu
Family: Cyprinidae
Order: Cypriniformes
Maximum size: 183 cm
Environment: Fresh water
Temperament: Non-aggressive.
Water parameter: Tropical

vi. *Anguilla rostrata*

Common Names: Eel
Family: Actinopterygii
Order: Anguilliformes
Maximum size: 5 cm to 3 m
Environment: Fresh water
Temperament: Non-aggressive.
Water parameter: 24-30°C

vii. *Schizothorax plagiostomus*

Common Names: Swati
Family: Cyprinidae
Order: Cypriniformes
Maximum size: 31 cm
Environment: Fresh water
Temperament: Non-aggressive.
Water parameter: Sub Tropical

3.2 River Water Quality

The results of water quality sampling are summarised in Table 2 below. The Dissolved Oxygen (DO) saturation level at 12.48 °C is known to be 11.79 mg/l and therefore the river water DO level, being 8.21-8.55 mg/l, is below saturation.

Table 2: Mean* Water Quality Results at Three Sampling Sites

PARAMETER	HEADPOND SUBMERGEN CE AREA	WEIR SITE (PATRIND)	DOMISHAHI	AVERAGE VALUE
PHYSICAL				
Water temperature (°C)	12	12.5	13	12.33
pH	6.16	6.54	6.36	6.36
Depth (m)	2.16	1.85	3.21	2.4
Total Suspended solids (mg/l)	88.01	89.93	93.33	90.42
Inorganic Suspended solids (mg/l)	59.93	64.56	71.15	65.21
Organic Suspended solids (mg/l)	19.22	22.39	26.11	19.22
Organic matter in bottom mud (ppm)	28,858	29,765	26,338	28,320
Rate of flow (cu.m/sec)	34	36	41	37
CHEMICAL				
Dissolved oxygen (mg/l)	8.21	8.55	8.34	8.33
Salinity (ppm)	0.017	0.019	0.018	0.018
Total alkalinity (mg/l)	1.98	1.60	1.52	1.7
Total carbon dioxide (mg/l)	2.12	2.42	2.51	2.35
Total Ammonia- nitrogen (mg/l)	0.015	0.023	0.031	0.023
BOD (mg/l)	0.076	0.081	0.086	0.081

*Mean values were calculated by averaging the results from three samples at each site, mixed together and a single sample was taken for analysis at Pakistan Forest Institute, Laboratory.

Table 3: Mean Water Quality of Kunhar River

S #	PARAMETER	AVERAGE VALUE
PHYSICAL		
1	Water temperature (°C)	12.33
2	pH	6.36
4	Depth (m)	2.4
5	Total Suspended solids (mg/L)	90.42
6	Inorganic Suspended solids (mg/L)	65.21
7	Organic Suspended solids (mg/L)	19.22
8	Organic matter in Bottom Mud OMBM (ppm)	28320
9	Rate of flow (cu.m/sec)	37
CHEMICAL		
11	Dissolved Oxygen (mg/L)	8.33
12	Salinity (ppm)	0.018
13	Total Alkalinity (mg/L)	1.7
14	Total Carbon dioxide (mg/L)	2.35
15	Total Ammonia- nitrogen (mg/L)	0.023
16	BOD (mg/L)	0.081

3.3 River Water Quality Versus Fish Culture

- The color of the water usually remains muddy (July-September) due to suspended solids of mud and sand remained more transparent from October to December as told by the local people. During course of study at the Project area it was found light muddy to transparent.
- Fish are very sensitive to temperature, sensing even 1-3°C difference in water temperature. Fish will move elsewhere if the temperature exceeds its preference. Cold water fish remain in 0-12°C temperature regime. The average mean monthly temperatures of Kunhar River water at Garhi Habibullah (weir site) from 1980-1993 and in the Jhelum River water at Domel (powerhouse site) for the period from 1980-1995 are summarized in Table 4 below.

Table 4: Mean Monthly Water Temperature in Kunhar River at Weir Site (Garhi Habibullah) and Jhelum River at PowerStation Site (Domel)

MONTH	TEMPERATURE (°C)	
	Kunhar River Near Garhi Habibullah (1980-1993)	Jhelum River Near Domel (1980-1995)
January	6.1	8.5
February	7.2	10.4
March	10.2	13.6
April	11.4	16.8
May	12.0	19.9
June	12.3	22.4
July	14.9	25.1
August	17.9	25.0
September	16.5	23.3
October	13.6	19.2
November	9.8	14.6
December	7.0	9.4

- Total suspended solids and organic suspended solids comprised greater proportion during the monsoon season when each and every thing is washed down, coupled with greater water velocity. Dissolved organic matter which acts as food for aquatic organisms like algae for fishes was found suitable. The organic matter in bottom mud increases from July-December due to settlement of organic compounds in the bottom.
- Salinity tolerance varies with the fish species. Some scientists think that 0.6-20 ppm is lethal, while others consider 7 ppm to be lethal for freshwater fishes. At project site the value found was 0.017 ± 0.001 was harmless for fish life. It also affects other aquatic life causing migration of fish from fresh to salt water for growth and reproduction.
- Fish can survive in water with a pH of 6-10 (Lone.1983). A pH value of 6.36 ± 0.2 is considered suitable for fishes. Some scientists consider pH 6-6.5 to be dangerous when aeration remains improper in water.
- Dissolved oxygen remains lower in summer, increase up to December because cold water has great ability to hold Oxygen than warm water. Upper lethal levels 16.8-32.11 mg/l and lower lethal levels 3-4 mg/l (Rounsefell and Everhast, 1983). The value for the project area was found 8.33 ± 0.2 mg/l and was not lethal.

- Biological oxygen demand (BOD) generally decreased from July-December because the organic matter and micro-organisms (Phytoplentention, zooplentention) activity remained rich during the summer and decreased up to December. It is inversely proportion to the dissolved Oxygen. The value of BOD calculated for Project site was 0.081 ± 0.05 mg/l and was found suitable for aquatic life.
- Alkalinity is not a pollutant. Total alkalinity value >20 mg/l is considered dangerous for fish and other aquatic life (Ahmad et al, 1983).The value calculated for the project area was 1.7 ± 0.3 mg/l so it was safer for aquatic and fish life.
- Upper dangerous limit total carbon dioxide is 6 mg/l (Lone, 1983).It was calculated as 2.35 ± 0.2 (mg/l) was considered fit for every kind of fish.
- Ammonia is much more toxic to fish and aquatic life when water contains very little dissolved oxygen and carbon dioxide. Ammonia nitrate has an upper dangerous limit of 0.1 mg/l (Lone, 1983). The calculated value was 0.023 ± 0.008 far below the danger.

4. POTENTIAL IMPACTS AND MITIGATION MEASURES

Aquatic ecology is affected by water quality, quantity, availability of breeding habitat (such as spawning and rearing grounds), foot access to the river, fishing methods and terrestrial activities along the river banks and in the watershed (Helland-Hansen *et. al.*, 1995). The existing aquatic habitat of the Kunhar River in the Project area is continuous, fast flowing where water quality and quantity are seasonally affected, primarily by monsoon runoff and snowmelt. The Patrind Hydropower Project will divide the existing aquatic environment into three distinct habitat areas with different flow conditions:

- Upstream of the weir
- Within the weir pond
- Downstream of the weir

4.1 Upstream of the Weir and in the Pond

Flow rates, water quality and fish habitat in the Kunhar River and its tributaries, above the reservoir will not be affected by the Project, except for the distribution of some aquatic organisms. The presence of the reservoir will isolate these upstream, fast-flowing habitats from the riverine habitat below the reservoir, preventing migratory species from reaching these areas. The populations of sedentary, resident fish species above the reservoir will not be directly affected by the Project,

but will become genetically isolated from populations downstream. The isolation of these fish populations may increase extinction rates in the upper reaches in the long-term

The pond area behind the weir upstream/at the weir will create a deep, still water aquatic habitat, replacing about 7km of existing riverine habitat. Water quality in the reservoir was found suitable for the protection of aquatic ecosystems. The most productive parts of the reservoir will be the shallower sections where light is able to penetrate to the bottom and allow the growth of attached aquatic macrophytes.

The creation of the pond will provide a large open water fish habitat that could be used for promotion of fish culture. The harvesting of fish culture, if it proves viable will be an offset to the lost production. This will also increase the fish fauna and their density to be exploited locally for the socio-economic uplift of local communities.

4.2 Downstream of the Weir

The Project will alter the Kunhar River flow regime in the stretch starting from the weir to the confluence with Jhelum River (13 Km length). Changes in the flow regime will affect the composition and abundance of plank-tonic and benthic communities, thus affecting the food supply of fish. These changes will have the potential to influence the species composition of the fish population in the Project area, but due to the low availability of fish fauna in the Project area as shown by the study results, the impact shall not be significant.

Furthermore, it should be noted that the topography of Kunhar River valley downstream of the weir is characterized by high river banks with relatively deeper bed levels that prevent the use of the Kunhar River for agricultural irrigation and drinking water supply. The operation of the Project for hydropower generation will reduce flows downstream of the weir. A minimum of 2 m³/s of water will be released from the head pond as ecological flow throughout the year. This flow will increase further downstream as numerous large and small streams enter the Kunhar River, thus providing mitigation measures for aquatic flora and fauna in the reach downstream of the weir. These additional sidestream will, on average, contribute an estimated 1.8 m³/s to the Kunhar River flow downstream of the weir.

5. FINDINGS OF LOCAL INTERVIEWS

The netting data and discussion with people indicated that the occasional fishing in the Project area is not an occupation but a hobby due to little availability of fish fauna. The fishing activity was practiced more in winter due to lesser speed, low turbidity and depth of the river. The same position persists from the head pond area to the confluence of Kunhar River with Jhelum River as far as the availability of fish and angling is concerned according to local people. When asked about the availability of trout, the answer of majority of the public was no with occasional evidences of trout availability in the Project area after many years. They revealed that the Trout was restricted mainly above the Balakot area of KP.

6. FISH MIGRATION PAST MANGLA DAM

The warm water regime exist in the Jhelum River below Domel (confluence of Neelum river with Jhelum River) and becomes unsuitable for snow carps during most of the summer months and they migrate either in Neelum River or in Kunhar River due to the existence of cold water regime .It is true that 138 m high Mangla Dam reservoir with 10,300 feet (3140 m) length 97.7 square miles (253 km²) area has become home for many deep water fishes. But due to the existence of different water regimes at the Mangla Dam (Warm Water regime) and confluence of Jhelum river with Kunhar River (cold water regime) there exist no possibility of migration upstream that will be damaged due to reduced water regime in Kunhar River after the implementation of Patrind Hydro-Power Project. Secondly if we assume that such a migration can take place then that can be compensated by the Neelum river and Project impact in this case will also be negligible. Thirdly, due to the long distance of Mangla dam (about 155Km) from the Project area in Muzaffarabad, the possibility of upstream migration coupled with variation in water temperature regime seemed to be insignificant as indicated by the availability of minimal fish fauna in the Project area. It is acknowledged that the results of the study are not necessarily representative of long term waterway conditions. The lack of long term data on water quality, plankton concentrations and fish populations limits the conclusions that can be made about the aquatic ecology in the Project area. The scope of present study does not require covering of fish fauna present in Jhelum River along with its migration status. There is almost no possibility of upstream migration of fish fauna above Mangla Dam to the Project area as authenticated by the study results and supported by the local information recorded through the information. Even then, if some migration occurs that will be compensated by the

Neelum river. Thus, it can be safely concluded that the proposed Project will have minimal effects on the available fish fauna as well as the migration of fish species above Mangla dam.

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