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147 MW PATRIND HYDROPOWER PROJECT PAKISTAN



VEGETATION STUDY

APRIL 2011

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EXECUTIVE SUMMARY

1. KUNHAR RIVER WATERSHED

The Kunhar river catchment is commonly known as Kaghan Valley, situated between 34°-17' & 35°-10' N latitudes and 73°-28' & 74°-7' E longitudes.

2. FOREST TYPES (ECOLOGICAL CLASSIFICATION)

Ecological distribution of different types of forest is described in the following paragraphs to give an overall picture of the vegetative worth of the project area. It is also needed because it affects the life of reservoir through sedimentation. The principal plant communities of Kunhar catchments are related to the altitudinal zonation.

- A. Sub-tropical pine forests
 - i) Himalayan sub-tropical scrub forests
 - ii) Himalayan chir pine (*Pinus roxburghii*) forests
- B. Himalayan moist temperate forests
 - i) Low level blue pine (*Pinus wallichiana*) forests
 - ii) Moist deodar (*Cedrus deodara*) forests
 - iii) Western mixed coniferous forests
 - iv) Upper west Himalayan fir and broad-leave forests
- C. Dry temperate forests
- D. Sub Alpine Scrub and Alpine Pastures

3. LEGAL CLASSIFICATION OF FORESTS

Legally the productive forests of the Kunhar catchments are of two types the reserved or the Government owned forests, and the guzaras or the private or community owned forests.

4. RANGELANDS

Rangelands occupy about 50 % of the entire land area of the valley; therefore the production of grass is a major land use of Kunhar river watershed. The rangelands were classified as under:

- i) Sub-mountain rangeland: below 4000 elevation sub-divided into two slope classes i.e. less than 50% slope and more than 50% slope.
- ii) Mountain rangelands: between 1,200 m and 3,050 m elevation subdivided into two slope classes i.e. less than 50% slope and more than 50% slope.
- iii) Alpine pastures: between 3,050 m elevation and the permanent snow line.

5. PATRIND HYDROPOWER PROJECT AREA

A detailed study of the Project site was conducted. The area behind the weir site is up to almost 7 Km backward. Three representative sites were selected for vegetation survey. At each site two transect lines of 500 meter each were laid across one another. On each transect line 1m X 1m Quadrat for grasses/herbs, 4m X 4m Quadrat for shrubs/trees were laid on an interval of 50 meter. The data was collected and compiled for identification, calculation of cover percentage, species composition and forage production. For forage production the species were clipped and air dried at 2 cm from the ground level. The study yielded following results.

5.1 Vegetation Species

The Vegetation Species comprising of grasses, herbs, shrubs and trees collected and identified in the Project site are listed below;

Trees

Pinus roxburghii (Chir Pine), *Ailanthus altissima* (Tree of Heaven), *Salix spp* (Willow), *Pyrus pashia* (Pear), *Picea smythiana* (Spruce), *Prunus padus* (Birds cherry), *Ascer spp* (Maple),

Cornus macrophylla (Kandar), *Acacia modesta* (Kiker), *Robinia pseudocacia* (Phulai), *Olea cuspidata* (Kau), *Bauhinia variagata* (Kahnar), *Azadarachta indica* (Bakain), *Zizyphus jujuba* (Ber), *Cedrela serrata* (Drawa), *Salmalia malabericum* (Simal), *Acacia arabica* (Punjabi Kiker), *Cassia fistula* (Amaltas), *Aesculus indica* (Bankhour), *Juglans regia* (Walnut), *Grevia oppositifolia* (Tamman), *Celtis australis* (Batkara), and *Populus spp.* (Sufaida).

Shrubs

Dodonaea viscosa (Hopseed bush), *Berberis lyceum* (Barberry), *Rosa moschata* (Wild Rose), *Vitex negundo* (Five leave Chaste tree), *Buxus wallichiana* (The Boxwood tree) and *Clematis gouriana* (Oldmans Breed).

Herbs

Tribulus terrestris (Calthrop), *Oxalis repens* (Wood Sorrel), *Mentha sylvestris* (Pepermint), *Chenopodium album* (Whitegoosefoot), *Amaranthus viridis* (Amaranthus),

Grasses

Themeda anathera (Red Oat Grass), *Pennisetum typhoide* (Pearl, Millet), *Aristida cyanatha* (Wildgrass), *Apluda mutica* (Apluda), *Heteropogon contortus* (Speargrass), *Bothriochloa pertusa* (Palwan), *Cynodon dactylon* (Lawnglass) and *Cymbopogon jawarancusa* (Common Scented Grass).

5.1.1 Biomass estimates (Tons/ha)

Biomass data was calculated in the project site supposed to be submerged. It was estimated that on the average about 3.5 tons per hectare of biomass would be submerged.

6. OUTCOME OF THE STUDY

The Project site lies in the Guzara/Community owned forests and was far away from the Reserved/Protected forests. On left bank of river Kunhar no reserved forests exists anywhere near the Project site. While Doga Reserve Forest and Shoal Reserve Forests occur on the right bank. These forests are about 3-5 km away from the project area. Thus the project has no influence on Reserved/Protected forests.

Most of the Chir trees in the area to be submerged were found in Pole stage. The same is the case with other broadleaved species. So, all in all not much cutting was involved due to the implementation of the project.

Project site vegetation does not contain any species listed as endangered or threatened by the Government of Pakistan or IUCN.

It was also observed that most of the submerged area comprised of rangelands of Guzaras forest area with few trees here and there, owned by the people/community and they exploit it according to their needs of timber, firewood and fodder for livestock rather than visualizing of its protective/environmental role. The present status of vegetation does not depend upon the river Kunhar water but it depends on precipitation available in the area. So reduction in water regime down stream will not affect the vegetation of the area.

The average biomass that will be submerged under water after the construction of weir was calculated as 3.5 tons/ha comprising of all the vegetation types like herbs, shrubs and grasses. The total area expected to be inundated is 57.2 ha, hence estimated total biomass to be affected will be about 200 tons.

Based upon the total number of trees, their total volume, average wood density of different types of species present, ratio of molecular weight of Carbon & Carbon dioxide and root shoot ratio factors etc, the total tree biomass going to be inundated is about 950 tons (775 tons above ground & 175 tons below ground). So the total biomass expected to be inundated is 1,150 tons (950 tons (trees) + 200 tons (forage)).

VEGETATION STUDY

1. INTRODUCTION

Patrind Hydropower Project is located near Village Patrind in Muzaffarabad District of AJ&K. It spreads over two sides of Lohar Gali ridge. The water will be diverted from Kunhar river through a conveyance system and discharged into Jhelum river after power generation. A weir will be constructed on Kunhar river to divert the flow. The head pond will be created due to the weir at an elevation of 765 masl with a length of about 7 Km upstream of the project site.

1.1 KUNHAR RIVER WATERSHED

The Kunhar river catchment is commonly known as Kaghan Valley, situated between 34°-17' & 35°-10' N latitudes and 73°-28' & 74°-7' E longitudes. Out of the total catchment area about 1000 sq. miles lie in Mansehra and Abbottabad Districts of Hazara Division and about 25sq.miles are situated in the territory of Azad Kashmir.

The catchment area of the Kunhar river is subdivided into upper and lower sub-basins.

The catchment area up to Naran is 1,036 sq. km (400 sq. miles). Mean elevation in the area is 2,500 m amsl. Upper basin consists of steep mountains covered with snow. The slope of river in upper basin is very steep i.e. 20 m/km. In this basin most of river flow is due to snow melt in summer season.

The lower basin extends from Naran to its confluence with Jhelum River. The catchment area of the lower basin is 1,453 sq. km (561 sq. miles) confluence with Jhelum River. Mean elevation in area is 800 m. The lower basin consists of steep mountains covered with vegetation / forestry. Most of river flows are due to rainfall in the catchment area. In lower reach the river has relatively flatter slope of 11 m/km.

2. FOREST TYPES (ECOLOGICAL CLASSIFICATION)

The principal plant communities of Kunhar catchments are related to the altitudinal zonation. There is sharp altitudinal variation in the valley resulting in the development of prominent vegetation types which according to the standard classification of forest types of Pakistan (Champion, Seith and Khattak, 1987 & M.I. Sheikh, 1997) are given as follows:

- **Sub-tropical Pine Forests**

- i) Himalayan sub-tropical scrub forests
- ii) Himalayan chir pine (*Pinus roxburghii*) forests

- **Himalayan Moist Temperate Forests**

- i) Low level blue pine (*Pinus wallichiana*) forests
- ii) Moist deodar (*Cedrus deodara*) forests
- iii) Western mixed coniferous forests
- iv) Upper west Himalayan fir and broad-leave forests

- **Dry Temperate Forests**

- i. **Himalayan Sub-tropical Scrub Forests**

This type of poor scrub growth mainly consisting of *Sanatha* (*Dodonaea viscosa*) and *Olive Palm* (*Olea cuspidata*) is found in the lower reaches of the valley up to 750-900 m elevation merging in the chir pine zone.

- ii. **Himalayan Chir Pine Forest**

This type comprises bulk of the managed chir forests generally starting from 750-900 m elevation. The chir pine forms full cover with no under storey except along the moist depressions where a few Oak (*Quercus incana*) and other broad-leaved species are seen if still saved from fire. However shrubs like *Myrsine Africana* and *Berberis* spp are found on cool aspects.

- iii. **Low-level Blue Pine Forests**

This type is generally met within the altitudinal range of 1,500 m to 2,100 m with marked variations depending on aspect. The forests consist of blue pine with a small admixture of chir pine, deodar and occasionally spruce depending of the locality, aspect and elevation. Broad leaved species are restricted to moist depressions and there is very little undergrowth found in these forests.

- iv. **Moist Deodar Forests**

These forests occupy the altitudinal range of about 1,500 m to 2,450 m extending to the lower and higher elevations by about 300 m on suitable sites. These forest in pure form, are found in a very small extent close to the settlements where these form a scattered open canopy. Some blue pine and spruce trees are commonly present with oaks and rhododendron arboretum trees scattered as the under storey. *Pohu* shrub (*Parrotia Jacquemontiana*) form dense underwood at places. The ground flora is rich between the shrubs consisting of a variety of species. Deodar is one of the most valuable timbers. Deodar trees growing in Kaghan valley have been declared as state trees and are forbidden for felling save with the prior

permission of the Government.

v. Western mixed Coniferous Forests

This is one of the most important and most commonly met forest types of the Kunhar catchment and constitutes bulk of the forests of moist temperate region in the valley a variety of combination of both coniferous and broad-leaved species. The altitudinal range of this type is between 2,300 m and 2,900 m on the warmer aspects with variation of 150 m to 300 m on the cool northern slopes.

Some of the valuable broad leaved trees are found in this zone. These are walnut (*Juglans regia*) and ash (*Fraxinus* spp). The other broad leaved species are oak (*Quercus dilatata*) horse chestnut (*Aesculus indica*) poplar (*Populus alba*) bird cherry (*Prunus padus*) maples (*Acer* spp) and batangi (*Pyrus pashia*).

The density of the undergrowth depends on that of the overwood and the extent of grazing. Pohnu shrub forms thickets where the canopy has been broken. A rich herbaceous growth is developed on the ground during the monsoons.

vi. Upper West Himalaya Fir and Broad – Leaved Forests

All the silver fir forests, growing between 2,750 m and 3,200 m elevation with usual variations according to aspect are grouped in this type. Kargil fir is generally restricted towards ridges with blanks along the depressions where the snow slides are common during the winter. Spruce (*Picea smithiana*) is scarce while blue pine is found at places.

vii. Dry Temperate Forests

North of Mahandri the valley is not in the reach of south west monsoons and receives most of the precipitation in the form of winter snow. Here, in addition to the dry temperate coniferous forests which are similar to their counterpart in the moist zone except for their growth, degraded temperate scrubs are found which are represented by birch (*Betula utilis*) on rocky spurs. In the interior of the valley, some juniper (*Juniperus macrocarpa*) is found on eastern and south eastern aspects with *Plectranthus rugosus* and *Artemisia* spp. The latter type is very limited and has no economic value other than its utility as open rangeland.

viii. Sub Alpine Scrubs and Alpine Pastures

Large areas above the tree limit are covered by pastures which have long been used as summer ranges. Due to extensive use, the rangelands have been deteriorated and especially the eastern slopes are invaded by the

shrub growth of *Artemisia* spp. and in moist situation *Simbucus* spp. has spread considerably.

2.1 LEGAL CLASSIFICATION OF FORESTS

Legally the productive forests of the Kunhar catchments are of two types the reserved or the Government owned forests, and the guzaras or the private or community owned forests. The latter are managed by the Forests Department of KP Province since their transfer from the Revenue Departments in 1950.

2.2 RESERVED / PROTECTED FORESTS

The reserved forests in Kunhar watershed were declared Reserved after the first regular settlement in 1873. The reserved forests of Kunhar catchment lie in the three territorial forest divisions and are managed through regular working plans.

2.3 GUZARA/PRIVATE/COMMUNITY FORESTS

These forests, which were left out as village forests at the time of first settlement, are privately or severally owned and are termed as guzaras as these are primarily set out to meet the bonafide needs of local population. The forests remained under the control of Revenue Department till 1950, when these were transferred to forest department for rational and scientific management. Although efforts to prepare working plans for these valuable forests started in the early 1960s yet these remained without proper scientific management till recently. The Guzara Demarcation sub-division was created in 1961 to demarcate the guzara forest and thus the permanent demarcation is yet to be completed and it will only be after the completion of demarcation work that the exact boundaries of these forests will be known and permanently marked on the maps. So at this point of time it is not possible to give the details pertaining to the total area etc.

In addition to the above guzara forests, some degraded areas outside the reserve forests were taken up by the Forest Department for anti-erosion works in consultation with the local owners under the Forest Act. These areas now constitute the scrub forest and except for watershed protection and provision of rough firewood, their economic importance remains to be as potential rangelands. These are located in Garhi Habibullah forest range of Mansehra Forest Division. These areas were taken for periods ranging from 5 to 15 years and have now been mostly returned to the owners on expiry of the period. These protections along with the closures against the grazing have decidedly helped in improving the watershed properties and rehabilitation of the badly eroded sites. In many cases, however the vegetation cover has been destroyed

after the return of areas to the owners and the areas have again been subjected to active erosion. Similarly the guzara forests/community forests located in Muzaffarabad Forest Division falling in the Patrind Hydropower Project area were also not demarcated properly. The areas outside the reserved forests, exploited by the local people for timber, firewood, grazing of livestock and cultivation purposes were termed as Guzaras /community forests.

3. RANGELANDS

Rangelands occupy about 50 % of the entire land area of the valley; therefore the production of grass is a major land use of Kunhar river watershed. In the beginning, trees were removed for cultivating the land but later it deteriorated due to ruthless cutting and mal-treatment thud the was considered suitable only for grazing. The rangelands were classified (M.A.A. Qureshi, 1996, M.A. Khan, 1995) as under:

- i) Sub-mountain rangeland: below 1,200 m elevation sub-divided into two slope classes i.e. less than 50% slope and more than 50% slope.
- ii) Mountain rangelands: between 1,200 m and 3,050 m elevation subdivided into two slope classes i.e. less then 50% slope and more the than 50% slope.
- iii) Alpine pastures: between 3,050 m elevation and the permanent snow line.

3.1 Temperate Humid Zone

The important shrubs found in this zone are: vibernum nrevosum idigofera spp Rosa webbiana; Cotoneaster spp Pistacia spp Berberis lyceum; Prunus cornata Rhodedendron arboretum; Lonicera quinquelocularis; Rubus spp Myrsine Africana; and Parrotia spp'

The grasses found in the zone are: Dactylis glomerata; Agropyron dentatum; Phacelurus flaccidum Oryzopis spp Poa spp Stipa Bromus inermis Bothiochlos pseudoischemum; chrysopogon achinueltus and themedata anathera.

The forbs are: Plantago spp Senecio Spp: Rumex neplensis; Astragalus spp; Trifolium spp lotus cuvrniculauts; Fragaria vaxa; Medicago spp; Geranium spp; Thymus serphyllum; Polygonum spp Tarzium sp; Tarazium officinalis; and sambucus ebulus.

There are five forest range and three range types in this zone. The range types are shrub grasslands shrub savans, and grasslands.

3.2 Sub-Alpine Zone

Some of the grass species found in the zone are Phleum alpinum; Agrostis gigantea; trisetum spp., clamaagrostis spp and carex spp.

3.3 Alpine Zone

The grasses found in this zone are phleum alpinum, agrostis spp; Festuca ovina; trisetum specatum poa spp. Carex spp and agropyron spp.

The forbs found in the zone are polygonum spp., pentstemon spp Taraxacum officinale; astragalus spp; Thymus serpyllus; Geranium nepalensis; Plantago spp; Galeum spp Trifolium repens and vicia cornifolium.

3.4 Trans-Himalayan Sub humid Zone

The important species of the zone among the trees are Juniperus macrocarpa (Chalia) Quercus ilex (Rhin) pinus gerardiana Chilgoza and Ficus xanthoxyloides (Hanzu)

The shrubs are (Artemisia spp indigofera spp: Rosa spp and Ephedra spp: the important grasses are Chrysopogon spp: chrysopogon spp. Dicanthium annulatum: Pennisetum orientale: Aristida spp; Oryzopsis spp; Poa spp; Bromus inermis; Agropyron spp. Agrostis spp: and dactyloctenium spp.

3.5 Glacier and Snow fields

This zone is permanently covered with snow and is characterized by almost absence of flowering plants. Thus the zone is non productive or barren from the view point of range management.

4. MEDICINAL PLANTS

The Kunhar valley is rich in medicinal plants, some of which are of pharmaceutical importance, while many others are utilized for local medicines. These plants are generally found on slopes, away from habitation and grazing pressure, therefore the project footprint is unlikely to contain such plants.

On account of lack of knowledge and facilities, this resource has remained partly untapped in the past, although it can play a vital role in the economy of the valley. Following is the list of major medicinal plants identified (Tariq Mahmood, 2007 & Shabbir Mughal, 2009) in the Kaghan valley.

1. *Achillea millefolium* (Blood Wort)
2. *Adhatoda vasica* (Malabar Nut tree)
3. *Asparagus adscendens* (Asparagus)
4. *Berberis lyceum* (Berberry)
5. *Cannabis sativa* (Pakistani hemp)
6. *Chenopodium ambrosioides* (Mexican tea)
7. *Colchicum luteum* (Golden Collyrium)
8. *Dioscorea deltoidea* (Yam)

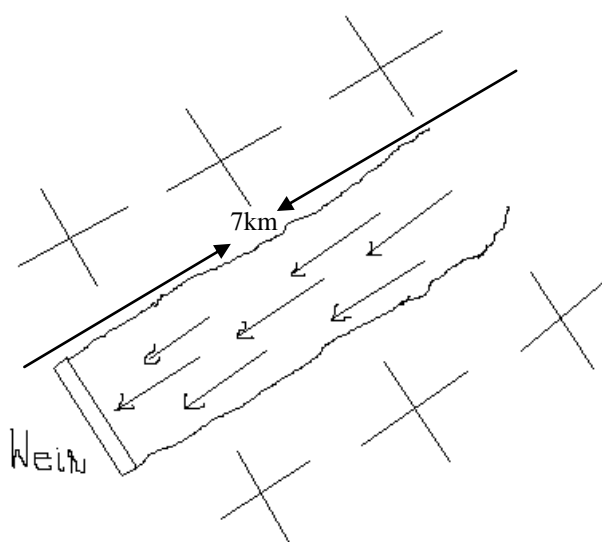
9. <i>Malva sylvestris</i>	(Common Mallow)
10. <i>Moringa oleifera</i>	(Drumstick Tree)
11. <i>Plantago ciliate</i>	(Ispaghul)
12. <i>Rosa moschata</i>	(Wild Rose)
13. <i>Valeriana wallichii</i>	(Pakistani Valeriae)
14. <i>Viola odorata</i>	(Sweet Violet)
15. <i>Withania somnifera</i>	(Winter Cherry)
16. <i>Podophylum emodii</i>	(Baukhakri)
17. <i>Atropa belladonna</i>	(Namaku Sag)

5. PATRIND HYDROPOWER PROJECT AREA

Following is the discussion on the vegetation types (both forests and range) in the Kunhar river watershed falling in the Patrind Hydropower Project area.

5.1 Methodology

Based on the climate, topography and vegetation density of the area behind the weir site up to almost 7 Km backwards, three representative sites each on both sides (covering the eastern and western aspects) of the river were selected for vegetation survey. At each site two transect lines of 500 meter each were laid across one another. The transects running upslope commenced at river level. On each transect line 1m X 1m Quadrat for grasses/herbs, 4m X 4m Quadrat for shrubs/trees were laid on an interval of 50 meter as shown in the sketch below. The data was collected on standard data collection forms and compiled for identification, calculation of cover percentage, species composition and forage production. For forage production the species were clipped and air dried at 2 cm from the ground level. This air dried mass was then computed on Hectare basis for calculating the forage production in Kg/tones per hectare.



5.2 Results

Two forest types and two range types occur in the surveyed areas.

5.2.1 Forest Types

5.2.1.1 Himalayan Sub-tropical Scrub Forests

This is a poor type of scrub growth, mainly consisting of *Sanatha* (*Dodonaea viscosa*), found in lower reaches of valley merging in Chir Pine forests comprising of gentle to medium sloping rocks. The type has been degraded by excessive cutting and grazing, thus classified as rangelands. In this zone grasses occupied the maximum area (65%), followed by shrubs (15%) and forbs (10%). The remaining 10% area was either bare or consists of rocks. On the basis of density these forests are categorized as sparse with <25 percent density.

Major grasses found in the zone were *Aristida cyanatha* (32%), followed by *Themeda anathera* (23%), *Cynodon dactylon* (22%) and *Cymbopogon jawarancusa* (21%). The same trend was observed in frequency of the grass species.

5.2.1.2 Himalayan Chir Pine Forests

This type comprises bulk of the managed Chir pine forests generally starting from 750 m elevation and merging with the Blue Pine forests at an elevation of 1,700-1,800 m mostly comprising of steep slopes. These forests forms full cover with no under storey except along the moist depressions where a few Oaks (*Quercus incana*) and broad-leaved species are seen, if saved from the frequent fire hazards prevailed in Chir Pine Forests. However, shrubs like *Myrsine Africana* and *Berberis lyceum* are found on cooler aspects. Due to frequent fire incidences, the ground cover is scant and a few grasses likes *Heteropogon* and *Aristida* still survive locally. The forests were exploited commercially unless a ban on green felling was imposed in 1992. On the basis of density these forests were classified as open to medium dense 25-50%. Major tree species was Chirpine with some brobleaved trees.

In this zone grasses occupied the maximum area (55%), followed by shrubs (20%) and forbs (15%) and trees (10%). The remaining 5% area was either bare or consists of rocks.

Major shrubs found were *Rosa webbiana* (24%), *Cannabus sativa* (18%), *Buxus papillus* (25%) and *Astragalis candolensis* (10%).

Major forbs found in the zone were *Cunoglossum lanceolatum* (29%), *Echinops corinigrus* (17%) and *Ajuga bracteosa* (15%).

Major grasses found in the zone were *Aristida cyanatha* (23%) followed by

Themeda anathera (18%), *Cynodon dactylon* (17%), *Heteropogon contortus* (17%) and *Cymbopogon jawarancusa* (16%). Same trend was observed in frequency of the grass species.

5.2.2 Range Types

5.2.2.1 Sub-Tropical Sub Humid Zone

It is potentially a zone of good rangelands in which three range types are recognizable these are acacia, olea type, *Dodonaea* type and *Imperata* type.

In acacia olea type acacia *modesta* develops almost pure on southern aspects and low altitudes while *Olea cuspidata* appear on cooler and higher altitudes along gently sloping river banks and adjoining areas. The productivity is mainly dependent upon soil cover and soil depth and several subtypes or forms of rangelands are recognizable. *Dodonaea* type has a very low forage potential and develops on warmer aspects to almost exclusion of its tree associates. *Imperata* type occurs on gently sloping river flood plains and has a high potential of forage production.

5.2.2.2 Sub-Tropical Humid Zone

This zone consists of several types of ranges which are often highly productive comprising of steep rocky slopes with little soil traces in depressions. Climax species is chir pine and the zone is situated above Acacia, olea zone and below kail zone. On account of the human interference large tracts have been converted for cultivation purposes or for grazing in this zone. With the removal of chir needles and or trees there develop good and productive grass lands. But still there are vast areas covered by chir pine with limited shrub and herbaceous under growth.

The grasses found in this zone are: *Themeda anathera*; *Heteropogon contortus*; *Chrysopogon aucheri*; *bothriocloa* spp; *cymbopogon martini*; *apluda aristata*; *aristida cyanantha*; *digitaria* spp; *branciararia* spp; *imperata cylindrica*; *sotari* spp; *rottboia exaltata*; and *pennisetum orientale*.

The chir zone is occupied by chir forest type. The range utility of this forest type depends on the openness of the crop. Herbaceous forage is available wherever there is enough light and open canopies. Within the chir forest type two forest range types are recognizable one having more than 50% canopy cover and the other 50% there are three range types found in the zone. There are chir tree savanna, shrub savanna, and grasslands.

5.2.3 Vegetation Species

The Vegetation Species comprising of grasses, herbs, shrubs and trees collected and identified in the project area are listed below;

Trees

1. *Pinus roxburghii* (Chir Pine)
2. *Ailanthus altissima* (Tree of Heaven)
3. *Salix spp* (Willow)
4. *Pyrus pashia* (Pear)
5. *Picca smythianaPi* (Spruce)
6. *Prunus padus* (Birds cherry)
7. *Ascer spp.* (Maple)
8. *Cornus macrophylla* (Kandar)
9. *Acacia modesta* (Kiker)
10. *Robinia pseudocacia* (Phulai)
11. *Olea cuspidata* (Kau)
12. *Bauhinia variagata* (Kahnar)
13. *Azadarachta indica* (Bakain)
14. *Zizyphus jujuba* (Ber)
15. *Cedrela serrata* (Drawa)
16. *Salmalia malabericum* (Simal)
17. *Acacia arabica* (Punjabi Kike)
18. *Cassia fistula* (Amaltas)
19. *Aesculus indica* (Bankhour)
20. *Juglans regia* (Wallnut)
21. *Grevia opposittifolia* (Tamman)
22. *Celtis australis* (Batkarakar)
23. *Populus spp.* (Sufaida)

Shrubs

1. *Dodonaea viscosa* (Hopseed bush)
2. *Berberis lyceum* (Barberry)
3. *Rosa moschata* (Wild Rose)
4. *Vitex negundo* (Five leave Chaste tree)
5. *Buxus wallichiana* (The Boxwood tree)
6. *Clematis gouriana* (Oldmans Breed)

Herbs

1. *Tribulus terrestris* (Calthrop)
2. *Oxalis repens* (Wood Sorrel)
3. *Mentha sylvestris* (Pepermint)
4. *Chenopodium album* (Whitegoosefoot)
5. *Amaranthus viridis* (Amaranthus)
6. *Etchinops corrinigrus*
7. *Ajuga bracteosa*
8. *Lespedezzia spp*

Grasses

1. *Themeda anathera* (Red Oat Grass)
2. *Pennisetum typhoide* (Pearl, Millet)
3. *Aristida cyanatha* (Wildgrass)
4. *Apluda mutica* (Apluda)
5. *Heteropogon contortus* (Speargrass)
6. *Bothriochloa pertusa* (Palwan)
7. *Cynodon dactylon* (Lawngrass)
8. *Cymbopogon jawarancusa* (Common Scented Grass)
9. *Hyperhennia spp*
10. *Agrostis spp*
11. *Digitaria spp*

5.2.4 Biomass Estimate (Kg/ha)

A biomass estimate was calculated for the weir inundation area to indicate the net biomass loss from this area. The data for forage was computed per hectare for ease of calculation. The average biomass that will be submerged under water after the construction of weir comprises of all the vegetation types like herbs, shrubs and grasses.

Eastern Aspect		
Serial #	Vegetation Type	Production (kg/ha)
1	Grasses	3,530
2	Forbs	600
3	Shrubs	490
	Total	4,620
Western Aspect		
1	Grasses	1,630
2	Forbs	450
3	Shrubs	230
	Total	2,310
Average		
1	Grasses	2,580
2	Forbs	525
3	Shrubs	363
	Total	3,468

The total area expected to be inundated is 57.2 ha, hence estimated total biomass to be affected will be about 200 tons.

Based upon the total number of trees, their total volume, average wood density of different types of species present, ratio of molecular weight of Carbon & Carbon dioxide and root shoot ratio factors etc, the total tree biomass going to be inundated is about 950 tons (775 tons above ground & 175 tons below ground). So the total biomass expected to be inundated is 1,150 tons (950 tons (trees) + 200 tons (forage)).

5.2.5 Species Conservation Status

Species	Forest Type	Distribution	Conservation Significance	
			IUCN	GoP
<i>Pinus roxburghii</i>	Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Ailanthus altissima</i>	Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Salix spp</i>	Himalayan Chirpine	Scattered	Common	Common
<i>Celtis australis</i>	Himalayan Chirpine	Scattered	Common	Rare
<i>Pyrus pashia</i>	Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Ficus carica</i>	Himalayan Chirpine	Scattered	Common	Rare
<i>Dodonaea viscosa</i>	Himalayan sub-tropical scrub	Common	Protected/Common	Protected/Common
<i>Berberis lyceum</i>	Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Rosa webbiana</i>	Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Vitex negundo</i>	Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Buxus wallichiana</i>	Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Clematis gouriana</i>	Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Tribulus terrestris</i>	Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Oxalis repens</i>	Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Mentha sylvestris</i>	Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Chenopodium album</i>	Himalayan Chirpine	Common	Protected/Common	Protected/Common

<i>Amaranthus viridis</i>	Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Etchinops corrinigrus</i>	Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Ajuga bracteosa</i>	Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Lespedezia spp</i>	Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Themeda anathera</i>	Himalayan sub-tropical scrub Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Pennisetum typhoide</i>	Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Aristida cyanatha</i>	Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Apluda mutica</i>	Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Heteropogon contortus</i>	Himalayan sub-tropical scrub Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Bothriochloa pertusa</i>	Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Cynodon dactylon</i>	Himalayan sub-tropical scrub Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Cymbopogon jawarancusa</i>	Himalayan sub-tropical scrub Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Hyperhennia spp</i>	Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Digitaria spp</i>	Himalayan Chirpine	Common	Protected/Common	Protected/Common
<i>Agrostis spp</i>	Himalayan Chirpine	Common	Protected/Common	Protected/Common

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6. OUTCOME OF THE STUDY

The Project site lies in the Guzara/Community owned forests and was far away from the Reserved/Protected forests. On left bank of river Kunhar in Muzaffarabad District no reserved forest exists anywhere near the Project site. While the Reserved forests on the right bank of river Kunhar in Abbotabad District, Doga Reserve Forest and Shoal Reserve Forests are at least about 3-5 km away from the Project site. Thus the project has no influence on Reserved/Protected forests.

Most of the Chir trees in the area to be submerged were found in Pole stage (age 20-30 years) with few at tree stage. The same is the case with other broadleaved species. So all in all not much cutting was found involved due to the implementation of the project.

Project site vegetation does not contain any species listed as endangered or threatened by the Government of Pakistan or IUCN. Only two species *Celtis austarlus* (Tree of Heaven) and *Ficus carica* (Fig) were found rare in Pakistan but they are listed as common for the rest of the world. The presence of these two species will not be disturbed as they were found above the submerged area and away from the area where trees needed to be felled down. The rest of the vegetation species were found protected and common in Pakistan and for the rest of the world. So it is concluded that there will be no negative impacts of Patrind Hydropower Project on conservation status of the vegetation of the area.

It was also observed that most of the submerged area comprised of rangelands of Guzaras forest area with few trees here and there. The Project site consisted of Guzara forests owned by the people/community and they exploit it according to their needs of timber, firewood and fodder for livestock rather than visualizing its protective/environmental role. Due to this the area was in degraded form. Heavy uncontrolled grazing and clearance of area for cultivation also affected the area badly.

The present status of vegetation does not depend upon the river Kunhar water but it depends on precipitation available in the area. So reduction in water regime down stream will not affect the vegetation of the area.

The average biomass for forage that will be submerged under water after the construction of weir was calculated as 3,468 Kg/ha. The total biomass to be inundated is estimated to about 200 tons.

The area affected on the weir site due to inundation is 57.2 ha and on the powerhouse site is 5.5 ha which will come under construction. In the headpond area, 222 numbers of trees and on powerhouse site 263 numbers of trees are visualized to be affected. The tree biomass going to be inundated is about 950

tons (775 tons above ground & 175 tons below ground). The name, number and type of affected trees are given below in tabular form.

Sr. No.	Name of Trees		Type of Trees	Numbers
	Common Name	Botanical Name		
Reservoir Impounding				
1.	Sherol	<i>Alnus nitida</i>	Firewood	30
2.	Shahtoot	<i>Morus alba</i>	Fruit	22
3.	Dhraik	<i>Melia Azadrach</i>	Firewood	16
4.	Wallnut	<i>Juglans regia</i>	Fruit	4
5.	Daraba	<i>Cedrela serrata</i>	Firewood	14
6.	Angeer	<i>Ficus carica</i>	Fruit Tree	16
7.	Nim	<i>Azadirachata indica</i>	Firewood	6
8.	Balkald	-	Firewood	25
9.	Kau	<i>Olea cuspidate</i>	Firewood	23
10.	Chir	<i>Pinus roxburglii</i>	Timber	14
11.	Shesham	<i>Dilbergia sisso</i>	Timber	6
12.	Pipal	<i>Ficus religiosa</i>	Firewood	8
13.	Kiker	<i>Acacia nilotica</i>	Firewood	6
14.	Phulai	<i>Acacia modesta</i>	Firewood	7
15.	Beence	-	Firewood	6
16.	Deodar	<i>Cedrus deodara</i>	Timber	11
17.	Phagwar	<i>Ficus palmate</i>	Firewood	8
Sub Total				222
Powerhouse Site				
1.	Sherol	<i>Alnus nitida</i>	Firewood	200
2.	Phagwar	<i>Ficus palmate</i>	Firewood	19
3.	Wallnut	<i>Juglans regia</i>	Fruit Tree	9
4.	Mixed Fruit Trees	-	Mixed Fruit Trees	35
Sub Total				263

There are 31 timber wood trees, 76 mixed fruit trees and the remaining 378 trees are used as fire wood. Cost of each tree has been estimated after consulting the local market and forest department and is given in EIA report. The grasses are used for grazing. Shrubs sometimes are collected to be used as firewood. As already mentioned the Guzara/Community forest is under degraded condition. No endangered species exist in the Project site.

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