



STAR HYDROPOWER LTD.

Vegetation Study
PATRIND HYDROPOWER PROJECT

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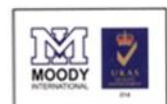


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EXECUTIVE SUMMARY

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. Kaghan Valley is well known for its valuable forests which play a vital role in providing timber.

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 catchment 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 4000 and 10000 elevation subdivided into two slope classes i.e. less than 50% slope and more than 50% slope.
- iii) Alpine pastures: between 10000 elevation and the permanent snow line.

5. PATRIND HYDROPOWER PROJECT AREA

A detailed study of the project area 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 area are listed below;

Trees

Pinus roxburghii (Chir Pine), *Ailanthus altissima* (Tree of Heaven), *Salix spp.* (Willow), *Celtis australis* (Hack berry tree), *Pyrus pashia* (Pear), *Ficus carica* (Fig), *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* (Batkarar), 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* (Lawnggrass) and *Cymbopogon jawarancusa* (Common Scented Grass).

5.1.2 Forage Production Data (Kg/ha)

Forage production data was calculated in the area supposed to be submerged so as to calculate the biomass going under water. 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 area was lying 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 area. 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.

The vegetation does not contain any species which was declared as endangered, threatened or rare.

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 downstream of the weir 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 trees, herbs, shrubs and grasses.

VEGETATION STUDY

1. INTRODUCTION

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. Kaghan Valley is well known for its valuable forests which play a vital role in providing timber. The people largely depend on forests for their requirements of livelihood. The importance of forests can not be emphasized from them but also by their role in the environmental regulation point of view.

1.2 Forest Types (Ecological Classification)

The principal plant communities of Kunhar catchment's 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 by Champion et al, 1987, 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**

1.2.1 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 2500 or 3000 ft elevation merging in the chir pine zone.

1.2.2 Himalayan Chir Pine Forest

This type comprises bulk of the managed chir forests generally starting from 2500 or 3000 ft 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.

1.2.3 Low-level Blue Pine Forests

This type is generally met within the altitudinal range of 5000 to 7000 ft 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.

1.2.4 Moist Deodar Forests

These forests occupy the altitudinal range of about 5000 to 8000 ft extending to the lower and higher elevations by about 1000 ft 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 jaquemontiana*) 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 timber. 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.

1.2.5 Western mixed Coniferous Forests

This is one of the most important and most commonly met forest type 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 7500 and 9500 ft on the warmer aspects with variation of 500 ft to 1000 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. Pohu shrub forms thickets where the canopy has been broken. A rich herbaceous growth is developed on the ground during the monsoons.

1.2.6 Upper West Himalaya Fir and Broad – Leaved Forests

All the silver fir forests, growing between 9,000 and 10500 ft elevation with usual variations according to aspect are grouped in this type. Kaghan 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.

1.2.7 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 counter part 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.

1.2.8 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. 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.

2.1 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.

2.2 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 since 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.

In addition to the above guzara forests, some areas were taken up by the Forest Department for anti-erosion works in consultation with the local owners under the Hazara Forest Act. These areas now constitute the scrub areas 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.

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 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 4000 and 10000 elevation subdivided into two slope classes i.e. less then 50% slope and more the than 50% slope.
- iii) Alpine pastures: between 10000 elevation and the permanent snow line.

3.1 Temperate Humid Zone

The important shrubs found in this zone are: vibernum nreosum 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; Medicaga 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; tristum spp., clamagrosits spp orgapisi spp and carex spp.

3.3 Alpine Zone

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

The forbs found in the zone are polygonum spp., ptentilla spp Taraxicum officinslias astragalus spp; Thymus serphyllus; Geranium nepalensis; Plantago spp; Galeum spp Trifolium repens and vicia cornifoium.

3.4 Trans-Himalayan Subhumid Zone

The important species of the zone among the trees are Juniperus macropoda (Chalia) Quercus ilex (Rhin) pinus gerardian Chilghoza and Faxiunus xanthohloies (Hanzu)

The shrubs are (Artemisa spp indigofera spp: Rosa spp and Ephedura sppo: the important grasses are Chrysopogon spp: chmbogon sppp. Dicanthium annulatum: Pennisetum orientale: Aristida spp; Oryzopisis spp; Poa spp; Bromus inermis; Agropyron spp. Agrostis spp: and dactylic 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 valley is very rich in medicinal plants some of which are of pharmaceutical importance and many others are utilized in local system of medicines. 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 in the Kaghan valley.

1. *Achillea millefolium* (Blood Wort)
2. *Adhatoda vasica* (Malabar Nut tree)
3. *Asparagus adscendens* (Asparagus)
4. *Berberis lyceum* (Berberry)
5. *Cannabus sativa* (Pakistani hemp)
6. *Chenopodium ambrosioides* (Mexican tea)
7. *Colchicum luteum* (Golden Collyrium)
8. *Dioscorea deltoides* (Yam)
9. *Malva sylvestris* (Common Mallow)
10. *Moringa oleifera* (Drumstick Tree)
11. *Plantago ciliate* (Ispaghul)
12. *Rosa moschata* (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 river Kunhar watershed falling in the Patrind Hydropower Project area.

5.1 Methodology

Depending upon the climate, topography and vegetation density of the area behind the weir site up to almost 7 Km backwards three representative site 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. 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 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

5.2.1 Vegetation Species

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

Trees

- | | | |
|-----|----------------------------|-------------------|
| 1. | <i>Pinus roxburghii</i> | (Chir Pine) |
| 2. | <i>Ailanthus altissima</i> | (Tree of Heaven) |
| 3. | <i>Salix spp</i> | (Willow) |
| 4. | <i>Celtis australis</i> | (Hack berry tree) |
| 5. | <i>Pyrus pashia</i> | (Pear) |
| 6. | <i>Ficus carica</i> | (Fig) |
| 7. | <i>Picea smithiana</i> | (Spruce) |
| 8. | <i>Prunus padus</i> | (Birds cherry) |
| 9. | <i>Ascer spp.</i> | (Maple) |
| 10. | <i>Cornus macrophylla</i> | (Kandar) |
| 11. | <i>Acacia modesta</i> | (Kiker) |
| 12. | <i>Robinia pseudocacia</i> | (Phulai) |

13. *Olea cuspidata* (Kau)
14. *Bauhinia variagata* (Kahnar)
15. *Azadarachta indica* (Bakain)
16. *Zizyphus jujuba* (Ber)
17. *Cedrela serrata* (Drawa)
18. *Salmalia malabericum* (Simal)
19. *Acacia arabica* (Punjabi Kike)
20. *Cassia fistula* (Amaltas)
21. *Aesculus indica* (Bankhour)
22. *Juglans regia* (Wallnut)
23. *Grevia opposittifolia* (Tamman)
24. *Celtis australis* (Batkarak)
25. *Populus spp.* (Sufaida)

Shrubs

1. *Dodonaea viscosa* (Hopseed bush)
3. *Berberis lyceum* (Barberry)
4. *Rosa moschata* (Wild Rose)
5. *Vitex negundo* (Five leave Chaste tree)
6. *Buxus wallichiana* (The Boxwood tree)
7. *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. *Lespedezia 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* (Lawnglass)

8. *Cymbopogon jawarancusa* (Common Scented Grass)
9. *Hyperhennia* spp
10. *Agrostis* spp
11. *Digitaria* spp

5.2.2 Forage Production Data (Kg/ha)

Forage production data was calculated in the area supposed to be submerged so as to calculate the biomass going under water. The data was computed on Hectare basis for ease of calculation.

Eastern Aspect		
Serial #	Vegetation Type	Production (Kg/ha)
1	Grasses	3530
2	Forbs	600
3	Shrubs	490
	Total	4620
Western Aspect		
1	Grasses	1630
2	Forbs	450
3	Shrubs	230
	Total	2310
Average		
1	Grasses	2580
2	Forbs	525
3	Shrubs	363
	Total	3468

6. OUTCOME OF THE STUDY

The project area was laying in the Guzara/Community owned forests and was far away from the Reserved/Protected forests. On left bank of river Kunhar in Muzaffarabad District there exists no reserved forest anywhere nears the project area. 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 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 (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.

The vegetation does not contain any species which was declared as endangered, threatened or rare. As far as the conservation status of the vegetation species (Grasses, herbs, shrubs, trees and medicinal plants) is concerned none of the species was found endangered either for Pakistan or in the world. 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 can be easily 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 area 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 downstream of the weir 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 3468 Kg/ha comprising of all the vegetation types like trees, herbs, shrubs and grasses.

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