CUMULATIVE IMPACT ASSESSMENT
OF
KABELI-A HYDROELECTRIC PROJECT (KAHEP)

Submitted to

WORLD BANK

Submitted by

KABELI ENERGY LIMITED

Buddha Nagar, Kathmandu, Nepal

Prepared by

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Thapathali, Kathmandu, Nepal

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Acronyms

BOOT	Build, own, operate and transfer
CAT	Catchment area treatment plan
CIA	Cumulative Impact Assessment
DOED	Department of Electricity Development
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EMP	Environmentall Management Plan
GoN	Government of Nepal
GWh	Gigga Watt hours
HEP	Hydroelectricity Project
IEE	Initial Environmental Examination
KAHEP	Kabeli A Hydroelectric Project
KEL	Kabeli Energy Ltd
Km	Kilometer
km^2	Square Kilometre
kV	Kilo Volt
m	m
MW	Mega Watt
NEA	Nepal Electricity Authority
NESS	Nepal Environmental and Scientific Services
PDA	Project Development Agreement
PROR	Peaking Run-Of-River
ToR	Terms of Reference
VECs	Valued Environmental Components

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1.0 Introduction

The Kabeli -A Hydroelectric Project (KAHEP) located in between the geographical coordinates, latitudes 27o17'32"N to 27o13'41"N and longitudes 87o45'50"E to 87o40'55"E in Pachthar and Taplejung district, Mechi zone of Eastern Development Region of Nepal, is based on the water resources of the Kabeli Khola, a natural border between the Panchthar and Taplejiung districts in the Middle Mountains of Eastern Nepal about 620 km east of Kathmandu. This project utilizes a more than 15 km long loop of Kabeli River formed with Tamor River. The Kabeli River is diverted through a 4.322 km long tunnel and discharges into Tamor River for power generation.

Initial identification of the project was made during the Koshi River Basin Master Plan Study (1983-85). Successive studies (MHSP/NEA, 1998) formulated the 30 MW Kabeli-A Hydroelectric Project with an average annual estimated energy of 164 GWh. The project was later offered for competitive bidding to private developers on build, own, operate and transfer (BOOT) model. Butwal Power Company Limited in JV with Shangrila Energy Ltd and Khudi Hydropower Ltd from Nepal and two foreign companies SCPHI (Canada) and APP, China won the bid and established a Project company named Kabeli Energy Ltd (KEL)and signed the Project Development Agreement (PDA) with the Department of Electricity Development (DoED), Government of Nepal (GoN) in 2010 AD. Subsequently, DOED has assigned the survey license of the project to KEL.

The Project configuration was decided by performing project optimization studies during updated feasibility study by KEL in 2010. Major project features of KAHEP are diversion weir, side intake, settling basin, headrace tunnel, surge shaft, surface penstock, powerhouse and tailrace. Now KEL is undergoing the detailed design and environmental and social studies and is set for the development of the Project at the earliest possible.

The updated feasibility study (KEL, 2010) proposed a 37.6 MW installed capacity to the project. The gross head of the project is 116.8 m and the design discharge based on the 40 percentile flow in the river is 37.73 m3/s.The proposed project is a Peaking Run-Off-River (PROR) type project with a peaking reservoir constructed by damming the Kabeli River at the headworks. The live storage capacity of the reservoir is 0.315 million m3. The plant has been designed as a 6 hour peaking plant but at a reduced capacity of 26.5 MW during the month of the lowest mean monthly flow. The peaking will be done in two slots in a day with 2 hour in the morning and 4 hour in the evening peak. The annual average energy generation is estimated as 215.9 GWh before outage and 203 GWh after considering an outage of 6%.

Over 1996-1997 the Government of Nepal carried out a comprehensive screening and ranking process of 138 candidate projects that ultimately identified seven projects, including Kabeli -A HEP for detailed feasibility study. The feasibility study and environmental impact assessment were prepared in 1998. The project was eventually offered to the public for competitive tender on the basis of tariff. The GoN and Kabeli Energy Limited (majority of share owned by Butwal Power Company) signed the Project Development Agreement on January 31, 2010.

The KEL is the project proponent and has signed a Project Development Agreement (PDA) with the Department of Electricity Development (DoED) for the development of KAHEP. The detailed address of the project proponent is given below:

Kabeli Energy Limited

Ganga Devi Marga - 313, Buddha Nagar,

P.O Box: 11728, Kathmandu, Nepal

Tel: +977 – 1- 4781776 / 4784026;

Fax: + 977 1-4780994;

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2.0 Assignment

Kabeli Energy Limited has entrusted Nepal Environmental and Scientific Services (NESS) P. Ltd for "Assessment of Cumulative Impact of Kabeli -A Hydroelectric Project" The Cumulative Impact Assessment (CIA) of Kabeli Basin is prepared as per the requirements and ToR provided by the KAHEP to the consultant. The analysis in this report is made based on the consultant's own experience of conducing EIA of KAHEP, past experiences and reviewing secondary information of the basin. The challenge faced by NESS in establishing appropriate basin boundaries is in finding the balance between practical constraints of time, budget, available data, and need to adequately address complex environmental interactions that, theoretically, could extend for considerable distances away and well into the future.

3.0 Approaches for Assessment of Cumulative Impact of Kabeli Basin

Both primary and secondary source of information were used in assessing Cumulative Impact Assessment of KAHEP. For collecting the primary information extensive field visits and surveys were conducted during the preparation of EIA report. Similarly, several social assessment tools were used to gather field level information which includes PRA, RRA, FGD, Key Informant survey, stakeholders meeting etc.

The secondary data were obtained from feasibility report of KAHEP, IEE and EIA report of KAHEP. Besides the primary and secondary source of information, a stakeholder s meeting was held to identify Valued Environmental Components (VECs) of the Kabeli basin which set a basis for assessing the cumulative impacts in the basin.

A Kabeli basin wise approach for assessing environmental and social impacts at the planning stage would help identify opportunities for maximizing benefits and mitigating or compensating for risks, leading to better outcomes for all potential developers in Kabeli basin.

It is envisaged that this Cumulative Impact Assessment (CIA) helps in selecting the optimum combination of projects and sites for the greater benefit with least impact. It also helps to identify the best combination of a range of benefits through collaboration among developers in Kabeli basin. This helps achieve greater certainty in defining project requirements as well as greater acceptance of those requirements by all stakeholders.

4.0 Geographical Areas of Study

KAHEP is located on the Kabeli River Basin in Eastern Nepal (**Figure No. 4.1**). The Kabeli River at the project site is designated as a natural border between the Panchthar and Taplejung districts. The project site is approximately 620 km east of Kathmandu, the capital city of Nepal.

Figure 4.1: Location Map of KAHEP

The weir of the project is located at the border of Amarpur VDC of Panchthar and Thechambu VDCs of Taplejung district (**Figure 4.2**). The approximate longitude and latitude of the proposed intake is 87°44'56"E and 27°16'40"N. The intake, desander basin, tunnel alignment, surge shaft, penstock pipe, powerhouse and tailrace canal of the project fall within the jurisdiction of Amarpur VDC in the Pachthar District (**Figure 4.2**).

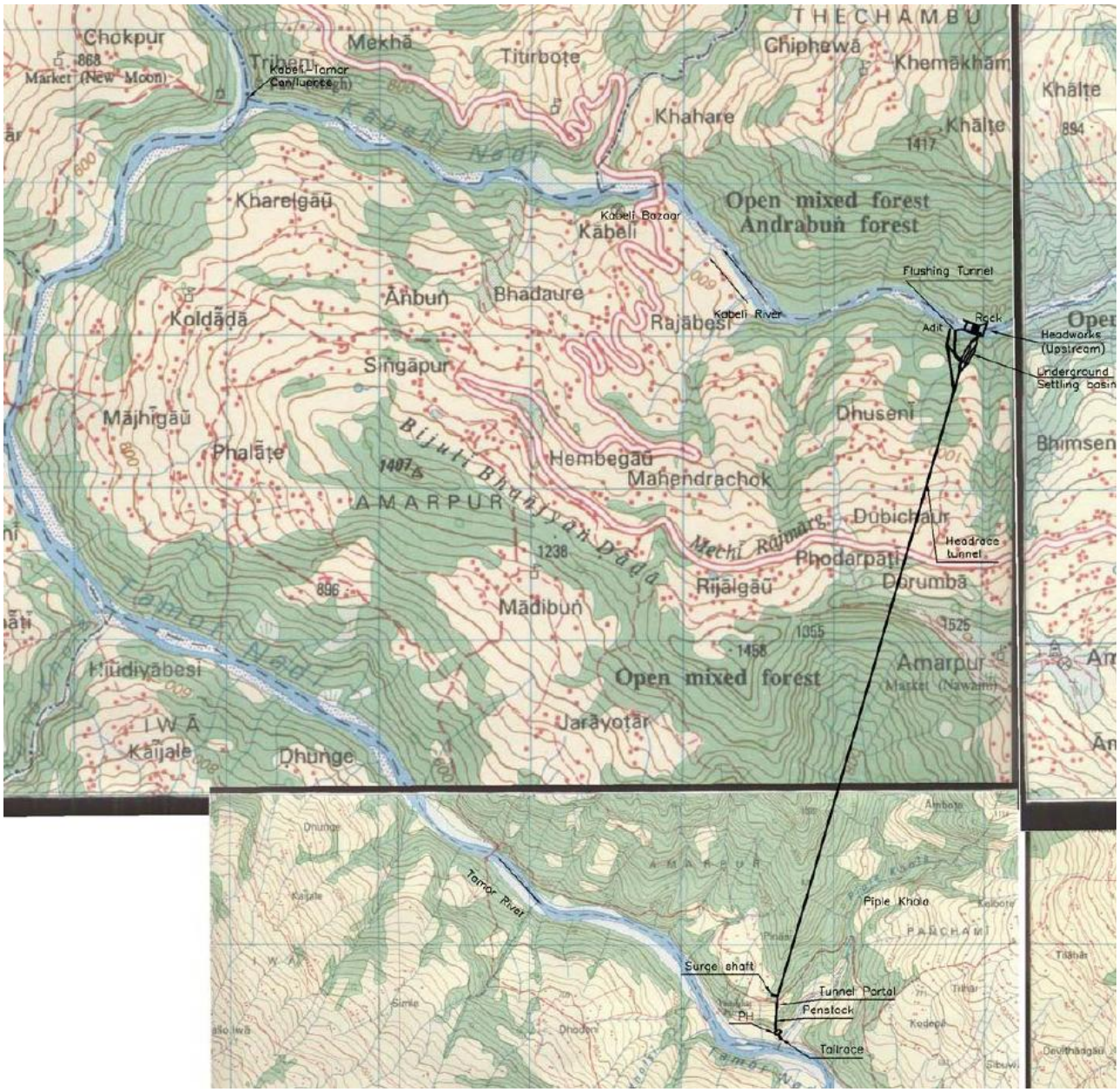


Figure 4.2: Location of the Key Project Structures in relation to the Project Districts and VDCs

The geographical grid assigned in the survey license for the project does not fall inside the boundary of any National Park, Wildlife Reserve, Hunting Reserve, Wildlife Sanctuary and conservation area.

4.1 Physical Environment

4.1.1 Topography and Geomorphology

The major part of the project area is located in the Mid-Mountain Physiographic Zone (LRMP, 1986). Characteristic of the Mid-Mountain Physiographic Zone is a ramification of the elevated mountainous topography (>1500m) with intervening deeply entrenched "V"shaped valleys (<700m). The higher mountain ranges and the principal valley generally extend north south whereas the minor mountains and tributary valleys extend in the east west direction. The physiographic distribution of the project area is presented in Table 4.2.

Table 4.1: Physiographic Division of the Project Area

Project District	Physiographic Zone	Area in Hectare (Ha)	Percentage (%)
Panchthar	High Himalaya	715	0.57
	High mountain	17264	13.86
	Mid Mountain	106611	85.57
	Subtotal	124590	100.00
Taplejung	High Himalaya	16588	20.93
	High Mountain	15072	19.01
	Mid Mountain	47609	60.06
	Subtotal	79269	100.00
Total Panchhar and Taplejung	High Himalaya	17303	8.49
	High Mountain	32336	15.86
	Mid Mountain	154220	75.65
	Total	**203859**	**100.00**

Source: ISRSC, 2004

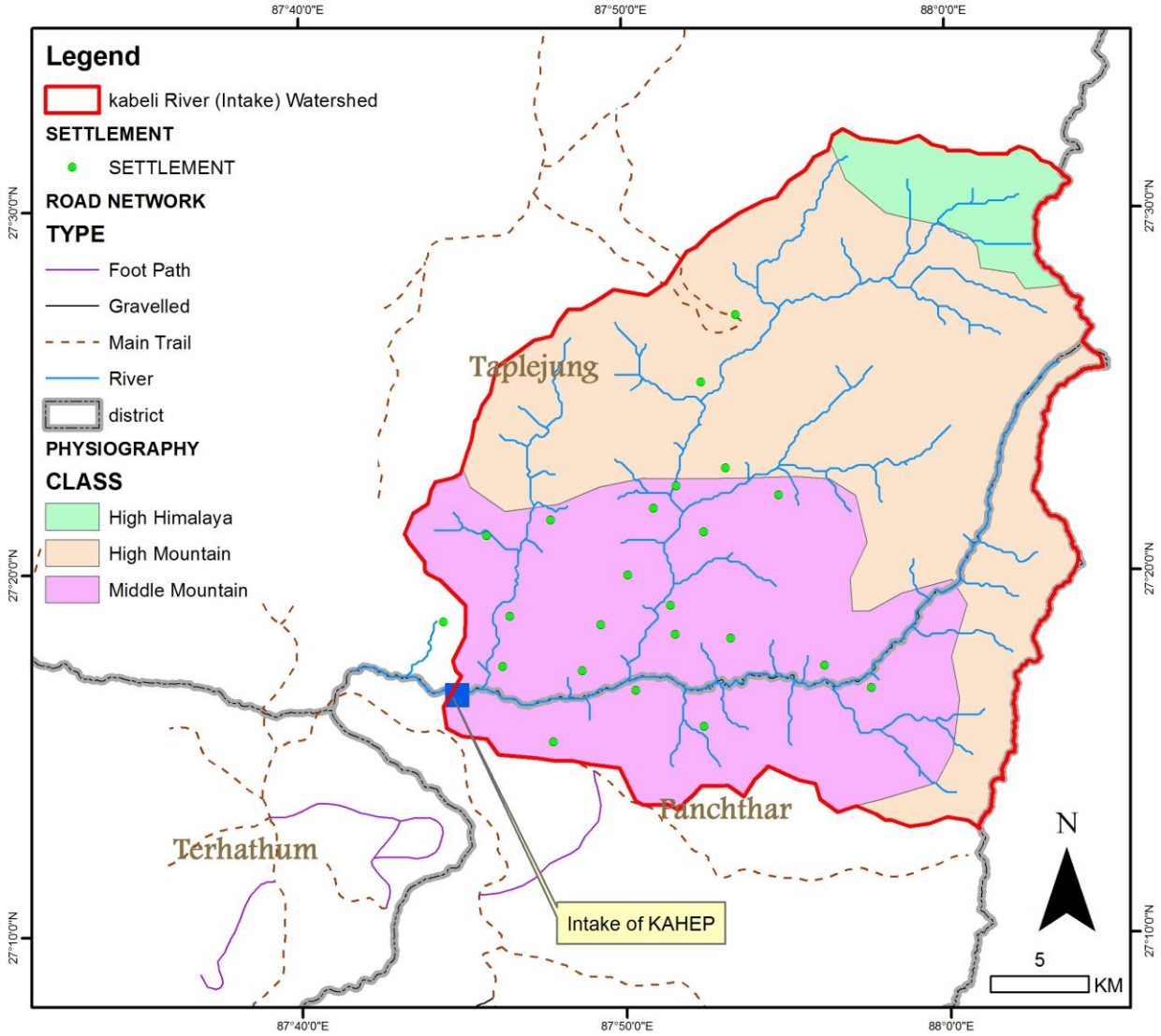


Figure 4.3: Physiography of Kabeli River Basin (Intake)

Geomorphologically, the basin is still in the formative process. The steep mountain slopes, particularly the valley slopes and the upper middle hill slopes reflect the geomorphic dynamism of the area related to the mountain building tectonic activities. The general topographic forms reveal periods of active tectonism and tectonic quiescence. The terraces at 2 to 3 levels at the Tamor valley and one or two levels towards the mouth of the tributary valleys reveals periods of tectonic quiescence and high degree of sediment deposition. Whereas the steep valley mountain slopes, particularly the vertical topographic breaks between the alluvial terraces (Tars) are the product of high degrees of active tectonism related to the Himalayan uplift and active riverine erosion. The gentler lower middle, and upper middle mountain slopes reflect stabilization of the landforms and mostly represent stabilized pre-historic landslide areas.

The general land use in the basin is dictated by the geomorphic forms of the area. The valley alluvial tars, lower and middle mountain slopes are extensively used for agriculture and human settlement. The steep valley slopes and upper mountain slopes are either under forest cover or are very steep represented by the bare rocks with thin soil development.

The active alluvial plain of the Kabeli is reported to be changing its geomorphic forms depending upon the river floods and sediment deposition. The location of the river channel changes its course within the confines of the active flood plain. With the change in the river channel the shape size of the flood plain and the sand/boulder island bars also changes. The high standing alluvial terraces (above 5m from the river bed) and the geomorphic forms of the sloping valley flanks are, however, stable (Powerhouse camp areas) and are not reported to have changed their forms since the establishment of settlements in these

areas. The piple Khola alluvial fan at the powerhouse site is also reported to have changed its geomorphic forms frequently due to floods and debris slides in the catchment of the Piple Khola.

4.1.2 Geology and Soil

Geologically the area lies in the Lesser Himalayan Crystalline to Meta-sedimentary rock sequences representing Taplejung Window. The headwork area is comprised of dominantly granites. The settling basin, and headrace tunnel is made up of granite, gneisses, schists, phyllites and quartzite whereas the surge shaft and powerhouse areas consist of phyllite, schist, and quartzite. In general the orientation of the foliation is 30-40° towards the north direction.

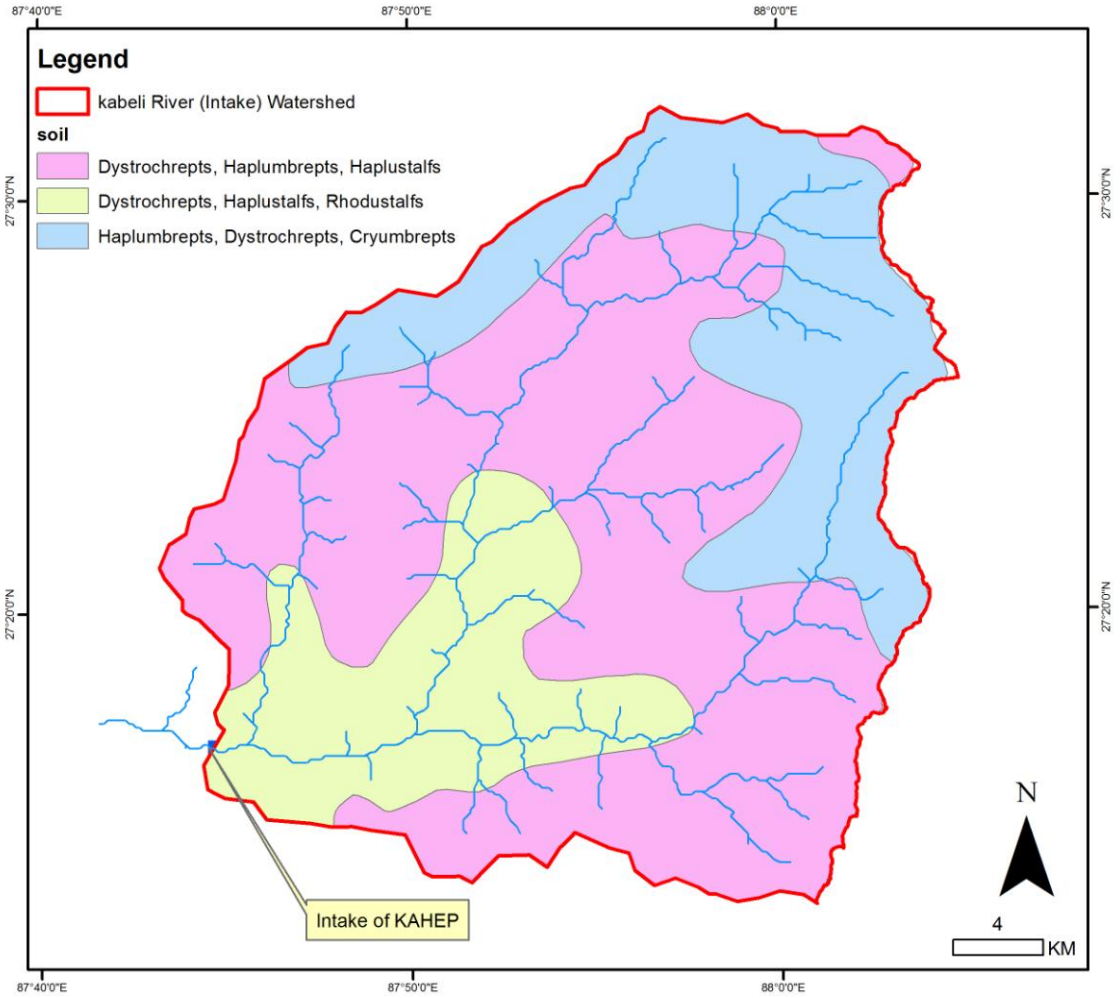


Figure 4.4: Kabeli Basin Thematic Map (Soil)

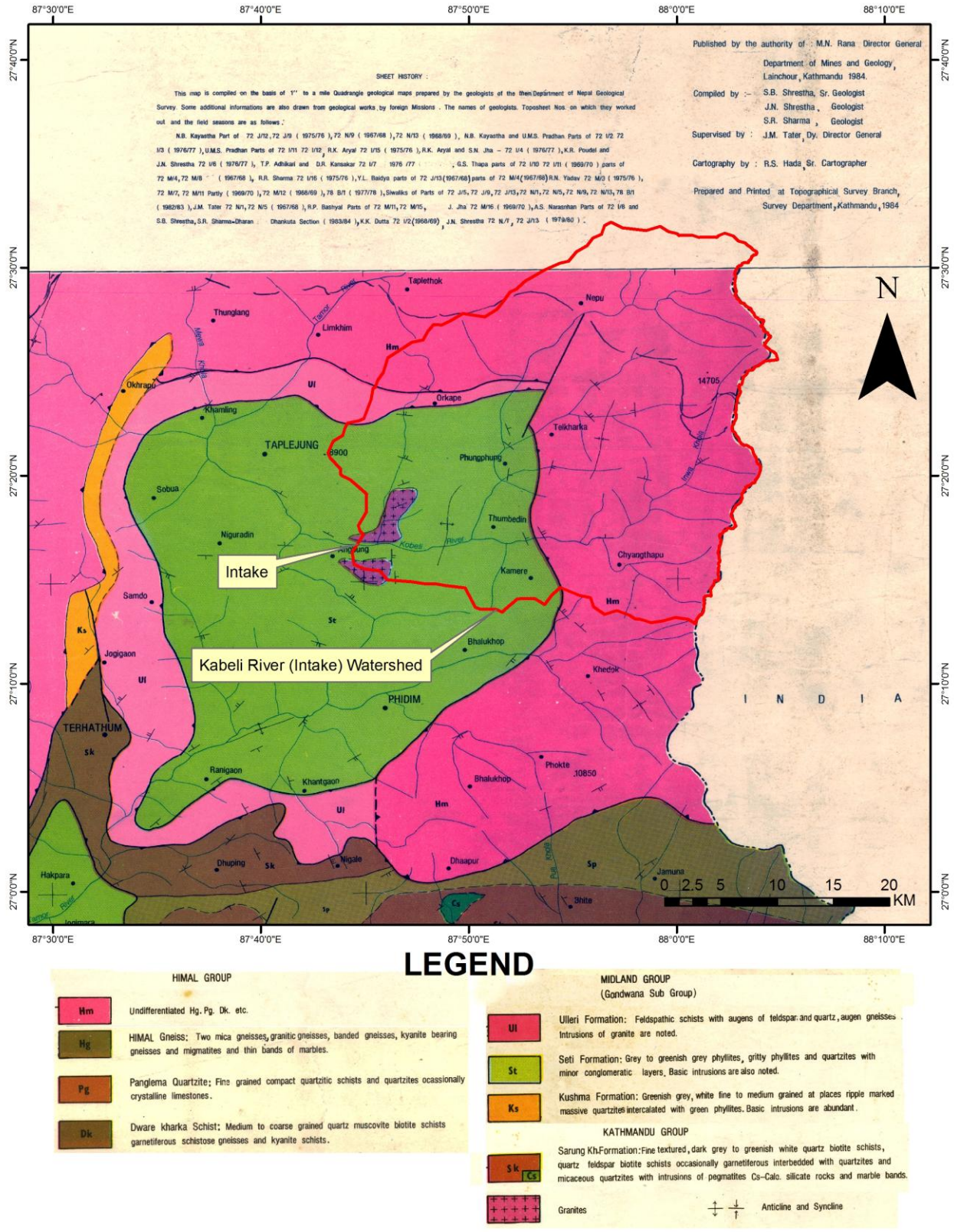


Figure 4.5: Geology of Kabeli Basin (Intake)

4.1.3 Climate and Meteorology

As is typical for most of the watershed of Nepal, the Kabeli Basin covers a wide range of climates due to high topographic variations from valley bottoms to mountain ridges. Within the project development site, the altitude varies between 500m masl to >2000m masl. This difference in the altitude greatly influences the climatic region within short distances. Further, the aspects of mountain slopes also influence the

climatic conditions. Two distinct climatic zones at the immediate project location sites are observed. The valley sections less than 1000m asl experience a sub-tropical climate while the uplands above 1000m and above experience a warm temperate to cool temperate climate. The project vicinity area exhibits four seasons annually: Winter (December-February), Pre-monsoon (March-May), Monsoon (June-September), and Post-monsoon (October-November).

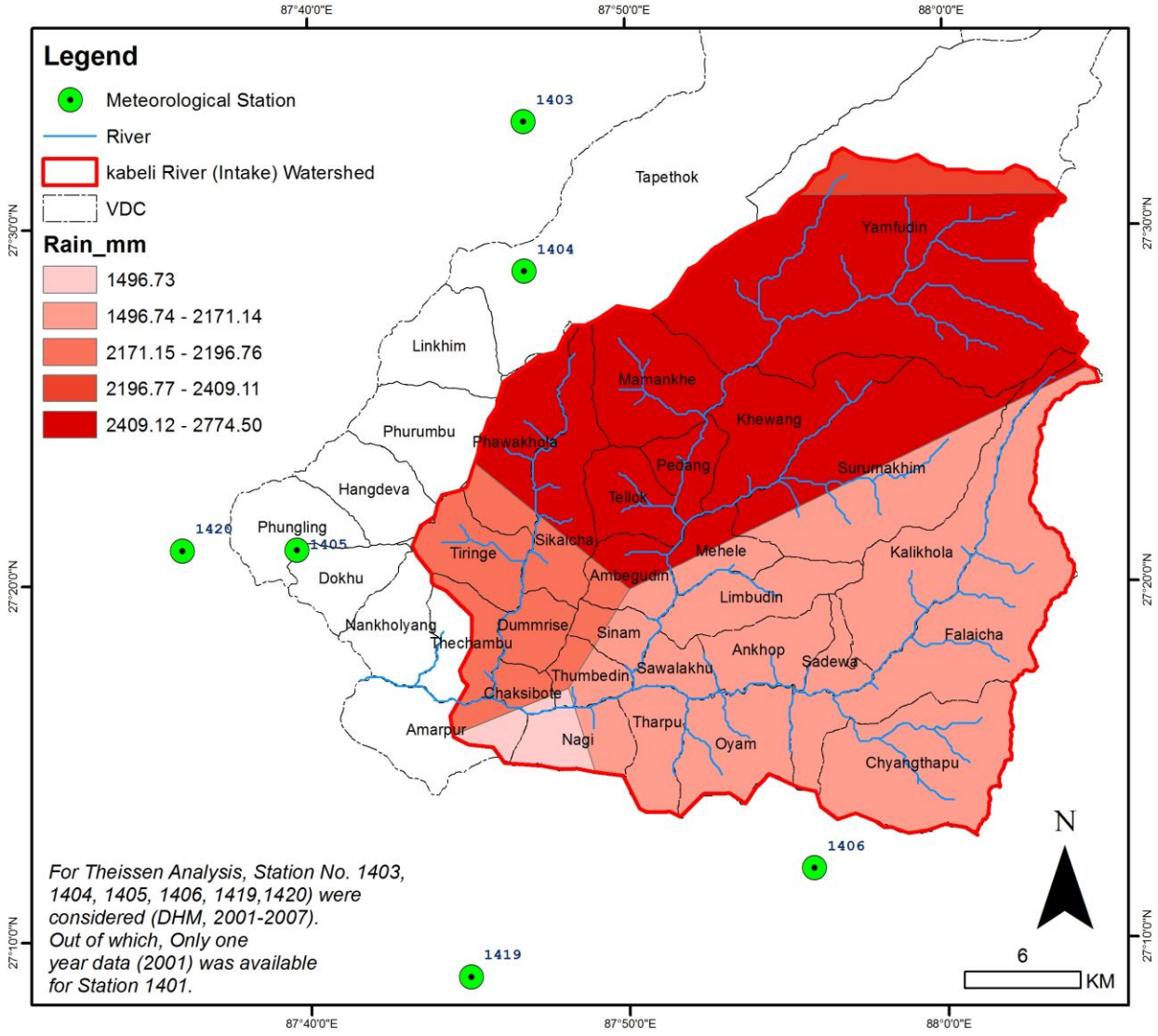


Figure 4.6: Annual Rainfall Map of Kabeli Basin (Intake)

4.1.4: Drainage and Hydrology

The Kabeli River is one of the tributaries of the Tamor River and the Tamor River is one of the major rivers of the Sapta Koshi Basin. The total length of the river is about 57 km and that up to the intake site is 52.4 km. The Kabeli basin is located in between latitudes 27° 16' and 27° 17' N and longitudes 87° 42' and 87° 43' E .The Sapta Koshi Basin drains the Eastern Development Region of Nepal to the Ganges in the Indian Territory. The map of the catchment area of the Kabeli River above the proposed intake site is presented in Figure 4.3.

The catchment area of the Kabeli River is 864 km2 at the proposed barrage site of KAHEP. The catchment area above the permanent snowline (El. 5000m) is about 0.5 km2only (Table 4.4). The catchment elevation ranges from 560 m amsl to 5600 m amsl. The oval shaped basin extends northeast southwest. The mountain ranges separting the basin from other sub-basins of Tamor on the east and west elevates from 2000 to 4000m amsl whereas on the north the elevation exceeds 5000m amsl. Tawa Khola, Phawa Khola and Inwa Khola are the major tributaries of the Kabeli River.

Table 4.2: Catchment Area Altitudinal Characteristics

Elevation, amsl	Intake Area		Powerhouse Area	
	Area in km^2	% of total area	Area in km^2	% of total area
Above 5000	0.5	0.1	717.0	18.2
Between 5000 and 3000	177.5	20.5	1325.0	33.7
Below 3000	686.0	79.4	1888.0	48.1
Total catchment area	**864.0**	**100**	**3930**	**100**

Source: KEL, 2010

Water from the Kabeli River is used for fishing, bathing, swimming and ritual purposes while the river water for the drinking purpose has not been reported. There are two cremation sites in the downstream area; one below Kabeli Bazaar, 2.5 km downstream of weir of the proposed Kabeli A Hydroelectric Project and another at 3.5 km downstream in Sirupa. However, there is no irrigation system in the downstream as the cultivated terraces lie above the riverbed. In addition, there are no other water right conflicts in the dewatered stretch.

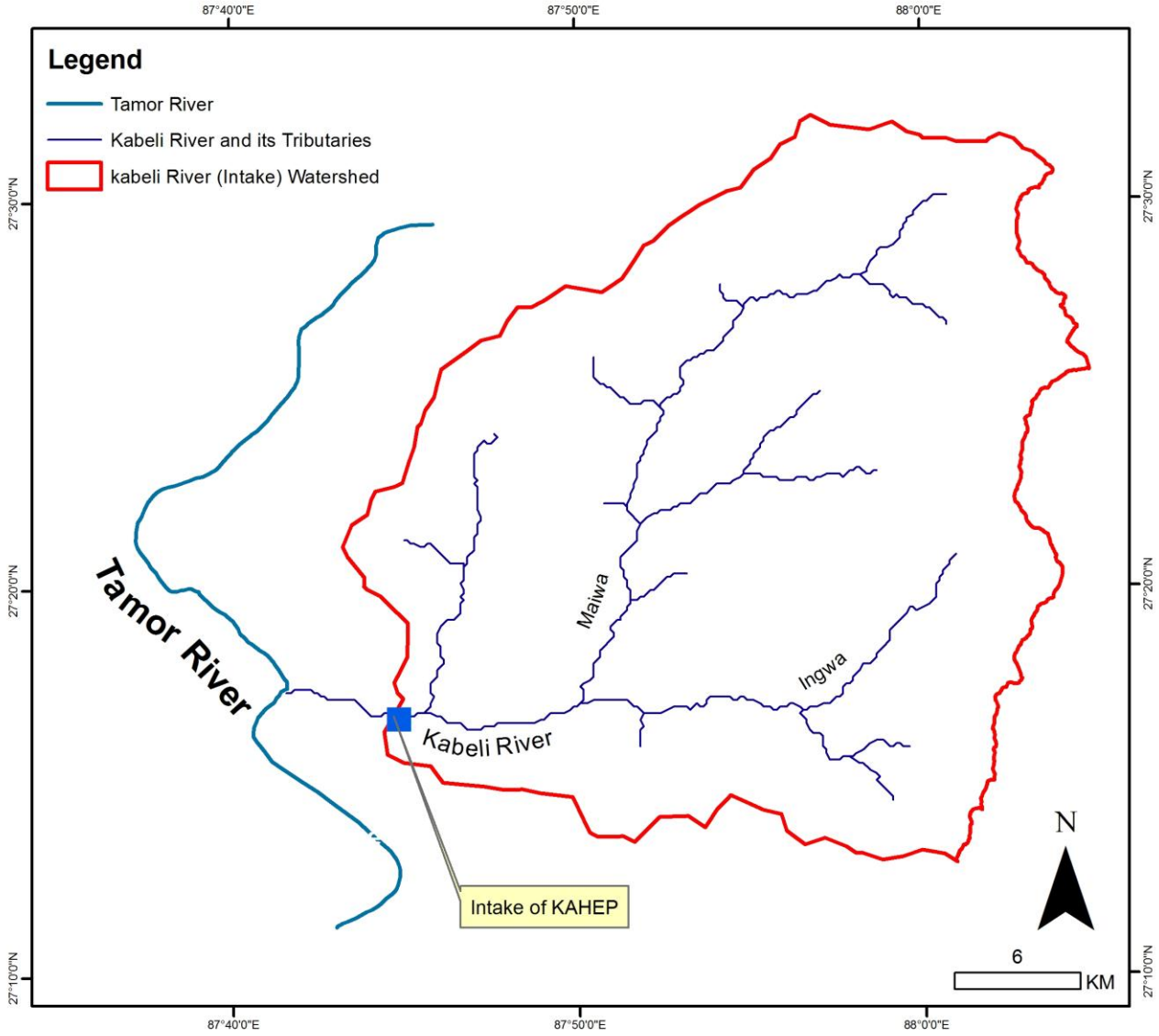


Figure 4.7: Catchment area of Kabeli River above the propsed intake area

Kabeli River Hydrology

As the Kabeli River is an ungauged river, various methodologies, common for ungauged catchments, are used to determine the hydrology of the Kabeli River. The mean monthly flow derived from 3 methods (Correlation with Tamor at Mulghat, HYDEST, and MSHP) is presented in Table 4.2.

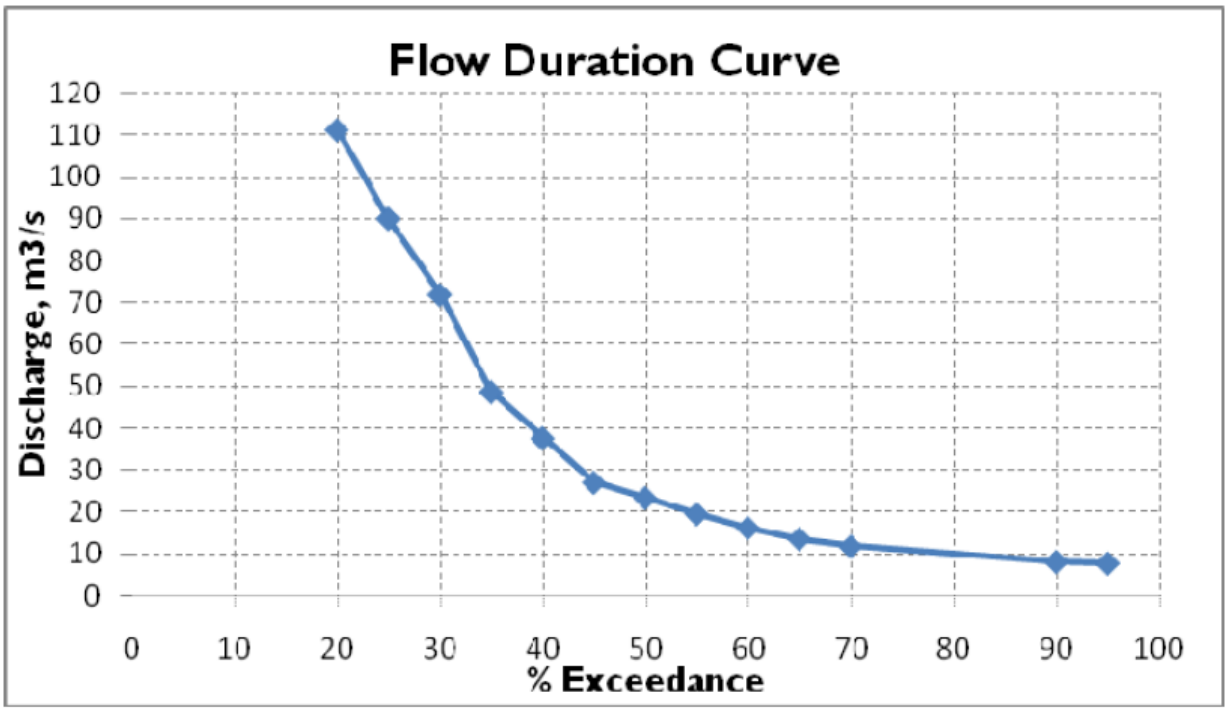
Table 4.3: Mean Monthly Flows from various Methods, m³/s

Months	Correlation with Tamor at Mulghat	HYDEST	MSHP
January	9.93	10.58	10.77
February	8.25	9	8.98
March	8.11	8.34	8.44
April	11.83	9.25	11.43
May	25.92	13.38	13.22
June	72.42	39.6	40.70
July	142.08	123.70	115.21
August	151.09	145.96	134.98
September	106.31	110.73	103.14
October	49.49	48.52	46.98

November	21.95	20.32	22.77
December	13.61	13.11	14.92
Annual Average	**51.75**	**46.04**	**44.29**

Source: KEL, *2010*

Since Station 690 at Mulghat being the mother catchment of Kabeli and having a long term data of 41 years, the mean monthly flow based on the catchment correlation and precipitation ratio has been adopted for the design of KAHEP.



Source: Updated Feasibility Report, 2010

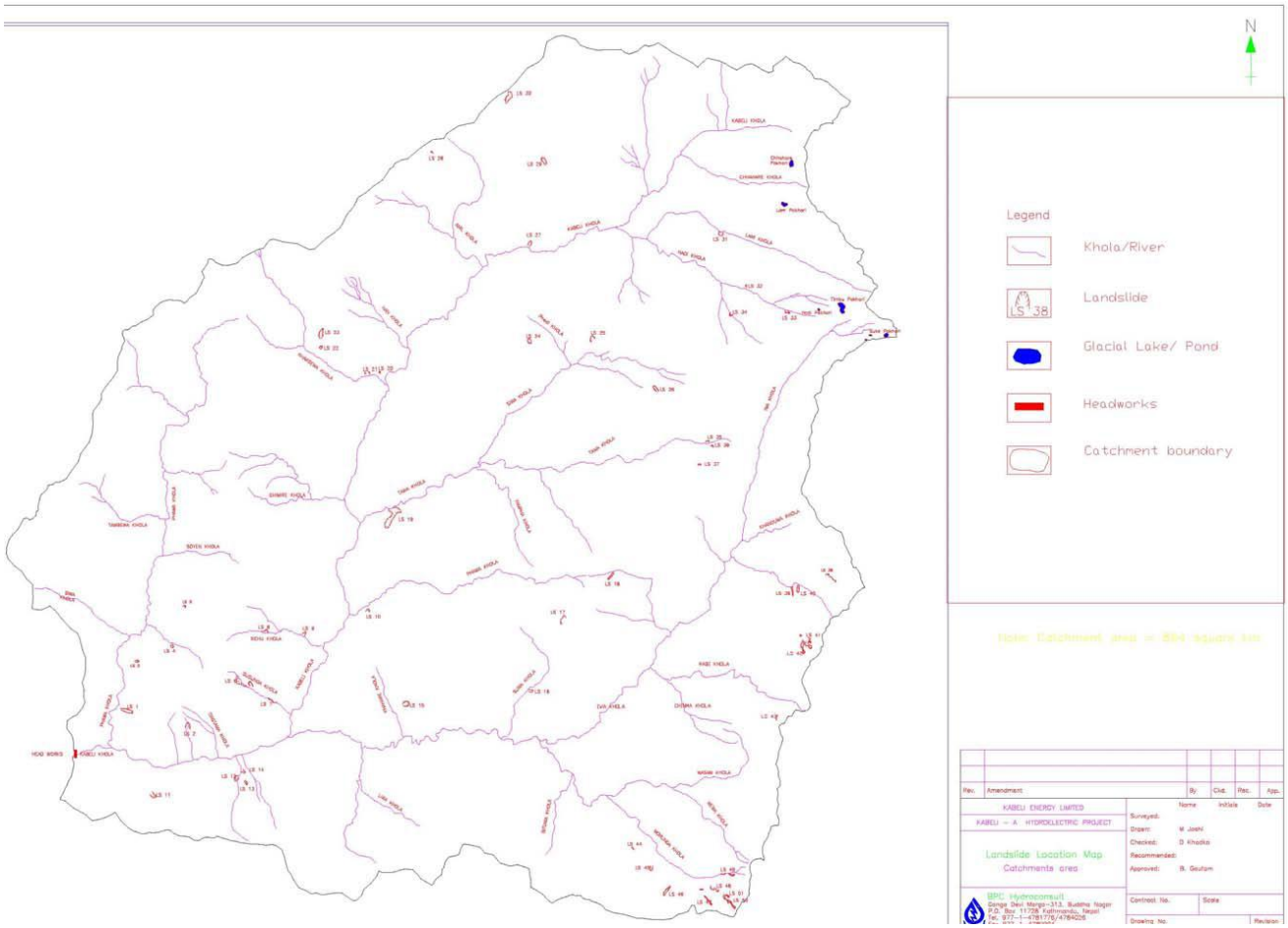
Figure 4.8: Flow Duration Curve for Kabeli River

4.1.5 Erosion and Sedimentation

The unstable features like landslides, debris flows, gulley erosions and rill erosions are the key erosional features within the catchment areas. The monsoon rain and its intensity are the major factors influencing erosion in the mountain slopes as well as along the river adjoining areas.

The Himalayan Rivers are known for the high load of sediment transport and Kabeli is not an exception. Result of Suspended Sediment Concentration Analysis of Kabeli-A HEP has been recorded from the monsoon of 22 April -11 July, 2010 from Hydro Lab Pvt.Ltd. The maximum recorded suspended sediment concentration is 13,616 ppm. The Monsoon is the period of high sediment load in the river. The sediment load could be exceptionally high in the event of landslides in the immediate upstream of the headwork site. The high floods of 1987 brought a huge amount of sediment and even scoured the toe slopes of the alluvial terraces causing small scale debris flows in the entire stretch of the Kabeli river and changed the morphology of the active flood plain of the Kabeli.

About 40 to 50 landslides were seen in the catchment of Kabeli above proposed Headworks of KAHEP, which are depicted in the Figure 4.9. Most of the landslides seemed to be old and stable at present. However, owing to steep terrain, rugged geology and heavy rainfall in a short period of monsoon season, there are always possibilities of landslide triggering in the Himalayas. Slide prone zones were seen in the eastern and northwestern boundary of the catchments, which are 25 to 30 km upstream from the headworks. Thus are least vulnerable to the project.



Source Source: Updated Feasibility Report, 2010

Figure 4.9: Landslide and Glacial Lake Location in the Kabeli Catchment

Upon discussion with villagers, two slides were reported to have been occurred at Fedappa of Amarpur VDC and Pauwa of Thechambu VDC in 2050 Shrawan. Including the loss of property, the slides accounted the loss of 22 and 28 human lives respectively in the slide events. Presently those slides are observed to be stable. No recent active landslide features have been reported or noted close to the project development sites

4.1.6 Air Quality

There exist no monitoring data on the air quality of the basin. Eye observations indicate that the air quality of the basin is generally good as the project area lies in a rural setting completely devoid of industrial emissions. However, along the roadside, the air is dusty (high TSP and PM 10) because of frequent movement of the vehicles along earthen roads. Contribution of fuelwood burning in the houses to the overall air pollution is minimal, however, the indoor air quality because of the use of fuelwood for cooking is considered poor. The other major source of air pollution envisaged is dust (TSP and PM 10) arising from ground or soil disturbance during the dry season while preparing the field for agriculture. As dust (TSP and PM10) is likely to be the problem during project construction, air quality at the boundary of the nearby settlements needs to be monitored to establish the baseline.

4.1.7 Water Quality

Rapid assessment indicated that the water quality of the Kabeli River is good. There are no big industries that discharge effluents in the river directly. However, activities like open defecation and use of water for different domestic purposes like bathing, washing utensils, etc are common among the settlements residing along the riverbank and is likely to be contaminated by microbial contamination. Increasing trends of chemical fertilizers and pesticide use in the catchment areas is envisaged to pollute the river water in future with increments in the nitrogen and phosphorous concentrations besides pesticides. The river water in the post monsoon and pre-monsoon season (October through May) is clear with low or negligible suspended sediment load. The sediment load is expected to be high (above 5000 ppm) during the rainy season from July to October. The major contributor of the sediment load is the catchment erosion associated with the high monsoon precipitation. The water quality monitored during the EIA study is presented in Table 4.9. The water quality parameters of other sources of water in Kabeli basin are not available.

Table 4.4: Water Quality of the Kabeli River

SN	Parameters	Test Methods	Observed Values			Water Quality Standards for Protection of Aquatic Ecosystem, GoN 2008
			Site 1 (Upstream of Dam)	Site 2 (Downstream of Dam)	Site 3 (Dewatered Zone)	
1.	pH @ 18°C	pH Meter	7.5	7.7	7.8	-
2.	Temperature. (^{0}C)	Thermometer	18	18	18	-
3.	Total Dissolved Solids, (mg/l)	Gravimetric	83	75	82	-
4.	Total Suspended Solids, (mg/l)		<1	<1	<1	-
5.	Total Hardness as $CaCO_3$, (mg/l)		18	19	23	-
6.	Residual Chlorine, (mg/l)	Iodometric Titration	N. D. (<0.05)	N. D. (<0.05)	N. D. (<0.05)	<0.05
7.	Fluoride, (mg/l)	SPANDS	N. D. (<0.01)	N. D. (<0.01)	N. D. (<0.01)	1.5
8.	Dissolved Oxygen, (%	Winkler Azide Modification	80	100	99	60, chronic

SN	Parameters	Test Methods	Observed Values			Water Quality Standards for Protection of Aquatic Ecosystem, GoN 2008
			Site 1 (Upstream of Dam)	Site 2 (Downstream of Dam)	Site 3 (Dewatered Zone)	
	saturation)					
9.	Ammonia, (mg/l)	Nesslerisation	**0.05**	N. D. (<0.05)	N. D. (<0.05)	<0.002, chronic
10.	Aluminum, (mg/l)	Erichrome Cyanine - R	0.21	0.001	0.16	20
11.	Nitrate, (mg/l)	UV Screening	1.10	1.25	0.88	-
12.	Nitrite, (mg/l)	NEDA	N. D. (<0.01)	N. D. (<0.01)	N. D. (<0.01)	-
13.	Lead, (mg/l)	AAS (FULL FORM)	N. D. (<0.01)	N. D. (<0.01)	N. D. (<0.01)	1 (medium water)
14.	Copper, (mg/l)		N. D. (<0.002)	**0.01**	N. D. (<0.002)	0.002, chronic
15.	Zinc, (mg/l)		**0.03**	**0.01**	**0.03**	0.004, chronic
16.	Cadmium, (m/l)		N. D. (<0.002)	N. D. (<0.002)	N. D. (<0.002)	0.005 (medium water)
17.	Iron, (mg/l)		1.26	0.26	1.23	
18.	Manganese, (mg/l)		N. D. (<0.02)	N. D. (<0.02)	N. D. (<0.02)	0.37, chronic
19.	Dissolved Phosphorus, (mg/l)	Ascorbic Acid	N. D. (<0.05)	N. D. (<0.05)	N. D. (<0.05)	-
20.	Arsenic, (mg/l)	Hydride	N. D. (<0.002)	N. D.	N. D.	<0.002,

SN	Parameters	Test Methods	Observed Values			Water Quality Standards for Protection of Aquatic Ecosystem, GoN 2008
			Site 1 (Upstream of Dam)	Site 2 (Downstream of Dam)	Site 3 (Dewatered Zone)	
		Generation		(<0.002)	(<0.002)	chronic

Note: *N. D.: Not Detected*

AAS: Atomic Absorption Spectrophotometer

Remarks: The observed values for ammonia and zinc in site 1; copper and zinc in site 2; zinc in site 3 exceeded the prescribed standards for protection of aquatic ecosystem. However, the percent saturation dissolved oxygen level exceeded by 60 (chronic level).

4.1.8 Noise Level

Localized noise problems at the Bazaar areas along the Mechi Highway due to the frequent movements of vehicles were observed. Other noise problems were not observed throughout the project area because of the absence of industrial activities. The measured spot noise level at the existing access road (near Kabeli Bazar) is 45 to 60 dBA. The noise level at the dam site is between 40 to 45 dBA. Likewise, the noise level at the powerhouse is between 40 to 50 dBA. In the prevailing trends of the settlements, roads and agro-economic practices, the area is not likely to experience measurable change in the noise level in foreseeable future except in pocket areas of roadside markets.

4.1.9 Water Uses and Water Rights

Currently the downstream area of the dam site of KAHEP does not have irrigation or water mill water uses. Potential of such water uses from Kabeli Rive are highly unlikely even in future because of the topographic constraints. The only water use of Kabeli River downstream Dam site is bathing, swimming and ritual purposes such as cremation of the dead bodies. There are 2 cremation sites in the downstream area; one below Kabeli Bazaar at Khola Kharka (10 minutes' walk from Kabel Bazaar), second 2.5 km downstream of weir, and the third 3.5 km downstream in Sirupa area. Most of the above water uses are non-consumptive uses. However, for the above uses a minimum of about once cubic meter per second flow is sufficient to keep the area for a minimum threshold of sanitation cleanliness. In addition, there are no other water right conflictsdownstream of the barrage. Kabeli River is not used for irrigation purpose in its stretch. Since this CIA is based on desk study and there is no such secondary information available on description of water use in other tributaries and streams of basin, it is not possible to come up with water use situation of other sources except Kabeli River in this report.

4.1.10 Land Use

The terrain in the basin exhibits wide variations in slope gradient with settlements, cultivated land and forests at different locations. The majority of the land of the project affected VDCs is being occupied agricultural land followed by forest vegetation). Settlements are scattered and are located at distance from the project development sites in Kabeli basin . The topography of the project affected VDCs shows that the low land, flat and gentle slopes are being used as cultivated terraced land. Generally, the slopes of colluvial soil are used for settlments and cutivation. Hills surrounding the villages are covered with scares vegetation with trees.

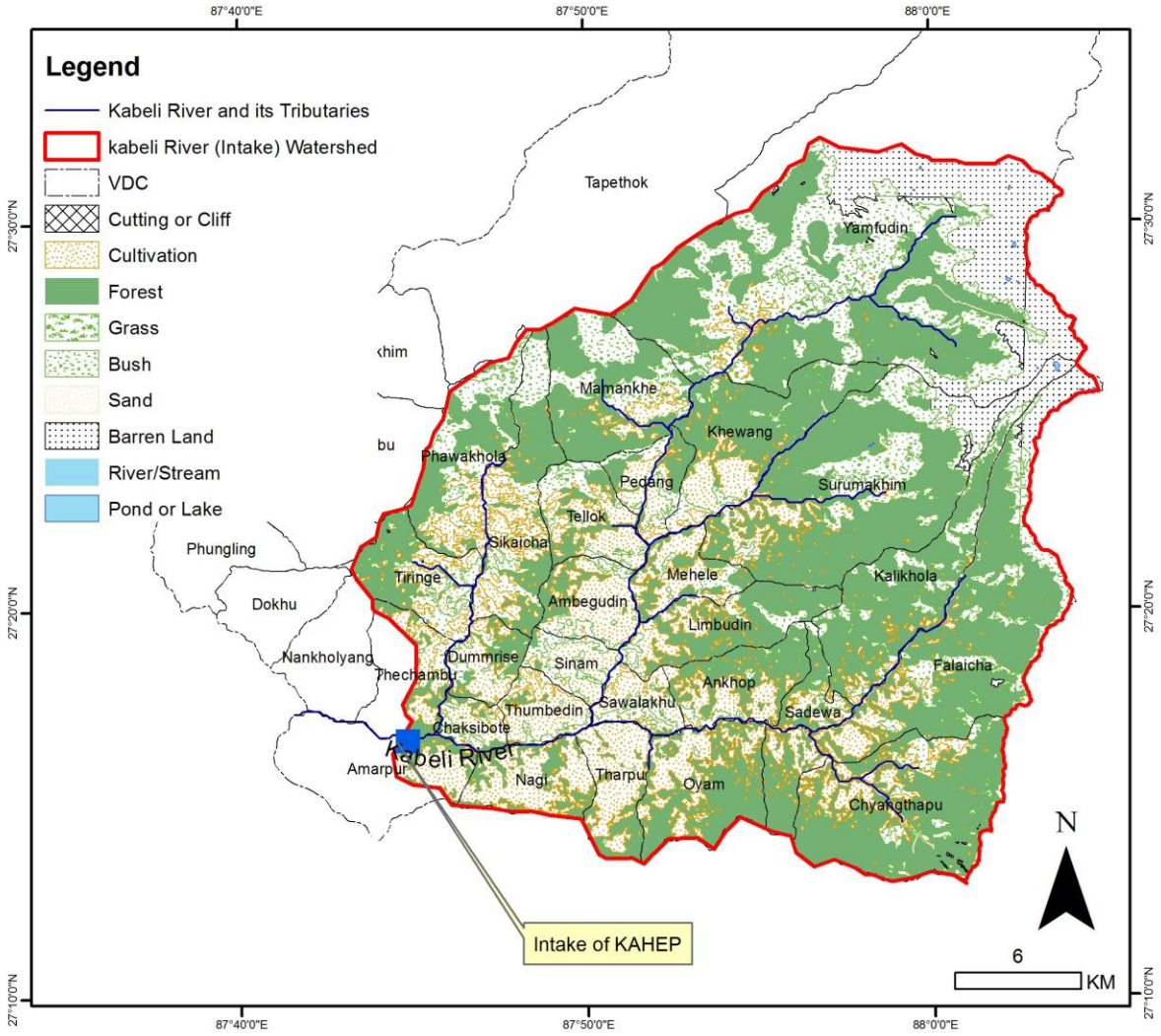


Figure 4.10: Land Use Pattern of Kabeli River Basin (Intake)

Table 4.5: Land Use Pattern of Kabeli River Basin (Intake)

S.N.	Category	Area_sqkm
1	Cliff Total	0.20
2	Cultivation Total	180.77
3	Forest Total	410.00
4	Grass Total	25.62
5	Bush Total	180.56
6	Sand Total	5.00
7	Barren Land Total	63.19
8	Waterbody Total	0.04
9	Pond Total	0.24
	Total	*865.62*

4.1.11 Seismicity

Seismicity Hazards Mapping and Risk Assessment Mapping for Nepal done by UNDP/UNCHS has divided Nepal into 3 assumed uniform seismicity zones based on the seismic characteristics and tectonic features of the respective regions. Based on this division, the Kabeli-A Hydroelectric Project area falls in the seismicity area-3 close to its border with the seismicity area-2.The seismic area-3 is characterized by the relatively low distribution of seismicity where the subduction zone lies at the deeper portion. The earthquakes generated around the project area are mostly of a magnitude less than 4. However, four great earthquakes are known to have occurred recently within the distance of 60km to 130km from the project area. Among them, the great Bihar-Nepal earthquake of 1934 having a magnitude of 8.3 (Richter scale) and epicenter at Chainpur is the nearest one which is about 70km away in the WNW direction from the project area. Though, its damages in Nepal and Bihar were recorded considerable, the actual damages intensity occurred around the proposed project area are not known. There is availability of information on damages due to the Udaipur earthquake (1988) of magnitude of M 6.6 whose damage intensity around the project area is of Modified Mercari scale V, whereas, at the epicenter zone damage intensity was of the Modified Mercari Scale upper VII. The effect of the other neighboring earthquakes of magnitude greater than 6.1 occured in 1980 and 1996 at a distance of 100km east in the India territory and were not experienced in Nepal (HCPL, 2010). More recently, an earthquake of magnitude 6.9 (Richter scale) was recorded with epi-centre at Indo-Nepal boundary (Border of Taplejung in Nepal and Sikkim in India). However, no significant damage of lives and properties were reported from the Kabeli basin.

4.1.12 Glacial Lake and Glacial Lake Outbrust Floods

There are a few glacier lakes identified in the Kabeli basin. All the lakes are located below 4200 m altitude. The identified lakes are shown in Table *4.*3.

Table 4.6: Glacial Lake/ Pond within the Catchment of the Kabeli River

SN	Glacial Lake/pond	Elevation (amsl) (Approximate)	Dimension (m) (Approximate)	Aerial Distance(km) (Approximate)
1	Timbu Pokhari	4330	220*450	35
2	Hadi Pokhari	4220	754*115	36
3	Suke Pokhari	4350	156*190	36
4	Lam Pokhari	4360	250*140	36
5	Chhahare Pokhari	4440	290*167	36

Source: KEL, 2010

Most of the glacial lakes of the catchment are small. None of these lakes are identified as potentially dangerous lakes in the study conducted by ICIMOD and UNEP in 2001 and there is no evidence of GLOF in the Kabeli basin in the past. However, a possibility of GLOF in the future cannot be ignored in the context of the ongoing rapid global warming. Since the sizes of the glacial lakes are very small with a potential of water discharge of about 1100m3/s at the project site from the largest glacial lake of the catchment "Timbu pokhari" there is no immediate threat of the glacial lake to the barrage at the Kabeli River structure which has a higher design discharge capacity

The Tamor river catchment, where the powerhouse of the project is located, has a number of glacial lakes. The Tamor river has a history of glacial lake outbrust. The GLOF of 1980 originating from Lake Nagma Pokhari had a flood surge reaching 20 m above the river bed of Yangma Khola. It is estimated that the peak flow at Yagma Khola was about 8500 m3/s decreasing to about 3300 m3/s at the gauging station 690 at Mulghat.

Since there are more than 8 major glaciers in the upper catchment of the Tamor river namely Chhubuk Glacier, Lonak Glacier, Chhatang Glacier, Pyramid Glacier, Kanchanjangha Glacier, Ramdung glacier, Khumbha Karna Glacier and Yalari Glacier there is high potential of GLOF in the basin. However, considering the distance from these lakes to the powerhouse site and dessepation of peak discharge, immediate threats to the designed tailrace is not envisaged.

4.2 Biological Environment

The project area lies outside the biodiversity conservation sites (National Parks, Wildlife Reserves, Conservation Areas, Strict Nature Reserves, Hunting Reserves and Buffer Zones) officially declared by the Government of Nepal. There is no plan of proposing protection and conservation areas by the local and central government in the project influence area. The nearest conservation area is the Kanchanjunga Conservation Area (KCAP) about 25 km to the north of the project development site. Issues of impact on KCAP due to on-going and other proposed projects in a basin are insignificant. So discussion and elaboration of KCAP environment is irrelevant in the present context of this report. Despite this, an overview of KCAP included below for the purpose of disseminating the information about it.

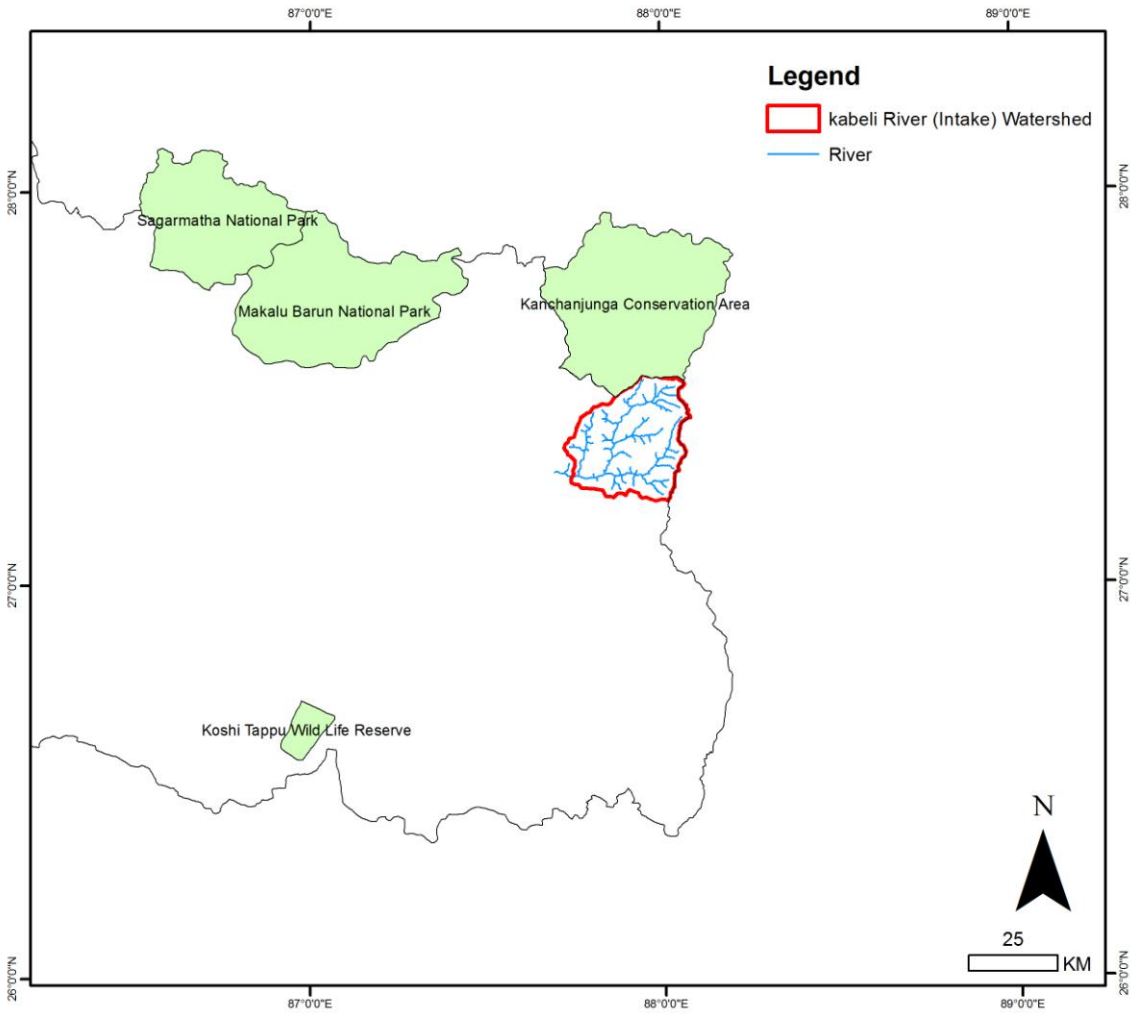


Figure 4.11: Government Desiated Protected Area near Kabeli Basin (Intake)

THE KANCHENJUNGA CONSERVATION AREA

The Kangchenjunga Conservation Area (KCA), designated as category IV (Habitat/Species Management Area) under IUCN categorization of protected areas, lies in the Taplejung district, bordered by the Qomolangma Feng National Nature Reserve, Tibet, China in North and Kanchanjunga Biosphere Reserve, Sikkim in the East. The conservation area covers an area of 2035 sq. km extending between 27.48^{0}N to 27.95^{0}N latitudes and 87.65^{0}E to 88.20^{0}E longitudes. Variations in altitude range from 1200m to 8586m amsl. The landscape of the area comprises cultivated lands, forests, pastures, rivers, high latitude lakes, glaciers and peaks of Kanchenjunga. The area represents high mountain physiographic regions with 65% of its area covered by rocks and ice. The remaining 35% is covered by forests (14.1%), shrubland (10.1%), Grassland (9.2%) and Agricultural land (1.6). The area is well known for its three river valleys; namely, the Simbua Khola, the Ghunsa and the Tamur valleys.

Climate varies from subtropical monsoon and humid summer at the lower elevations to cold and wet winter in the alpine region. Number of frost days is generally high. The conservation area experiences an average precipitation of 1775 mm annually. The conservation area is represented by subtropical vegetation in the lower mid-hill basins to alpine grasslands in the high mountains Forest types include Rhododendron forests upto treeline; Larix griffithiana- Juniperus forest - a characteristic east Himalayan vegetation type - found in the two main river valleys of this area between 3000-3700 m; Coniferous forest of Abies sepectabilis and Tsuga dumosa between 2800-3500 m; Mixed broadleaved forest of Quercus sp., Castanopsis sp., Magnolia campbellii, Acer campbellii and Osmanthus suavia between 1200-2800 m; Shorea-Schima mixed forest at 1200 m. 2500 species of flowering plants. 810 sp of flowering plants. Largest number of species occupy by the families consist of Compositae (56 sp), Leguminosae (51 sp), Orchidaceae (48 sp), Rosaceae (45 sp), Ericaceae (42 sp) and Gramineae (40 sp). Largest number of genera includes Rhododendron (23 sp), Rubus (14 sp), Pedicularis (10 sp) and Primula (10 sp). Important floras constitute Taxus baccata, Tetracentron sinense and Rhododendron sp.

The KCA in the eastern Himalaya comprises some of the most stunning scenery in Nepal. Not only does this region host the third highest peak in the world (Mt. Kangchenjunga, 8586m), but it is also a global hotspot for plant biodiversity. Botanists have identified twenty-three species of rhododendrons growing in the area. In this eastern Himalayan setting, glacial streams cut through high ridges creating remote and steep valleys where traditional farming practices are a way of life. Tuked within these hidden valleys, one can encounter rich forests that support more than 250 species of birds and some endangered wildlife species such as snowleopard, redpanda and musk deer. However, the habitat of these specilies in distant far from the current project site..KCA holds the boundary of landmass from four village development committees of Lelep, Tapeyhok, Walangchung Gola and Yamphudin. The conservation area has ethnic diversity and culture; approximately 5000 people of about 11 ethnic communities live in the area. As the original settlers of the Upper Tamur Valley, the Limbu are the dominant ethnic group in the lower regions. The Sherpa/Lama people are in the higher altitude where they arrived from Tibet more than four hundred years ago. These Sherpas have a distinct culture and tradition from those in the Solukhumbu District in the Sagarmatha region. Rais, Chhetris, Brahmins and other casts also reside traditionally in the area.

The region has a mosaic of ethnic groups. The religious sites (temples and monasteries) in the area attest to Kanchenjunga's rich cultural heritage. Local people combine agriculture, pastoralism and trade to subsist. Monasteries., chhortens, temples, prayer-walls are the icons of the conservation area's cultural heritage.

4.2.1 Forest and Plant Diversity at Basin Level

Altitudinal variation of Kabeli basin ranges from 560 m amsl to 5520 m amsl. This variation of altitude contributes to the existence of multiple bioclimatic zones within the basin. As such, five different forest types exists in Kabeli basin; namely Tropical forest, Sub-tropical forest, Temperate forest, Sub-alpine forest and Alpine Scrub. The construction site for the Kabeli Hydroelectric Project components lies in Upper tropical to sub-tropical zone (400 to 1200m) of Nepal. Phytogeographically, and also in the

regional concept this area falls in the eastern part of Nepal. Panchthar and Taplejung districts are the impacted districts by the proposed hydroelectricity project. Panchthar district has 18.3% upper tropical region and 66.9% subtropical region while Taplejung has 2.4% upper tropical and 14.8% sub-tropical region of the total district area. The flora within the project area is representative to that of the upper tropical and sub-tropical areas.

Tropical zone

Tropical zone (<1000 m) is characterized by warm and humid climate. At Kabeli basin the lower reaches of river valleys form this zone. The major life forms includes many kinds of deciduous species largely dominated by Sal (*Shorea robusta*). Other associated species include karma (*Adina cordofolia*), *Bauhinia malbarica*, *Careya arborea, Dillenia pentogyna, Holarrhena antidysenterica, Lagerstroemia parviflora, Mallotus philippinensis,* jamuna (*Syzigium cumini*), *Terminalia bellirica*, *T. tomentosa, T. chebula, T. myriocarpa* etc. Shisam (*Dalbergia sisoo*), and khair (*Acacia catechu*) structure the riverine vegetation of this zone.

Some of the commonly occurring medicinal plants in this zone are *Abrus precatorius, Achyranthus aspera, Adhatoda vasica, Aegle marmelos, Alstonia scholaris, Anogeissus latifolius, Asparagus racemosus, Bauhinia purpurea, Calotropis gigantean, Cynadon dactylon, Dalbergia latifolia, Desmostachya bipinnata, Dioscorea bulbifera, Elephantopus scaber, Garuga pinnata, Gmelina arborea, Holarrhena antidystenterica, Melia azedarach, Mucuna nigricans, Oroxylum indicum, Osbeckia nepalensis, Osyris wightiana, Phyllanthus amarus, P. emblica, Saccharum spontaneum, Stephania japonica, Syzygium cumini, Vitex negundo, Woodfordia fructicosa, Zizyphus mauritiana etc.*

Sub-Tropical Zone

Sub-tropical zone (1000-2100 m) is characterized by Schima-Castanopsis forest. Commonly occurring species are *Catanopsis indica* in the lower belts while these are replaced by *C. tribuloides* in the upper belts. *Castanopsis hystrix* are peculiar occurring in the eastern part of Nepal and Kabeli basin is not an exception. Utis (*Alnus nepalensis*) dominate the stream side vegetation in this region. Other life forms include *Acacia catechu, Ficus semicordata*, *Lithocarpus grandifolia, Myrica esculenta, Bombax ceiba, Rhododendron arboretum, Macaranga denticulate, Michelia champaca* etc.

Plants of the medicinal values found in this zone include *Abrus precatorius,Achyranthes aspera, Aconogonum molle, Acorus calamus, Adhatoda vasica, Aegle marmelos, Amaranthus spinosus, Asparagus racemosus, Barleria cristata, Bauhinia purpurea, Berberis aristata, Bergenia ciliate, Betula alnoides, Cassis fistula, Chenopodium album, Crateva unilocularis, Daphne bholua, Elephantopus scaber, Elaeocarpus sphericus, Holarrhena antidysenterica, Juglans regia, Melia azedarach, Oroxylum indicum, Phyllanthus emblica, Rhododendron arboreum, Swertia angustifolia* etc.

Temperate Zone

Temperate zone (2000-3100 m) is characterized by Laurel, evergreen oak, mixed broad-leaved deciduous and Rhododendron forests. The common life forms found in this zone are *Acer oblongum, Alnus nepalensis, Betula alnoides, Castanopsis tribuloides, C. hystrix, Cinnamomum tamala, Ilex dipyrena, Lindera bifaria, Litsea oblonga, Machilus duthiei, Michelia kisopa, Phoeba lanceolata, Quercus semicarpifolia etc.*

Plants of the medicinal values found in this zone include *Achyranthes aspera, Aconitum bisma, Acorus calamus, Asparagus racemosus, Dioscorea bulbifera, D. deltoidea, Ephedra gerardiana, Gaultheria fragrantissima, Selinum tenuifolium, Similax aspera, Taxus baccata, Thalictrum foliolosum, Zanthoxylum armatum* etc.

Sub-alpine and Alpine Zone

Sub-alpine zone (3100-4100 m) is characterized by conifer forest. As the average tree line in Nepal extends upto 3600 m, most plants of this zone forms the tree line. This zone is characterized by *Abies spectabilis* at lower level and birch-rhododendron (*Betula utilis-Rhododendron companulatum)* forests at the upper level. The alpine zone (>4100m) is represented by alpine scrubs.

Some of the commonly occurring medicinal plants in this zone include *Aconogonum molle, Bergenia ciliate, Dioscorea deltoidea, Lyonia ovalifolia, Picrorhiza scrophulariaeflora, Podophylum hexandrum, Taxus baccata,*

Valeriana jatamansi, Zanthoxylum armatum, Aconitum gammiei, A. spicatum, Allium wallichii, Rhododendron anthopogon etc.

The dominant tree species occurring in the upper tropical zone is Shorea robusta and other major associated species are *Adina cordifolia, Lagerstroemia parviflora, Terminalia alata, T. chebula, T. bellirica. Pinus roxburghii* is found in the subtropical region as dominant tree species. The major associated tree species are *Schima wallichii, Pyrus pashia, Lyonia ovalifolia* while *Hypericum cordifolium, Colebrookea oppositifolia, Zizyphus mauritiana, Woodfordia fruticosa* are the major shrub species in tropical region and *Melastoma melabathricum, Trichilia connaroides* are the major shrub species in the sub tropical region. Regarding herbs species, *Imperata cylindrical, Phramites karka,* and *Arundo donax* grow densely in the tropical region while *Ageratum conyzoides, Bidens pilosa, Cheilanthes bicolor, Cissampelos pareira, Sida cordata* etc are major herbacious species in the sub tropical region.

The forest in the area is mostly of patchy nature and is found only in the steeper sections of the land in the valley sections or along the ridge summit of the hills and mountains. Only about 35% of the total land use is occupied by the forests. Most of the forested areas are degraded or are on the extreme influence of human and grazing animals. It is said that the present forest status is better than few decades back. This positive trend in the forest quality and coverage is said to be due to the community forestry and leasehold forestry intervention. A large tract of the forested areas have been handed over to the communities and marginalized people for community forestry and leasehold forestry in the recent years. In future, with the present forest policy, it is envisaged that more and more government forest areas will be handed to the local community for forest management. If this is realized in practice, the status of the existing forest will be better than the present in the coming years. Hence, we can conclude that the forest management practices in Basin are found to be good.

4.2.2 Local Characteristics

There is a little different scenario in the local flora of the project area in comparison to the regional vegetation discussed above. The diversity of the flora in the KAHEP project VDCs is less significant to the regional floral diversity.

The status of the forest in Kabeli basin is similar to the regional forest status. Within the vicinity of the project sites, most of the forest tracts are either under community forestry or private forestry at present and are said to be improving in the stock quality and biodiversity.

4.2.3 Forest Management in Basin

The forest of majority of basin is the National Forest managed directly and indirectly under the supervision of the District Forest Office. There are a few patches of forests in the private land in Panchthar district which are not registered officially in the District Forest Office. All of the affected forests in the Taplejung district are private forest.

Within the **National Forest**, there are 3 categories of forests, one of the forest categories is handed over to the forest user communities under **Community Forests**, the other category is handed over to the local people on lease under **Leasehold Forest** and another **Government Managed Forest** is directly managed and supervised by Regional Range Post of the District Forest Office.

4.2.4 Rare/ Endangered/Threatened and Endemic Plants

The forest located in Kabeli basin shows the presence of the following species (**Table 4.4**) listed as Endangered/Threatened or Protected species under the Government of Nepal (Forest Act 1993), IUCN Red Book, and CITES Annexes. All of the listed species are common species of the project area and have a wider distribution in the project VDCs and districts.

Table 4.7: List of Rare/Endangered/Threatened and Endemic Plants in the Project Region

SN	Botanical Name	Local Name	English Name	CITES list	IUCN Redbook	GON
1	*Shorea robusta*	Sakhuwa	Sal tree			Protected
2	*Bombax ceiba*	Simal	Silk cotton tree			Protected
3	*Dioscorea deltoida*	Ban tarul	Wild yam	II	Threatened	
4	Different lichens species	Jhyau	Lichens			Protected
5	Different species of Orchids	Sungava	Orchids	II	Endangered	

Note: Government of Nepal Forest Act (1993): + Protected
IUCN Red Book: +CT Critically threatened; +V Vulnerable, +R Rare,
CITES: I Annexture I; II Annexture II, and III Annexture III.

4.2.5 Agro Biodiversity in Basin

The Kabeli basin comprises of traditional farming systems characterized by integrated crop-livestock production, sub-systems for the subsistence of the households. Farmers cultivate mostly in terraced upland and grow a number of cereals like maize, millets, wheat, Simal tarul (Manihot esculenta), various pulses, mustard, vegetables etc and some perennial crops like fruits, fodder, and timber species mostly for home consumption under rain-fed conditions. Few farmers own some irrigated low lands and grown rice, potato, wheat, mustard and other vegetables under irrigated conditions.

A mixed cropping pattern is common in the basin. The farming system is traditionally a mixed one in which the farmers grow almost all crops necessary to meet the food requirements of the family, feed for animals and cash for purchasing other daily necessities. Depending upon landholding size and type, farmers grow 2-3 crops in the same parcel of land. The household has developed its own way of cropping patterns for Khet land (irrigated low lands) and Bari land (uplands). The cropping pattern in these lands varies with the season. Normally, in irrigated lands farmers grow 3 crops namely wheat, maize and rice in a year. Some households grow mustard, potatoes and other winter vegetables between rice and maize crops. In uplands maize, millet and manioc/cassava are the most common cereal crops grown by almost all farmers in the upland area. The cropping patterns of the upland are quite different from irrigated land. The commonly grown varieties of cereals/pseudo cereals, vegetables, fruits, pulses, and spices recorded from the project area. Most of the agro cereals, vegetables, fruits, pulses and spices are common to all upper tropical and subtropical climatic areas of Nepal. The record of these plant species are presented in annex (1a)

4.2.6 Ethno-botany of Basin

The study showed that local people are highly dependent on forests and forest based non-timber forest products (NTFP) in the direct as well as indirect ways. People are using forest based resources like fuelwood, fodder, vegetables, medicines, timber, wild fruits etc. to fulfill their daily needs. Furthermore, forest products are also the income sources of the local people. Collection of wood, wild fruits and vegetables for own consumption and selling them in the local market is the common practice in the basin. The ethnobotanical use of various types of cereals, legumes, vegetables, spices and fruits species recorded of basin are presented in annex (1b).

4.2.7 Biodiversity and Ecological Status of the Forests in Basin

Altogether 168 plant species are recorded in the basin. Among these species, 61 are trees, 22 shrubs, 62 herbs, 15 climbers, 2 lichens, 4 mushrooms and 2 epiphytic plant species.

The dominant tree species in the upper tropical region of the project site is *Shorea robusta* and *Pinus roxburghii* in the sub-tropical region of the project site. The basal area of the measured plots indicate that the forest within the community forest category is more matured than that of government managed forests and private forests. The Government managed and private forests are in degraded conditions due to regular collection of fuel wood and timbers from these forests.

The ground vegetation is very poor in the *Pinus roxburghii* dominant forest in comparison to Shorea robusta dominated forest. The regeneration status of tree species is better in the *Shorea robusta* forest.

4.2.8 Mammals in Kabeli Basin

The basin consists of a few animal species as the forest area is scattered due to high human pressure and agriculture extension. It is not the prime habitat or migratory route of conservational or economical important mammals or any other animal life, though a few of conservation significance animals seasonally reported from the project vicinity forests. Some interesting wild animal species are Snow Leopard, Himalayan Black Bear, Musk Deer, Red Panda, Blue Sheep, Himalayan Langur and Assamese Monkey find this region as their favorites home.

4.2.9 Avi-fauna in Basin

The habitat observed for the project site of KAHEP is dominated either by the small girth *Shorea robusta* or of planted and natural *Pinus roxburghii*. The forest observation reflected that the community forest has more matured individual trees while in the government managed forests and private ones it is in a degraded condition. The ground vegetation is very poor especially in the *Pinus roxburghii* dominant forest. The birds as well other mammals are attracted with the fruiting, flowerings and young leaves bearing trees for their food and shelter. The Basin don't seems to have wildlife attractive plant species and also adjoining community forests and government forests are dominated by the non palatable species, the habitat diversity do not support diversity of bird species. The degraded area can only sustain fewer bird species diversity. One other study revealed that if the degraded area does not have external disturbance then only 16% of Nepal's total bird species might be found. However, the field study for this project shows that the species diversity of birds in the basin seems noteworthy due to listing of the species that passage through the project area and probable impact sites by participatory methods.

The common birds of significant values in KCA include over 210 species of birds. Some represented avi-fauna includes of Impheyan Pheasant, Red-Billed Blue Magpie, Ashy Drongo.

4.2.10 Herpeto-fauna

The basin consists of a few animal species as the forests area is scattered, high human pressure and agriculture extension. However, some of the herpeto-species diversity is reported in a combine format from the headworks area and powerhouse site.

The ongoing and proposed projects in a basin with lots of disturbances could not be a safe home for the rare and endangered species. It consists of frog, toad, snakes and lizards. Frog is neglected while snake is considered harmful while lizards are useless for local people's feelings. The species are only used by some healers or outsiders for rituals and commercial purposes. This section of animals includes the species which have great importance to ecosystem maintenance though mostly considered locally less valuable to human beings, are not in countable population status. The report of herpeto-fauna basically for snake species in the inner valleys of the mountain indicates the sub-tropical type of ecology in the area of hydropower development.

4.2.11 Terrestrial Wildlife of Conservation Significance in a Basin

Among the reported terrestrial wildlife in the Kabeli basin forests the following are of conservation significance as per the government of Nepal, IUCN Redbook and CITES Appendices (Table 4.5). As elaborated before, the terrestrial wildlife of conservation significance visit the project VDC forests only occasionally.

Table 4.8: Terrestrial Wildlife of Conservation Significance

SN	Scientific Name	Local Name	English Name	CITES list	IUCN Redbook	GON
1	*Macaca assamensis*	Pahare Bander	Assam Macaque		VU	√
2	*Neofelis nebulosa*	Dhwase chituwa	Clouded Leopard	I	VU	√
3	*Panthera paradus*	Chituwa	Common Leopard	I		
4	*Manis pentadactyla*	Salak	Chinese Pangolin			√
5	*Vulpes bengalensis*	Phyauro	Bengal Fox		DD	
6	*Semnopithecus hector*	Langur bader	Grey Langur	I		
7	*Muntiacus muntjak*	Ratuwa	Barking Deer	III		
8	*Naemorhedus goral*	Ghoral	Common Goral	I		
9	*Canis aureus*	Syal	Golden Jackal	I		

Note: Government of Nepal Forest Act (1993): √Protected
IUCN Red Book: **VU =** *Vulnerable,* **DD =** *Data Deficient*
CITES: I Annexture I; II Annexture II, and III Annexture III.

4.2.12 Aquatic Flora and Fauna in a Basin

Construction of the hydroelectric project will certainly have some positive as well as negative impacts on the aquatic environment. River impoundment and the resultant reservoir will create complex impacts affecting humans, vegetations, wildlife, aquatic resources and physic-chemical components of the environment. The natural lotic aquatic environment will be converted to lentic environment which affects temperature, flow, substrate, aquatic vegetation, dissolved substances and biotic interactions responsible for the composition of aquatic resources which are influenced to create a new environment. The present investigation was carried out to complement and amplify the baseline data that have been collected during the survey. Most of the fishermen reported in the area are part time fishermen. A majority of them go for fishing for recreational purpose for enjoyment in the leisure time. Only a few

households have adopted fishing as a profession that too in the non-agricultural periods and often sell the caught fish to the local markets for economic gains. According to the local fishermen and communities, the fish population of the area in the recent years is rapidly declining due to illegal fishing practices such as pesticide poisoning and electro-fishing. Their knowledge (majority of community people) on the fish species relates to the Asala and Kabre which are considered to be local delicacy. According to a few people the name Kabeli to the river is after Kabre fish in the river which was to be abundant in the past.

Fish diversity of the Kabeli basin is largely formed by the cold water fish species. As the Kabeli River drains to Tamor and Tamor drains subsequently to Koshi, fish diversity of Koshi river basin is represented in the Kabeli Watershed Rivers. The Koshi River in the eastern part of Nepal has 33 fish species (Shrestha, J.). A list of the coldwater fish species of Koshi basin is presented in **annex 1c.**

4.3 Socio Economic Profile of Project Districts

Panchthar District

Panchthar District is situated in the height of 609 meters to 3675 meters from sea level and its area is 1241 square kilo meters. The population of this district is 221594 as per the census of 2058 B.S. (2002 A.D.). Its literacy rate is 55.4% and main profession of the residents in this district is agriculture. Its agricultural land is 23138.6hectare. The headquarters of this district is at Phidim and there are 41 V.D.Cs. which are Phalaincha, Chayangthapu, Memeng, Prangbung, Sidin, Lungrupa, Nagin, Yangnam, Yektin, Oyam, Tharpu, Nagi, Amarpur, Panchami, Suvang, Bharappa, Phidim, Chokmagu, Siwa, Imbung, Chilingdin, Ranitar, Pauwasartap, Lumfabung, Ranigaon, Nawami Danda, Aasrang, Phaktep, Syabrumba, Yashok, Magjabung, Sarangdanda, Aangna, Aelane, Mauwa, Hangbung, Aarubote, Rabi, Kurumba, Limba, DurdimbaThere is no any Municipality in this district. Main residents of this district are Limbu, Bramhin, Chhetri, Tamang, Rai etc. Main attractions of this district Cardamom Farming and it is the largest residents of Limbu castes.

Taplejung District

Taplejung District is situated in the height of 777 meters to 8598 meters from sea level and its area is 3646 square kilo meters. The population of this district is 146810 as per the census of 2058 B.S. (2002 A.D.). Its literacy rate is 52.6% and main profession of the residents in this district is agriculture. Its agricultural land is 21998 hectare. Capital of this district is Taplejung and there are 50 V.D.Cs. which are Lalep, Olangchunggola, Papung, Tapethok , Yamphudin, Ikhabu, Nalbu, Sawa, Khejenim, Limkhim, Phurumbu, Phawakhola, Sikecha, Ambegudin , Mamangkhe, Khewang, Surumkhim, Kalikhola, Sadewa, Angkhop, Sablakhu, Limbudin, Mehele, Pedang, Teelok, Dumrise, Chaksibote, Thechambu, Sinam , Tirenge, Thumbedin, Namkhol Yang, Dokhu, Phulbari, Niguradin, Hangpang, Phungling, Hangdewa, Sawadin , Liwang, Thukimba, Thinglabu, Lingtep, Khamlung, Khoklin, Santhakra, Phakumba, Sanghu, Dhungesanghu, Change.There is no any Municipality in this district. Main tourism heritages in this east hilly district are Pathibhara and Kanchanjanga. Main residents of this district are Limbu, Bramhin, Chhetri, Sherpa, Rai etc. Main attraction of this district is world third highest peak Mt. Kanchanjanga with 8598 meters.

About 40% of the population of the basin is below 14 years of age, 54% is between the ages of 14 and 60, and 6% is above 60 years of age (District Profile, 2008)

More than 70 caste and ethnic groups inhabit the basin. The caste groups (as distinct from ethnic groups/Indigenous Nationalities) residing in the basin fall into two general categories: (a) Brahmin and Chhetri (the so-called 'advantaged', or 'upper' or 'higher' castes), and (b) Dalit (or artisan castes, the socio-economically 'disadvantaged' or 'vulnerable' groups, sometimes called 'lower' castes).

The Vulnerable Groups, as defined in GON, include both Dalit castes and Women (irrespective of caste or ethnicity). The Dalit castes found in the project area are, in order of magnitude, the Kami or Blacksmith caste, Damai or Dholi, Tailor caste, and Sarki or Leatherworker caste.

At the district level, the Brahmin and Chhetri castes predominate numerically. When considered together the Brahmin/Chhetri castes. There are ten ethnic groups resident in the four districts of the project. They are defined as Indigenous Nationalities (Adivasi/Janjati). Eight are hill ethnic groups (Limbu, Rai,

Tamang, Magar, et al), and two are lowland (Terai) ethnic groups. The more populous ethnic groups are the Limbu, Rai, Tamang and Magar. The smaller groups include Gurung, Majhi, Sunwar, and others.

4.3.1 Urban Development

The Government of Nepal has not prepared plans for guided urban development in the Basin. Despite this, there has been gradual growth in the urban population in the Basin districts over the past decade. Urban growth is higher in the Terai than in the Hill and Mountain zones.

With improvements to existing roads and the construction of new roads, urban centers at district headquarters and major road junctions are expected to grow substantially. The main district headquarters with growth potential are Phidim and Taplejung.

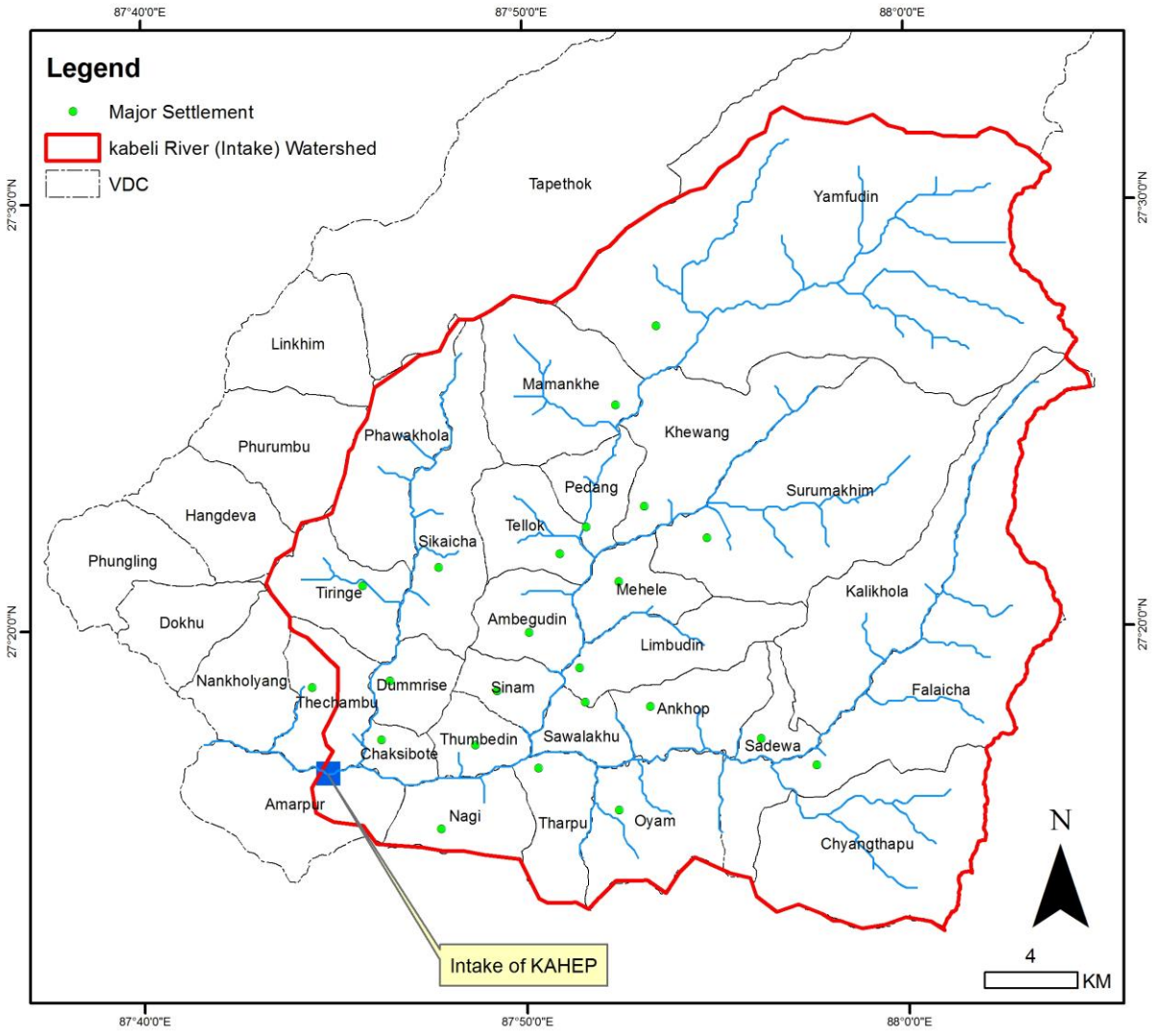


Figure 4.12: Major Settlements within Kabeli River Basin (Intake)

4.3.2 Agriculture and Horticulture Development

The Terai ecological zone has potential for diversified cereal, vegetable, pulse and oil seed production, while the Hills and Mountains have potential for vegetable, other horticulture and herbal medicine development. The lack of year-round irrigation in the Terai and poor road infrastructure in the Hills and Mountains has restricted agricultural and horticultural development in the Basin. With the development of the Kabeli basin projects, Terai agricultural production will increase.

The Agriculture Perspective Plan (1995) identified the Hills and Mountains as ecological belts for potential horticultural development. The topographic and climatic diversity and variability in solar radiation due to

aspect makes these ecological belts suitable for diversified horticultural development. The use of traditional knowledge and recent developments in horticultural science are expected to improve horticulture in these zones. However, for such a change to occur the development of road networks deep into the hinterland are a pre-requisite for the marketing of horticultural products. This is likely to require at least another 20 years based on the current rate of road development by the government and local communities.

4.3.3 Tourism Development

A lack of adequate infrastructure has hindered tourism development in the Basin districts. Despite several touristic places, the basin is visited by only a fraction of the tourists that visit Nepal. With improvements in transportation and communications, the Basin is expected to be visited by a growing numbers of tourists. Similarly, the ecologically and florally rich areas of Taplejung are likely to attract a greater number of tourists. Though outside the basin, Pathibhara Temple in Taplejung is one of the touristic place of the region, for which tourist go via the basin. The basin is in route to tourist destinations like KCAP, Pathibhara, etc. Due to development of roads and other infrastructures in future, there is a strong possibility of promotion of ecotourism in Kabeli basin in future.

4.3.4 Industrial Development

There are only limited manufacturing industries based on agriculture and forestry in the Basin, and these are confined to the urban centers. The majority areas of basin have no industry. The industries in urban center of basin in these ecological belts are cottage enterprises employing only a few people. A poor infrastructure base and limited power supply are the prime reasons for the lack of industrial development. Given the right conditions for industrial development (power supply, road networks and communication links), the Kabeli Basin has a bright future for industry based on agriculture.

5.0 Cumulative Impacts

The environmental and ecological aspects discussed in this chapter above in terms of impacts and measures to avoid/minimize and compensate the perceived impacts are based on the issues derived from a rigorous scoping exercise of the Valued Environmental/Ecological (VEC) components of the project development site. The issues and concerns identified by the public, technical experts, and regulatory agencies in these scoping exercises during TOR preparation stage have been listed out for the preparation of the EA. VECs are components of the natural and human ecosystems that are considered valuable by participants. VECs need not be environmental in nature. The values discussed here are attributed for economic, social, environmental, aesthetic or ethical reasons. VEC is considered as investigative focal point while conducting CEA for Kabeli basin. Such an exercise, however, was limited to the project development site only and did not have a coverage expanding to the Kabeli basin. If projects similar to KAHEP are developed in the upstream areas of the basin, they will impart impacts which could have detrimental effects to the valued environmental components of the basin as a whole. In this context, it is important to understand the VEC components of the basin so as to come up with sets of measures which upkeep the basin VEC components on the threshold of sustainability to create a win-win situation

A scoping exercise was undertaken to bring the Kabeli basin issues and concerns related to VECs. The participating members of the scoping session were the resident of the Kabeli basin (Annex 1). The VECs identified by the members of the scoping session for Kabeli basin are listed in Table 5.1. The purpose of identifying VEC of Kabeli Basin is to find out the component wise project specific and cumulative impacts of Kabeli basin

The series of consultations were held during the preparation of environmental and social reports of KAHEP. The consultations also focused on discussion regarding potential cumulative impacts in a basin due to KAHEP and other future potential projects

Table 5.1: Valued Environmental/Ecological Components of Kabeli Basin

VEC Components	VEC Sub-components	Concern
Physical Environment	Air quality	Community health, visibility
	Noise	Community health, disturbance to wildlife
	Surface water quantity	Shortage of water supply, water mills, irrigation etc, aquatic life/fish, cultural and religious purpose
	Surface water quality	Community health, aquatic life, religious and spiritual uses
	Groundwater quantity	Shortage of water for water supply and irrigation
	Groundwater quality	Community health
	Landslide/erosion and sedimentation	Damage to agriculture, infrastructure, housing structures etc.
	Landuse	Landuse change resulting to loss of productive agriculture, forests, pasture and grassland etc.
	Fish and Fish Habitats	Decline in the fish population, further decline of the following locally valued fishes due to interventions • *Schyzothoraichthys progastus* (Chuche Asala) • *Schyzothorax richardsoni* (Buche Asala) • *Glyptosterrum blythi* (Tilkabre) • *Glyptothorax cavia* (Kabre) • *Glyptothorax pectinopeturus* (Kabre0 • *Glyptothorax telchitta* (Rato Kabre) • *Psedecheneis sulcatus* (Kabre) • *Psilorhynchoides pseudecheneis* (Tite) • *Tor putitora* (Shahar)

Biological Environment		• *Bagarius yarrelli* (Gonj) • *Mastacembalus armatus* (Bam) • *Garra annandalei* (Budhuna) • *Anguilla bengalensis* (Rajabam) • *Barilius barila* (Faketa)
	Amphibians	Paha (Small-river river section, and larger – in the upper river section) valued highly
	Terrestrial ecosystem/vegetation	Loss of forested ecosystem which is already dwindling, loss of medicinal plants (study limited, traditional knowledgebase erosion, over and illegal harvesting may increase), Khair, Simal, Sal, Salla, Chattiwan (a medicinal plant) rapidly declining
	Wildlife and Wildlife habitats	Habitats already fragmented and wildlife are declining, common leopards was so common in the past is rare now, various types of wild bees so common in the past rapidly declining, Aringal hive very rare, Helix in upper region is declining, Peacock (lower valley sections) also rapidly declining due to habitat loss.
Socio-economic and Cultural Environment	Socio-economic	Agriculture land of the Kabeli is highly productive and is the food bowl of the area. Loss of land for development at the valley has a serious implication on the local food security apart from rehabilitation and resettlement of the affected people. Other concerns are: • Community growth- in migration and change in demography, • Constraints in local supply and demands, • Implication on the service facilities-water supply, health, education etc., • Implication on law and order, • Implication on community health- occurrence of unknown new diseases, • Employment opportunity-local/outsiders, • Business opportunities-local/outsiders, • Employment incomes, • Education and Training, • Substance abuse, • Wilderness-loss of wilderness, • Traffic and Noise-increase in traffic and noise, • Tourism enhancement, • Industrial development,
	Local food delicacies	• Kabre and Asala fish of Kabeli is a local delicacy-already declining now might decline further, • Chang (a kind of locally brewed beer) is an alcoholic beverage used in the festivals-might be replaced by foreign alcohols-loss of local beverage • Fish fingerlings of Tamor is the special delicacy taken together with Chang-possibility of over exploitation by development workers and other outsiders

	Culture and aesthetics	• Kabeli is the river of spiritual significance in line with Kabeli river in India-interference and dewatering in some stretches might impinge its spiritual importance, • People of the region taken holy dip in the river before visiting Pathivara Shrine of the region- interference and dewatering in some stretches might impinge its spiritual importance, • There is strong belief that meat of sacrificed animal should not be crossed across Kabeli-interference and dewatering in some stretches might impinge its spiritual importance, • Temples and shrines at the bank of Kabeli are considered to be of high spiritual significance-interference and dewatering in some stretches might impinge its spiritual importance, • There is a belief cremation of dead body in Kabeli will raise the dead person in the heaven- interference and dewatering in some stretches might impinge its spiritual importance, • Recognition of Rai and Limbu culture-dominance of people of other culture. This has happened in the past. The Lepchas were the people living in the Kabeli valley in the past now replaced by Rai and Limbu cultural groups, • Traditional activities-people might abandon their traditional activities (agriculture/festivals, Dhan Nach etc.) • Cross-cultural Sensitivities tentions and conflicts related to culture and traditions

Among the residents of the Kabeli basin, the most valued VECs is its fish particularly Kabre. There is a floklore sayning that Kabeli and Kabre fish go hand in hand. However, in the recent years fish populaion in the Kabeli is rapidly declining due to poisioning, and elctric shocks used by some of the local miscreats for fishing purpose. Culturally and spritually Kabeli has its own significance and is regarded as the most holy river by the people of the region. In that context, the water quantity and quality of the Kabeli River is and will always be regarded as a sense of being and spritualtity to the people of the region

As revealed by the list of valued environmental components of the Kabeli basin, there is not much of difference between the Kabeli VECs and KAHEP VECs (refer EA TOR). In other words, the impacts of the increased numbers of HEP in the basin will have a long term cumulative effects on the VECs of the basin as a whole, though individual project might incurr limited site specific to local alteration of the VECs

The KAHEP, as described in the sections above, has taken measures to minimise and avoid the impacts on VECs in the site specific area but its activities alone will not be sufficinet to mitigate the impacts of other projects in the upstream areas of the basin. Further, for every basin there is a limit on bearing capacity of the project activities to sustain the inherent VECs, even though the impacts of individual project activities are small. Becuase the cumulative residual impacts of multiple projects could exceed the limits of bearing capacities of the basin. It is for this reason strategic basin wise environmental impacts are studied to identify and limit the development activities within the bearing capacity of the basin. The KAHEP proponent, being a private party has no capcity as well authority to conduct such study and influence the decision making. In the context of hydropower development in Nepal, such a role is in the

jurisdiction of National Planning commission or Water and Energy Commission Secreteriate or Ministry of Energy or Department of Electicity Development. As a responsible private developer, what it could do is to highlight the likely consequences of the multiple HEP development in the Kabeli basin

5.1 Hydropower Development Scenario in Kabeli Basin: "As Is" Analysis

The total hydropower potential of the Kabeli basin is yet to be estimated by DOED. To date, eight hydropower development projects have been identified by the private developers and DOED in this basin of merely 870km^2 (**Table 2**).

Table 5.2: Hydropower Projects Identified in the Kabeli River Basin

S.N	Project	Capacity (MW)	River	License No	Issue Date	Promoter	Latitiude N		Longitude E	
1	Upper Ingwa Khola	9.7	Ingwa	218	3/12/2063	Ingwa Hydopower Pvt. Ltd.,	27° 16' 46"	27° 17' 20"	87° 55' 20"	87° 52' 22"
2	Kabeli B – 1	25	Kabeli	372	3/30/2065	Arun Valley Hydropower Development Co. P. Ltd.	27° 16' 23"	27° 17' 13"	87° 47' 00"	87° 50' 10"
3	Lower Igwa Khola	4	Igwa	418	6/30/2065	Shankar Narayan Linthep	27° 16' 41"	27° 17' 04"	87° 51' 55"	87° 52' 21"
4	Kabeli-A Hydropower Project	37.6	Kabeli	535	12/6/2066	Kabeli Energy Limited	27° 13' 41"	27° 17' 32"	87° 40' 55"	87° 45' 50"
5	Siwa Khola SHP	0.998	Siwa		3/16/2067	Hem Raj Gautam	27° 23' 36"	27° 25' 00"	87° 55' 00"	87° 57' 02"
6	Iwa Khola	9.5	Iwa	065/66 BUS 506	1/14/2066	Rairang Hydropower Development Co Pvt Ltd	27° 16' 30"	27° 17' 20"	87° 50' 05"	87° 51' 54"
7	Kabeli 3	12	Kabeli			Government of Nepal				
8	Sibani HEP	10								
Total		**101.198**								

Source: Department of Electricity Development (http://www.doed.gov.np/survey_license_for_generation)

The list of potential hydropower projects in a basin is obtained from the licensing authority (Department of Electricity Development, DOED) in Nepal. The record shows that there are 8 potential hydropower projects in Kabeli basin, including KAHEP. The detail statuses of other 7 projects are not available.

There is no holistic and strategic planning mechanism in place for planning and implementing all elements of hydropower development in Kabeli basin. Besides technical viability, the existence of proper supporting infrastructures such as access roads, transmission lines for power evacuation is required for prospective project in a Kabeli basin. To optimize hydropower development it is vital to pursue a Kabeli basin wise development policy so that the project infrastructure such as access road and transmission line are shared by all projects within the basin. Such a policy is absent in Nepal and project development is undertaken haphazardly and in isolation modes making them expensive.

Information of the project layout, land requirements, access infrastructures and locations of the project construction and operation facilities are not available except for KAHEP. In the above context, it is rather difficult to precisely define the cumulative impacts of HEP development in the Kabeli basin VECs.

It is to be noted that all the projects identified for development are located upstream of KAHEP. It is assumed that all the projects are to be developed as Run-off the River Projects. If some of these projects were to be developed as daily peaking storage or storage projects, then the operation modalities and expected energy generation of KAHEP and other downstream Run Off the River projects will be severely impacted. Besides above projects, it is not possible to know which new projects will come up in the future, so uncertainty under present condition is high. It is evident in Nepal that the holding of hydropower license is a serious issue and should be addressed with seriousness by GoN.

The development of the other projects in the catchment basin will have the following residual impacts of high significance to the basin VECs. Except KAHEP, if all other projects are built in the basin as proposed, there will be 63.6 MW power will be generated through 7 other prospective projects. However, looking at the progess of those hydropower projects, there is less possibility that these projects will come in near future or even built at all. Majority of them do not even have DPR level study, The basic infrastructure requried to built such projects are also seen evident on the ground. In addition, the project financing issue and stringent government regulations promulgated recently to discourage license holding could be major factors for cancellation of existing license in a basin. None the less, the CIA is "As is scenario"

5.2 Cumulative Impact Assessment (CIA) of KAHEP: Scenario Analysis

CIA of Kabeli basin that is presently undeveloped is necessarily speculative because it can consider only future scenario of development. It is not possible to know which projects will come up in the future, and also uncertainty under present condition in Nepal is fairly high. However, based on the "As Is" scenario, information of prospective developers in basin, and experiences of the similar work elsewhere, some pertinent CIA analysis are done which are elaborated below.

The cumulative impact of all likely major development in the Kabeli basin was assessed to predict the likely contribution and influence of the project to this impact over time. This assessment evaluates the existing basin/region condition, identifies recent development trends and like development scenarios across all major development sectors over the next several years, and predicts the cumulative impact of these developments on the basin.

5.2.1 Positive Cumulative Impacts

The direct economic benefit that will accrue to the Government of Nepal from royalties and revenue share during the generation license period of the prospective hydropower projects in the basin. Once the full ownership of the project is transferred to the government following the private generation period, the Government will operate the power station and receive full revenues. Another positive impact of KAHEP project on socioeconomic environment is contribution to the local and national electricity interconnection system. By this way, the Kabeli HEP will make a significant contribution to the local electricity production. These amounts of energy will make a significant contribution to the local and national electricity interconnection system.

Several elements were identified to represent the positive socioeconomic impacts. Such positive cumulative impact of development on socioeconomic conditions in the Kabeli basin over the next 20 years is predicted to be positive, primarily resulting from construction wages and the provision of services and material by local business. The environmental and social enhancement measures implemented by the potential hydropower projects in Kabeli basin will improve the quality of life of affected people. People directly affected by these projects from resettlement or land leasing will also benefit. However, environmental and social requirements stipulated by the GoN should be strictly followed by the project developers. As per the GoN and funding agencies policy, the pre project informs and livelihood sources of project affected people are also restored.

Other positive impacts includes road infrastructure development, increase in local government revenues, community development (school, health posts etc). Besides, there will be other off- spin developments in the area as well. The community support activities or programs planned under corporate social responsibilities of these potential hydropower projects will bring tangible cumulative benefits in the project affected communities which includes water supply and sanitation improvement, livelihood improvement/diversification, rural electrifications and other social benefits. These sub areas relative weighs should be necessarily reviewed. Some positive impacts also bring chances for negative impacts, example: road construction. This positive benefit of road construction will not only increase the length of road providing facilities, it changes the land use, destroys forest etc. So, this type of analytical interpretation is integral part considered for cumulative impact assessment.

5.2.2 Negative Cumulative and Synergetic Impacts

5.2.2.1 River Hydrology

The cumulative impact of developments in the Kabeli basin due to above expected forthcoming hydropower projects or others over the next 20 years is mainly predicted to affect river hydrology, riverine ecosystem, and social development.

5.2.2.2 Land use Change

Project structures and facilities will need land areas for project development. It is assumed that each of the projects will require nearly 20 ha of land for the placement of the project structures. This means an additional 100 ha of land of mainly agricultural and forest land use will be converted into developed structures. As most of the project development sites lack road infrastructure unlike KAHEP, they will require more land area mainly agricultural land for road development. For every kilometer of road development of 7.5m formational width, land requirement assumed is about one hectare. If about 100 km of total road length is developed from the present access roads to connect the different project sites and facilities, nearly 100 ha of land will be converted into infrastructure facilities by road development alone. The conversion of agricultural land and forest land for infrastructure will have a long lasting impact on the food security of the basin. The direct socio-economic consequences to the impacted households and resettlement and rehabilitation needs will further aggravate the situation. The issue and challenges related to land acquisition is one of the major aspects to be considered while developing projects in Kabeli basin.

The cumulative impact of development on terrestial biodiversity is predicted to relate to increasing forest resource demand by the general population versus increased protected area management. The development of eight HEPs in the basin in the basin may increase pressure on forests.

5.2.2.3 Erosion and Sedimentation

Road construction in the hilly steep terrain is always associated with land degradation because of the change in natural drainage and change in the general slope profiles. There is a high probability of landslips and debris flow both upslope and down slope of the road corridor for the first five years of road opening. Such mass wasting not only provides more sediment load to the rivers located in the valley section but also brings high degree of damages to the agricultural fields and forested areas depending upon the local land use conditions. The loss of forest, agricultural land and above all the top soil is of environmental and ecological concern to the livelihoods of local communities from the new road development activities.

The overall impact is not only a physical impact but will have ramifications of impacts to the valued biological as well as socio-economic environments.

The Kabeli River carries sedimentation loads. These create severe operating and environmental problems, including erosion of turbine runners, and loss of storage area due to siltation. As the number of project grows, sedimentation is likely to increase as a result of construction spoils and soil erosion. An upstream storage facility in each project, by regulating overall flow, reduce silt loads downstream as well as lead to greater energy output. In addition, catchment area treatment (CAT) plan is one of the effective means of stabilization of vegetation. CAT is elaborated in detail in recommendation section of this report.

5.2.2.4 Increase in Air, Water and Noise Pollution

Construction activities involving large number of workers at one confined location, frequent plying of construction vehicles along the dusty roads, excavations, and blasting operations all generate pollutants that have potentials to degrade the local and regional air, water and noise quality. A single project within the basin may be of high impact potential at the local level which dissipates to low impact potential at the regional level but the number of projects within one basin adds up to degrade the regional quality of water, air and noise level. The cumulative effects could be of significance to impact the ambient air quality, general quality of the river water, and increase the background noise levels at the basin level. As air, water and noise are also the environmental pathways could bring profound impacts of significance to the valued biological, socio-economic and cultural environments.

5.2.2.5 Impacts to the Aquatic Ecology and Loss of Fish Diversity

The change in river hydrology, basic element in the upkeep of the aquatic ecology, will have a long term impact on the aquatic ecology. Water regulation from the dam structures to generate power will fragment the river in a series of dewatered sections alternating with watered sections. This will impair fish migration from downstream reaches to the upstream reaches for spawning and feeding. When the breeding habitats are lost there will be a gradual decline in the fish population leading to extinction of certain fish species in the river stretch. Further holding of the organic detritus and nutrients by the dam structures will cause food scarcity to the fishes in the downstream sections causing morbidity and mortality effects to the downstream fisheries. As per the development proposal, what could be seen is the end of one project tailrace to the other project headwork. The consequent effect is: there will be a river course with series of headwoks and tailrace, but the actual river hardly has water flow except in the peak monsoon, In the dry season larger section of the river will be practically dry. Though the Tamor river is envisaged to provide refuge to the fisheries of Kabeli, it should be noted that the Tamor river fisheries is dependent upon the habitats (spawining and rareing) provided by the rivers like Kabeli. In this context , it is a serious related to fish and fish habitats a valued environmental component of Kabeli River.

Downstream water quality will also be altered by stored and regulated hydropower releases, with changes to temperature (though minimum), reduction in coarse and suspended sediments, and reduction in woody debris moving down the river.

It is important to consider are the interactions between the effects of hydroelectric development and the effects of other activities. The hydropower effects are not unique to hydropower: they are also caused by other land and water use activities. For instance, sedimentation effects on fish result not only from the construction of hydropower facilities, but also from deforestation, agricultural production, and road constructions etc. These interactions are very complex.

5.2.2.6 Economic Losses

The development of potential projects in Kabeli basin will involve the loss of private land permanently required for the project. The value of agricultural land that will be lost from this acquired land is direct economic losses. Other cumulative losses that have valued includes; inundation or removal of communal forest, shrubland, and grassland resources on Government land; loss or substantial reduction of the current fish catch from the Kabeli River in dewatered stretch, and degradation of the aquatic ecosystem downstream of the dam. Since majority of the potential projects IEE/EIA is not done or complete as of preparation of this report, quantification of economic losses of individual projects and its cumulative impact index couldn't be prepared.

5.2.2.7 Other Impacts Associated with Full Development Scenario

Since the exact natures of the project layout and development modalities are grossly unknown, evaluation of the other impacts will be only hypothetical. Issues of river fragmentation, population displacement, degradation of terrestrial flora and fauna, and change in the forest ecology are some of the burning environmental issues of local, national as well international concern and should be given due considerations by the agencies responsible for hydropower development decision making in Nepal, particularly National Planning commission or Water and Energy Commission Secretariat or Ministry of Energy or Department of Electricity Development. Due to unavailability of information of other potential projects, the total length of the river that would face reduced flow couldn't be exactly mentioned. However, substantial stretch of Kabeli River would face reduced flow.

As explained above, the Kabeli basin has several hydropower generation projects under construction. These projects require transmission capacity to evacuate the power they will generate. In total the present Kabeli transmission line will eventually make possible to evacuate approximately 170 MW, which will be a significant contribution to a power system that is currently based on less than 700 MW installed capacity. In order to evacuate 700 MW potential powers (upon harnessing potential energy of overall basin) to be generated from Kabeli basin, a holistic TL project with government initiation is required. If power generated from individual hydroelectric plant stats constructing its own TL, there will be severe environmental and social impacts and net effects will be devastating. This aspect is grossly neglected in planning of TL and in issuing hydropower license by DoED.

Due to this unplanned, poor coordination, there will be severe financial, environmental, and social implications in future. So, a holistic TL planning is required. This lesson learned shall be replicated in other projects and while talking about the regional development. The basin wise planning based on the cumulative impact assessment is one of the important parameters to be followed by DoED while awarding hydropower projects to the developers.

5.2.2.8 Global Warming Issues

In particular, shallow, tropical reservoirs with high volumes of residual organic compounds in flooded reservoir, intense aquatic primary production and high influx of organic material by their tributaries are of concern in global warming relevance. The proposed projects in Kabeli basin area however is small and only sparsely covered with vegetation and low influx of organic material. Furthermore the climate in Kabeli basin is not favorable for contribution to the greenhouse emission. As a result the projects in Kabeli basin will not contribute to the climate change.

5.3 Actions to be followed by Kabeli A HEP to Mitigate Cumulative Impacts

5.3.1 Environmental Program

The present Cumulative Impact Assessment studied the cumulative impacts on physical, biological and socio-economic environment that could be anticipated from implementation of the proposed Kabeli 'A' HEP in conjunction with other potential projects in the basin. The anticipated cumulative impacts are explained above. The mitigation measures shall be designed to mitigate such cumulative impacts.

5.3.2 Environmental Management

Based on the identified environmental impacts respective mitigation measures are developed in IEE of KAHEP. Similarly Environmental management Program for KAHEP has been prepared. The EMP will help the KEL to address the foreseen cumulative impacts of the project in line with the impacts described in KAHEP IEE/EIA prepared earlier, enhance the Project's overall benefits and introduce standards of good environmental practice. The EMP will be included in the contract documents to ensure contractors comply with EMP. It is very necessary that all the projects within the should follow the environmental and social requirements and EMP should be prepared and followed strictly.

To increase contractor's environmental awareness and ensure that they consider carefully and plan implementation of each mitigation measure that is their responsibility, contractors will be required to prepare their own construction phase EMP. The EMP should be further supported by site specific method statements and management plans that have to be prepared and submitted by the contractor to the client for approval prior to initiation of any construction work. These documents should comprise (but not limited to the following):

- Pre Construction Survey Plan
- Health and Safety Management Plan
- Traffic Management Plan
- Pollution Prevention and Abatement Plan
- Waste Management Plan
- Emergency Response Plan
- Community Development Plan

The contract documents should contain a listing of all required mitigation measures and a time frame for the compliance monitoring of these activities. The EMP and the required part or whole report of present cumulative impact assessment should be included in tender and contract documents so that the contractor is fully aware at bidding stage of what is expected of him in terms of environmental and social stewardship and can build the necessary costs into tender pricing. The monitoring will comprise surveillance to check whether the contractor is meeting the provisions of contract during construction and the executing agency during the operation of the project.

5.3.3 Environmental Monitoring

Environmental monitoring is a very important component of environmental management to safeguard the protection of environment at both construction and operation stages of the project. In response to environmental impacts identified during this Cumulative Impact Assessment, like KAHEP all potential projects shall develop EMP to complement the monitoring plan. Besides their individual project specific monitoring, the cumulative environmental social monitoring of Kabeli basin will be done by establishing community monitoring groups.

6.0 Conclusions and Recommendations

6.1 Conclusion

The cumulative impact study of Kabeli basin has shown that a number of impacts from KAHEP as well as from other HPP projects in projects in study area be unavoidable, but that their significance can be reduced or offset by appropriate mitigation. It is important to note that many others impacts are cumulative, such accumulation is additive not interactive, hence the total cumulative impact is not greater than the sum of the parts.

As a result of this cumulative impact assessment it is concluded that all major adverse cumulative impacts can be mitigated to acceptable levels through the measures proposed in EMP. The Kabeli basin side environmental, social, and economic assessment as well as basin wide yield estimations would be important and should take in consideration in every aspect of project planning and development. The gap between prospective projects in Kabeli basin is sufficient for the River to recuperate itself.

6.2 Recommendations

The hydropower development in Nepal doesn't capture all the potential costs and benefits of developing multiple projects in a single River basin like Kabeli. This cumulative impact assessment study develops recommendations for moving toward a holistic, river-basin wide approach to hydropower planning, design, and operation. The following section outlines some of the recommendations;

6.2.1 Enhance Coordination and Data Sharing

The Kabeli River basin planning requires close coordination among all the project developers from the project planning stage to the power evacuation stage. The long term sustainability of Kabeli River for hydropower generation will require easy, uniform access to data on hydrology, meteorology, topography, ecology, and sedimentation. This could be achieved by establishing a "developers" forum for data sharing and joint decision making. To initiate this, Department of Electricity, GoN should take a lead role to Kabeli River basin planning and development. It is impossible to assess the cumulative impacts without proper hydro-metrological database of the basin. So, it is advisable that the GoN to prepare such basin wise database. KEL could take the lead in proposing the formation of a forum of Kabeli River IPPs. The hydrological data of the basin is poor. With the coordination of all the developers in the basin, the hydrological data base could be established which ultimately becomes useful for the individual project and for basin level assessment.

6.2.2 Optimize Production in Kabeli Basin

The electricity generation is generally optimized ion the basis of individual projects, without taking into account other projects in cascade. Such practice can lead to substantially lower energy output and project revenues than would have been achieved with basin optimization. With a cascade of generators, the total energy output can be increased by optimizing the scheduling of successive generators as the peak river flow progress downstream. This sort of benefits could be gained in Kabeli basin with proper coordination and collaboration among developers.

6.2.3 Protection and Development of Catchments

The catchments area of Kabeli River is 864 square kilometer. The Kabeli River flows with an average rive slope of about 1 in 100 in the vicinity of headwork area. Tawa Khola, Phawa Khola, Inwa Khola are the major tributaries of Kabeli River.

As discussed above, some of the physical, biological and socio economic impacts are of cumulative in Nature. It is in this context, it is very important to categorically identify the roles and responsibilities of each hydropower projects in the basin. It is very important to mention here that the overall ecological balance of the Kabali basin has to be maintained with shared responsibilities. However some responsibilities are at individual level.

KAHEP is committed in complying with all the proposed enhancement and mitigation measures mentioned in the EA report. The KAHEP is committed to maintain the catchments areas of about 1.4 sq. KM areas upstream of dam. For the remaining Kabeli catchments, the project is willing to share the responsibility along with other hydropower developers in the region. Some of the activities to be carried out by KAHEP for this purpose shall be as follows.

- Soil conservation through biological and engineering solutions to reduce sediment load in the reservoir.
- Ecosystem conservation through improvement in water retaining properties of soil.
- Soil and increase in vegetative cover.
- To fulfill fuel and fodder requirements of the local people.
- Integration of the catchment area treatment plan with social and economic activities of the local population through employment generation and community participation.

6.2.4 Address Sedimentation: Initiate Catchment Area Treatment (CAT) Plan

As a shared responsibility, it is advisable that the developers of the Kabeli basin shall work jointly for the overall development of the Kabeli basin. For this purpose a joint Catchment Area Treatment (CAT) plan could be developed. The Catchment Area Treatment (CAT) plan highlights the techniques to control erosion in the Kabeli catchment area. The Kabeli catchment area treatment involves understanding of the erosion characteristics of the terrain and, suggesting remedial measures to reduce the erosion rate. Adequate preventive measures are thus needed for the treatment of Kabeli catchment for its stabilization against future erosion. The Kabeli Catchment Area Treatment Plan has been formulated for free draining catchment i.e. up to the tail water levels of proposed Kabeli River. The catchment area treatment involves understanding of the erosion characteristics of the terrain and, suggesting remedial measures to reduce the erosion rate.

The plan pertains to preparation of a management plan for treatment of erosion prone area of the catchment through biological and engineering measures; however, a comprehensive CAT plan should also include the social dimensions associated directly or indirectly with the catchment. A well-designed CAT plan should not only control the sedimentation of reservoir but should also provide a life support system to the local population through their active involvement. An effective CAT plan of a hydropower project is a key factor to make the project eco-friendly and sustainable. The CAT plan will adhere to **National Water Plan 2005**.

Integrated watershed management aimed at minimizing the sedimentation of reservoir and ecosystem conservation of the catchment area is the prime objective of the Kabeli catchment area treatment, which can be further elaborated as listed below:

- Soil conservation through biological and engineering solutions to reduce sediment load in the reservoir.
- Ecosystem conservation through improvement in water retaining properties of soil.
- No activity buffer zone along the rim f the reservoir may be created to avoid untoward incidences.
- Soil and increase in vegetative cover.
- To fulfill fuel and fodder requirements of the local people.
- Integration of the CAT plan with social and economic activities of the local population through employment generation and community participation.

The Following preventative Engineering and Biological measures shall be suggested for the catchment area treatment:

6.2.4.1 Physical measures

- Step Drain
- Angle Iron Barbed Wire Fencing
- Stone Masonry Wall
- Check Dams
- Stabilization of the disturbed strata so as to ensure regular and sediment free water in the River system.

6.2.4.2 Biological measures

- Development of Nurseries
- Compensatory Plantation/Afforestation
- Social Forestry

The basis of site selection for different biological and physical treatment measures under CAT plan are as follows.

- Social forestry, fuel wood and fodder grass and Pasture development
- To control tree felling near settlements
- Contour bunding to control of soil erosion from agricultural fields. Improvement of vegetation covers in the areas of individual projects within basin.
- Open canopy, barren land, degraded surface
- Afforestation Open canopy, degraded surface, high soil erosion, gentle to moderate slope
- Barbed wire fencing in the vicinity of Afforestation work to protect it from grazing etc.
- Step drain to check soil erosion in small streams, steps with concrete base are prepared in sloppy area where silt erosion in the stream and bank erosion is high due to turbidity of current.
- Centrally located nursery points for better supervision of proposed Afforestation to minimize cost of transportation of seedling and ensure better survival.

The proposed overall Watershed Management Plan of Kabeli Basin developers are as follows:

- Collect bio-physical and socio-economic information on watershed and aquatic system
- Promote involvement of NGOs
- Establish coordination committee to integrate
- Increase Infiltration into Soil;
- Control Excessive Runoff;
- Manage & Utilize Runoff for Useful Purpose
- Check Soil Erosion

6.2.4.3 Modality of Implementation

The working committee shall be formed from the hydropower developers of Kabeli Basin. The CAT plan will be discussed in the committee, and the operational modality for management, fund generation, roles

and responsibilities of each developer shall be decided. The effective implementation of CAT plan is crucial. Their implementation needs to be monitored and its effectiveness ensured.

6.2.5 Future Directions of Shared Responsibilities to Address Cumulative impacts

All the other potential hydropower projects that is going to be constructed in this Kabeli basin should follow strictly the enhancement and mitigation measures as spelled out in IEE/EIA report. Besides, for the overall development of the basin and the region at large, a vision for shared responsibilities shall be developed besides their own commitment in project areas.

Each potential project's social and environmental impacts as spelled out in IEE/EIA of the respective projects must be mitigated in accordance with measures described in EMP. The project resettlement practices should adhere with the resettlement plan.

Since there is no such policy to evaluate the project from the cumulative impact perspective and development of such policies by GoN might take substantial time, a basin specific coordinated approach to address the cumulative impacts could be initiated by the Government in collaboration with the potential developers of the Kabeli basin.

6.2.5.1 Maintain Environmental Flow

Optimal environmental flows should be released from every project keeping in view hydrological requirements of organisms, especially during the dry season and residual flow should be set at a level that is compatible with that the diverted stretch of the river will maintain flows necessary to meet ecological requirements.

6.2.5.2 Religious and Social Aspects

It should be ensured that sites of religious, cultural, and historical importance at the basin level are clearly identified and efforts are made to minimize adverse effects on them on account of the projects.

Regarding water requirements at places of religious importance, their needs on different festivals should be ascertained and the needed quantity of water should be released to meet these needs.

6.2.5.3 Establish Baseline Aquatic Data and Monitor Changes

The baseline aquatic data shall be developed in Kabeli basin. The changes in fish stock and monitoring for recording changes shall be regular. Similarly, the economic evaluation of basin fisheries shall be done.

6.2.5.4 Construction Related Aspects

Suitable dumping sites for disposal of muck generated during construction should be identified well in advance. The dumped muck should be protected by a retaining wall. Other mitigation measures mentioned in approved EA documents of individual projects of basin shall be followed strictly.

6.2.5.5 Shared Infrastructures

The potential developers in Kabeli basin can establish coordination in developing infrastructure such as access roads, power for construction, and transmission lines for power evacuation from Kabeli basin which could help developer to discover potential synergies and minimize cumulative impacts.

6.2.5.6 Proper Planning, Communication and Monitoring

The involvement of local representative in early Kabeli basin side planning, and ensuring good communication about the planning process, can build trust and understanding among all those involved. The local stakeholders of Kabeli basin could participate in monitoring the implementation of environmental management plans, catchment area treatment plans, and other plans to mitigate the environmental and social impacts of development.

6.2.5.7 Introducing Strategic environmental assessment (SEA)

For planning by incorporating CIA aspects, Government should introduce SIA so that environmental considerations will be included into policies, plans, and programs.

ANNEX 1: LIST OF PERSON CONSULTED IN DIFFERENT FGD MEETING

S.N	Name of Person	Position	Address
	Community Forests Users		
1	Mr. Amrit Bahadur Basnet	President, Pancha Kanya Kholi CFUC	Amarpur VDC-6
2	Mr. Indra Narayan Adhikari	Secretary, Pancha Kanya Kholi CFUC	Amarpur VDC-6
3	Mr. Harka Bahadur Thapa	Vice-Secretary, Pancha Kanya Kholi CFUC	Amarpur VDC-6
4	Mr. Dhan Bahadur Tamang	Treasurer, Pancha Kanya Kholi CFUC	Amarpur VDC-6
5	Mr. Dal Bahadur Bhattarai	Member, Pancha Kanya Kholi CFUC	Amarpur VDC-6
6	Mr. Rana Bahadur Hembe	Member, Pancha Kanya Kholi CFUC	Amarpur VDC-6
7	Mr. Bishnu Prasad Katwal	Member, Pancha Kanya Kholi CFUC	Amarpur VDC-6
8	Mr. Krishna Bahadur Poudyal	Member, Pancha Kanya Kholi CFUC	Amarpur VDC-6
9	Mr. Narendra Prakash Shrestha	President, Thulo Dhuseni CFUC	Amarpur VDC-5
10	Mr. Dil Bahadur Waiba	Vice President, Thulo Dhuseni CFUC	Amarpur VDC-5
11	Mr. Ram Prasad Tamang	Secretary, Thulo Dhuseni CFUC	Amarpur VDC-5
12	Mr. Punya Prasad Oli	Vice-Secretary, Thulo Dhuseni CFUC	Amarpur VDC-5
13	Mr. Megendra Tamang	Member, Thulo Dhuseni CFUC	Amarpur VDC-5
14	Mr. Santa Bahadur Pakhrin	Member, Thulo Dhuseni CFUC	Amarpur VDC-5

S.N.	Name	Age	Address			
			District	VDC	Ward No.	Village/ Tole
	Dam site Area					
1	Mr. Dev Bahadur khaling	43	Panchathar	Chakasibote	4	Phakse
2	Mr.Kamal Khaling	45	Panchathar	Chakasibote	4	Phakse
3	Mr.Nar kumar Rai	35	Panchathar	Chakasibote	4	Phakse
4	Mr.Kumar Rai	30	Panchathar	Chakasibote	4	Phakse
5	Mr.Kamal Rai	32	Panchathar	Chakasibote	4	Phakse
6	Mr.Kamal Rai	45	Panchathar	Chakasibote	4	Phakse
7	Mr.Rajendra Shrestha	25	Panchathar	Chakasibote	4	Phakse
8	Mr.Bir Bahadur		Panchathar	Chakasibote	4	Phakse
9	Mr.Milan Rai		Panchathar	Chakasibote	4	Phakse
10	Mr.Chandrapal Manyango		Taplejung	Thechambu	6	Khalte
11	Mr. Rabindra Manyango		Taplejung	Thechambu	7	Khalte
12	Mr. Dev kumar Manyango		Taplejung	Thechambu	8	Khalte
13	Mr. Lila Manyango		Taplejung	Thechambu	9	Khalte
14	Mr. Damodar Koirala		Taplejung	Thechambu	10	Khalte
15	Mr. Milan Rai		Taplejung	Thechambu	11	Khalte
	Kabeli Bazaar Area					
16	Mr. Suresh k. Magar	16	Panchathar	Ambapur	6	Kabeli Bazar
17	Mr. Gopal Khimting	26	Panchathar	Ambapur	6	Kabeli Bazar
18	Mr. Tek Bahadur Magar	25	Panchathar	Ambapur	6	Kabeli Bazar
19	Mr. Tej Bahadur Magar	25	Panchathar	Ambapur	6	Kabeli Bazar

S.N.	Name	Age	Address			
			District	VDC	Ward No.	Village/ Tole
20	Mr. Durga Khatri	17	Panchathar	Ambapur	6	Kabeli Bazar
21	Mr. Ganesh Khatri	40	Panchathar	Ambapur	6	Kabeli Bazar
22	Mr. Surya Hembya	30	Panchathar	Ambapur	6	Kabeli Bazar
23	Mr. Laxmi Hembya	20	Panchathar	Ambapur	6	Kabeli Bazar
24	Mr. Shyam Hembya	23	Panchathar	Ambapur	6	Kabeli Bazar
25	Mr. Bishwaraj Hembya	16	Panchathar	Ambapur	6	Kabeli Bazar
26	Mr. Nirdosh Bhandari	17	Panchathar	Ambapur	6	Kabeli Bazar
27	Mr. Baburam Khatri	35	Panchathar	Ambapur	6	Kabeli Bazar
28	Mr. Birendra Baniya	17	Panchathar	Ambapur	6	Kabeli Bazar
29	Mr.Nima Tamang	17	Panchathar	Ambapur	6	Kabeli Bazar
30	Mr. Ambar Khatri	18	Panchathar	Ambapur	6	Kabeli Bazar
31	Mr. Sher Bahadur Limbu	20	Panchathar	Ambapur	6	Kabeli Bazar
32	Mr. Dhan kumar Tiwari	22	Panchathar	Ambapur	6	Kabeli Bazar
33	Mr. Krishna Adhikari	24	Panchathar	Ambapur	6	Kabeli Bazar
34	Mr. Padma Khatri	30	Panchathar	Ambapur	6	Kabeli Bazar
35	Mr. Sanjay M. Limbu	17	Panchathar	Ambapur	6	Kabeli Bazar
36	Mr. Dal Bahadur Tamang	40	Taplejung	Thechambu	5	Thechambu
37	Mr. Titung Tamang	45	Taplejung	Thechambu	5	Thechambu
38	Mr. Prakash Rai	30	Taplejung	Thechambu	5	Thechambu
39	Mr. Bame Rai	50	Taplejung	Thechambu	5	Thechambu
	Power House site					
40	Mr. Sashidhar Majhi		Panchathar	Ambapur	9	Pinashi
41	Mr. Purna B. Majhi		Panchathar	Ambapur	9	Pinashi
42	Mr. Ganesh Majhi		Panchathar	Ambapur	9	Pinashi
43	Mr. Tika P. Majhi		Panchathar	Ambapur	9	Pinashi
44	Mr. Kedar Majhi		Panchathar	Ambapur	9	Pinashi
45	Mr. Shree Prashad Majhi		Panchathar	Ambapur	9	Pinashi
46	Mr. Tika Ram Majhi		Panchathar	Ambapur	9	Pinashi
47	Mr. Damber B. Majhi		Panchathar	Ambapur	9	Pinashi
48	Mr. Ram kumar Majhi		Panchathar	Ambapur	9	Pinashi
49	Mr. Chapal Shing Majhi		Panchathar	Ambapur	9	Pinashi
50	Mr. Bal kumar Majhi		Panchathar	Ambapur	9	Pinashi
51	Mr. Prashad Shing Majhi		Panchathar	Ambapur	9	Pinashi
52	Mr. Gyan Bahadur Majhi		Panchathar	Ambapur	9	Pinashi

S.N.	Name	Age	Address			
			District	VDC	Ward No.	Village/ Tole
53	Mr. Raj kumar Majhi		Panchathar	Ambapur	9	Pinashi
54	Mr. Kali Bahadur Majhi		Panchathar	Ambapur	9	Pinashi

Annex 1 a: Ethno botanical Uses of Plant species at Kabeli Basin

SN	Scientific Names	Uses Categories						
		M	W. Orn.	F	T	Fw	NTFP	Other
1.	*Abrus precatorius*	√					√	
2.	*Acacia catechu*	√					√	
3.	*Acacia rugata*	√						
4.	*Achyranthes aspera*	√						
5.	*Acorus calamus*	√						
6.	*Adina cordifolia*				√			
7.	*Aeschynanthus*		√					
8.	*Agave americana*						√	
9.	*Ageratum conyzoides*	√						
10.	*Albizzia chinensis*				√			
11.	*Albizzia lebbeck*				√			
12.	*Albizzia procera*				√			
13.	*Alnus nepalensis*				√			
14.	*Alternanthera sessilis*	√						
15.	*Amaranthus spinosus*	√						
16.	*Amaranthus viridis*	√						
17.	*Amomum subulatum*						√	
18.	*Anisomeles indica*	√						
19.	*Annona squamosa*	√						
20.	*Anoegissus latifolia*				√			
21.	*Anthocephalus chinensis*	√						
22.	*Areca catechu*	√						
23.	*Argemone Mexicana*	√						
24.	*Ariesaenma tortuosum*	√						
25.	*Artemisia dubia*	√						
26.	*Artemisia indica*	√						
27.	*Artmemisia vulgaris*	√						
28.	*Asparagus racemosus*	√						
29.	*Atrocarpus heterophyllus*							Fruit
30.	*Atrocarpus lakoocha*			√				Fruit
31.	*Azadiractah indica*	√						
32.	*Bahunia malabarica*			√				
33.	*Bambusa arundinacea*						√	
34.	*Bambusa balcooa*						√	
35.	*Barleria cristata*	√						
36.	*Bassia butyracea*						√	
37.	*Bauhinia bahli*						√	
38.	*Bauhinia purpurea*			√				
39.	*Begonia megaptera*							Orn.
40.	*Begonia nepalensis*							Orn.
41.	*Berberis aristata*	√						
42.	*Berginia ligulata*	√						
43.	*Bischofia javanica*				√			
44.	*Blumea lacera*	√						
45.	*Boehmeria macrophylla*	√						
46.	*Boehmeria rugulosa*						√	
47.	*Boehravia diffusa*	√						

SN	Scientific Names	Uses Categories						
		M	W. Orn.	F	T	Fw	NTFP	Other
48.	*Bombax ceiba*	√					√	
49.	*Bridelia retusa*			√				
50.	*Butea minor*	√						
51.	*Butea monosperma*	√						
52.	*Caesalpinia bonduc*	√						
53.	*Calamus acanthospathus*						√	
54.	*Calamus latifolius*						√	
55.	*Calamus leptospathus*						√	
56.	*Callicarpa arborea*	√						
57.	*Callistemon citrinus*							Orn
58.	*Calotropis gigantea*	√						
59.	*Calotropis procera*	√						
60.	*Camellia sinensis*	√						
61.	*Canabis sativa*	√						
62.	*Cassia fistula*	√						
63.	*Cassia floribunda*	√						
64.	*Cassia occidentalis*	√						
65.	*Cassia sophora*	√						
66.	*Cassia tora*	√						
67.	*Castanopsis indica*				√		√	
68.	*Castanopsis tribuloides*				√			
69.	*Casuarina equisetifolia*							OT
70.	*Cedrella toona*				√			
71.	*Celocea argentea*	√						
72.	*Centella asiatica*	√						
73.	*Cephalostachyum latifolium*						√	
74.	*Chenopodium album*	√						
75.	*Chrysopogon gryllus*			√				
76.	*Cinnamomum glaucescens*						√	
77.	*Cinnmmomum camphora*	√					√	
78.	*Cinnmmomum tamala*	√					√	
79.	*Cissampelos pariera*	√						
80.	*Clerodendron viscosum*	√						
81.	*Coelogyne sp.*							Orn
82.	*Coffea arabica*						√	
83.	*Colquhounia coccinea*		√					
84.	*Commelina benghalensis*	√						
85.	*Costus speciosus*	√						
86.	*Crotolaria pallida*	√						
87.	*Crytomeria japonica (Exoitic Plant)*				√			
88.	*Curculio orchioides*	√					√	
89.	*Cuscuta reflexa*	√						
90.	*Cycas pectinata*						√	
91.	*Cymbidium sp.*		√					
92.	*Cynodon dactylon*	√						
93.	*Cyperus rotundus*	√						
94.	*Cythea spinulosa*	√						
95.	*Dalbergia sissoo*				√			
96.	*Datura metel*	√						

SN	Scientific Names	Uses Categories						
		M	W. Orn.	F	T	Fw	NTFP	Other
97.	*Deeringia amaranthoides*	√						
98.	*Dendrobium pierardi*		√					
99.	*Dendrocalamus giganteus*						√	
100.	*Dendrocalamus hamiltonii*						√	
101.	*Desmodium oojeinensis*				√	√		
102.	*Desmotrichum fimbriatum*	√						
103.	*Dichora febrifuga*	√						
104.	*Didymocarpus leucocalyx*	√						
105.	*Dillenia indica*				√			
106.	*Dillenia pentagyna*				√			
107.	*Dioscorea bulbifera*	√						
108.	*Dioscorea deltoidea*	√						
109.	*Drymaria cordata*	√						
110.	*Dryopteris cochleata*						√	
111.	*Dryopteris filix-mas*	√						
112.	*Duabanga snonneratioides*				√			
113.	*Duranta repens*	√						
114.	*Eclipta prostrate*	√						
115.	*Edgeworthia gardneri*						√	
116.	*Elaeocarpus sphaericus*	√						Rele.
117.	*Elephantopus scaber*	√						
118.	*Englehardtia spicata*				√			
119.	*Entada phaseoloides*						√	
120.	*Equisetum debile*	√						
121.	*Equisetum sp.*	√						
122.	*Eragrostis japonica*			√				
123.	*Eragrostis tenella*			√				
124.	*Erythrina stricta*				√			
125.	*Eugenia formosa*							WE
126.	*Eulaliopsis binita*						√	
127.	*Eupatorium adenophorum*	√						
128.	*Euphorbia hirta*	√						
129.	*Euphorbia pulcherrima*	√						
130.	*Euphorbia royleana*	√						
131.	*Evodia fraxinifolia*	√						
132.	*Ficis hispida*			√				
133.	*Ficus auriculata*			√				
134.	*Ficus benghalensis*							Relig.
135.	*Ficus cunia*			√				
136.	*Ficus hispida*			√				
137.	*Ficus lacor*			√				
138.	*Ficus racemosa*						√	
139.	*Ficus racemosa*						√	
140.	*Ficus religiosa*							Relig.
141.	*Flacourtia jungomas*	√						
142.	*Flickingeria maracrraei*		√					
143.	*Garuga pinnata*			√				
144.	*Girardinia palmata*	√						
145.	*Gossypium herbaceum*						√	

SN	Scientific Names	Uses Categories						
		M	W. Orn.	F	T	Fw	NTFP	Other
146.	*Grewia oppositifolia*			√				
147.	*Hamiltonia suaveolens*	√						
148.	*Holarrena pubescens*	√						
149.	*Hygrophila schulii*	√						
150.	*Hyptis suaveolens*	√						
151.	*Imperata cylindrica*			√				
152.	*Inula cappa*	√						
153.	*Ipomoea aquatica*	√						
154.	*Ipomoea batatus*	√						Food
155.	*Jatropa curcus*	√						Bio Fuel
156.	*Jatropha curcus*	√						
157.	*Juglans regia*	√					√	
158.	*Justicia adhatoda*	√						
159.	*Lagestroemia indica Asare*		√					
160.	*Lantana camara*	√						
161.	*Lawsonia inermis*						√	
162.	*Leucus indica*	√						
163.	*Lindera neasiana*	√						
164.	*Litsea lancifolia*	√						
165.	*Litsea monopetala*			√				
166.	*Lobelia pyramidalis*	√						
167.	*Luculia gratissima*		√					
168.	*Lycopodium clavatum*	√					√	
169.	*Lyonia ovalifolia*	√						
170.	*Macaranga pustulata*				√			
171.	*Machilus odorattissima*				√		√	
172.	*Madhuca longifolia*							Fruit
173.	*Mahonia napaulensis*	√						
174.	*Mallotus philippinensis*	√						
175.	*Mangifera indica*	√						Fruit
176.	*Melastoma malabathrium*	√						
177.	*Melia azadiractah*	√						
178.	*Michelia champaka*				√			
179.	*Mimosa pudica*	√						
180.	*Momordica charantia*	√						
181.	*Moringa oliefera*	√					√	
182.	*Morus australis*	√						
183.	*Mucuna pririens*	√						
184.	*Murraya koenigii*						√	
185.	*Musa balbisiana*							WE
186.	*Mussaenda frondosa*	√						
187.	*Myrica esculenta*							WE
188.	*Nelumbo nucifera*							Orn.
189.	*Nephrolepis cordifolia*						√	
190.	*Neruim indicum*		√					Orn.
191.	*Nyctanthes arbo-tristis*	√						
192.	*Nymphea nouchali*							Orn.
193.	*Ocimum americana*	√						

SN	Scientific Names	Uses Categories						
		M	W. Orn.	F	T	Fw	NTFP	Other
194.	*Ocimum bacilicum*	√						
195.	*Ocimum sanctum*	√						
196.	*Ocimum tenuiflorum*	√						
197.	*Operculina turpetum*	√						
198.	*Oroxylon indicum*						√	
199.	*Osbeckia nepalensis*		√					
200.	*Osbekia stellata*		√					
201.	*Otochilus lancilabius*		√					
202.	*Oxalis corniculata*	√						
203.	*Oxyspora paniculata*		√					
204.	*Panadanus nepalense*							Rare
205.	*Pavetta indica*	√						
206.	*Pergularia daemia*	√						
207.	*Perilla fruitiscens*							Food
208.	*Phlogacanthus thrysiflorus*		√					
209.	*Phoenix humilis*						√	WE
210.	*Phyla nodoflora*	√						
211.	*Phyllanthus emblica*	√						
212.	*Pinus roxburghii*				√		√	
213.	*Piper chaba*	√						
214.	*Piper longum*	√						
215.	*Piper nigrum*	√						
216.	*Pistia stratiotes*	√						
217.	*Pithocellobium dulce*	√						
218.	*Plumeria rubra*		√					
219.	*Pogonantherum paniceum*			√				
220.	*Pogostemon benghalensis*	√						
221.	*Polygonum hydropiper*	√						
222.	*Polygonum barbatum*	√						
223.	*Polygonum molle*	√					√	
224.	*Premna barbata*			√				
225.	*Prunus cerasoides*						√	Orn.
226.	*Psidium guajava*	√						Fruit
227.	*Pterocarpus santalinus*	√					√	
228.	*Quercus glauca*				√			
229.	*Quercus languinosa*				√			
230.	*Rauvolfia serpentina*	√						
231.	*Reinwardtia indica*	√						
232.	*Rhododendron arboreum*		√					NF
233.	*Rhus javanica*						√	
234.	*Rhus parviflora*						√	
235.	*Ricinus communis*	√						
236.	*Rouwolfia serpentine*	√						
237.	*Rubia manjith*	√						
238.	*Rubus ellipticus*							WE
239.	*Rumex vesicarius*	√						
240.	*Saccarum spontaneum*						√	
241.	*Sambucus hookeri*							Orn
242.	*Sapindus mukorossi*						√	

SN	Scientific Names	Uses Categories						
		M	W. Orn.	F	T	Fw	NTFP	Other
243.	*Sapium insigne*						√	
244.	*Saurauia napulensis*			√				
245.	*Schima wallichii*				√	√		
246.	*Schleichera oleosa*							Fruit
247.	*Shorea robusta*				√		√	
248.	*Sida acuta*	√						
249.	*Sida rhombifolia*	√						
250.	*Sida spinosa*	√						
251.	*Smilax macrophylla*	√						
252.	*Smilax ovalifolia*						√	
253.	*Smilax zeylanica*						√	
254.	*Solanum angulvi*	√						
255.	*Solanum aquileatissimum*	√						
256.	*Solanum nigrum*	√						
257.	*Solanum torvum*	√						
258.	*Solanum xanthocarpum*	√						
259.	*Spondias pinnta*							WE
260.	*Stephania japonica*	√						
261.	*Swertia chirayita*	√						
262.	*Syzygium jambos*							WE
263.	*Syzyzium cuminii*						√	
264.	*Syzyzium operculatum*						√	
265.	*Tamarindus indica*	√						
266.	*Tamarix dioica*	√						
267.	*Tectona grandis*				√			
268.	*Telosma pallida*	√						
269.	*Terminalia alata*				√			
270.	*Terminalia bellirica*	√						
271.	*Terminalia chebula*	√						
272.	*Terminalia myriocarpa*				√			
273.	*Themeda triandra*						√	
274.	*Thevetia peruviana*	√						
275.	*Thysanolaena maxima*						√	
276.	*Tinospora cordifolia*	√						
277.	*Toona ciliata*	√			√			
278.	*Tragia involucrata*	√						
279.	*Typha angustifolia*						√	
280.	*Urtica dioca*	√					√	
281.	*Valeriana wallichii*	√						
282.	*Vetiveria zizanoides*	√					√	
283.	*Viscum artuculatum*	√						
284.	*Viscum sp.*	√						
285.	*Vitex negundo*	√						
286.	*Vitis repens*	√						
287.	*Woodfordia fruticosa*	√					√	
288.	*Zanthixylum armatum*	√					√	
289.	*Zizyphus mouritaniana*	√						Fruit

Note: M=Medicinal, Orn.=Ornamental, F=Fodder, T=Timber, Fw=Fulewood, NTFP=Non Timber Forest Products, W. Orn.= Wild ornamental, WE= Wild Edible, NF= National flower, OT= Ornamental Tree

Annex 1 b : Agro-biodiversity of the Kabeli Basin

A. Cereal Crops, Legumes, Vegetables, Spices and Fruits

SN	Local Name	English Name	Botanical Name	Local Varieties
1.	Dhan	Rice	*Oryza sativa*	Gauriya, Kanti, Dhusuri, , Bhadaiya, Sataraj, Chhoti, Pokhreli, Atte, , Tauli, , Khumal, Bhangeri, Darmi, Chirankhe Basmati Belguti, Lekali, Raduwa, Naniya, Chulthe, Phaudel, Seti, Jamaute, Junghe, Politar, Radha-12, Radha-17, Radha-4, Sabitri, Champhasari, Bhutane, Mansuli, Aumasuli, Borunge, Sanomasuli, Thulomasuli, Ranjit, Biju
2.	Gahun	Bread wheat	*Triticum aestivum*	Rato, Seto, Mudule, Lerma-52, RR-21, Makwanpur
3.	Jau	Barley	*Hordeum vulagre*	
4.	Makai	Maize, Indian, corn	*Zea mays*	Hiude, Barkhe, Khumal, Madise, Seto, Murali, Paheli, Sathiya, Juneli, Kalo, Chepti, Kukhure
5.	Kodo	Finger millet	*Eleusine coracana*	Mudke/Chhakre (Mansire), Nangkatuwa, Paudure, Madise, Muste (Asare)
6.	Phapar (Tite)	Common Buckwheat	*Fagopyrum esculentum*	
7.	Phapar (Mithe)	Tatary Buckwheat	*Fagopyrum tataricum*	
8.	Bhatmas	Soyabean	*Glycine max*	Khairo, Kalo, Seto
9.	Gahat	Harsegram	*Dolichus biflorus*	
10.	Rahar	Pigeon pea	*Cajanus cajan*	
11.	Bakulla Simi	Broad bean	*Vicia faba*	
12.	Chana	Gram	*Cicer arietinum*	

SN	Local Name	English Name	Botanical Name	Local Varieties
13.	Mas	Black gram	*Phaseolex mungo*	Kalo, Pahelo, Banmara (Rato)
14.	Masyang	Ricebean	*Vigna calcarata*	Pahelo, Kalo, Rato
15.	Thulo Kerau	Garden Pea	*Pisum sativum*	
16.	Bodi	Cowpea	*Vigna unguiculata*	Hade, Tune, Kattike, Bose, Kalo, Seto, Jare, Makai
17.	Simi	Common bean	*Phaseolus sp.*	Ghiu, Hade, Hiude, Barkhe, Seto, Rato, Kalo, Pothra, Bose
18.	Pharsi	Vegetable gourd	*cucurbita pepo*	Lamche, Madise, Dalle, Madale, Squash
19.	Iskus	Chayote	*Sehium edule*	
20.	Pyaj	Onion	*Allium cepa*	
21.	Lasun	Garlic	*Allium sativum*	
22.	Banda	Cabbage	*Barssica oleracea var capitata*	
23.	Kauli	Cauli flower	*Brassica oleracea var botrytis*	
24.	Golbhenda	Tomato	*Lycopersicon esculentum*	
25.	Brokauli	Sprouting broccoli	*Brassica oleraceae*	italica
26.	Chamsur	Garden cress	*Lepidium sp.*	
27.	Bethe	Lamb's quartar	*Chenopodium album*	
28.	Dhaniya	Coriander	*Coriandrum sativum*	
29.	Barela		*Momordica balsamina*	
30.	Kubbindo	Ash gourd	*Benincasa hispida*	
31.	Parwal		*Trichosanthes dioica*	
32.	Sahijan	Drum stick	*Moringa oleifera*	
33.	Ram Toriya	Lady's Finger	*Hibiscus esculentus*	
34.	Bhanta	Brinjal	*Solanum melogena*	

SN	Local Name	English Name	Botanical Name	Local Varieties
35.	Tori	Mustard	*Brassica compestris*	
36.	Gajar	Carrot	*Daucas corota*	
37.	Phul Tarul		*Canna sp.*	
38.	Simal Tarul		*Manihot esculentus*	
39.	Sakar Khanda	Sweet Potato	*Ipomea batatus*	
40.	Rayosag	Leaf Mustard	*Brassica juncea*	
41.	Mula	Radish	*Raphanus sativxs*	
42.	Alu	Potato	*Solanum tuberosum*	Rato, Seto
43.	Ghiraula	Sponge gourd	*Luffa cylindrica*	
44.	Chichindo	Snake gourd	*Trichosanthes anguina.*	
45.	Tite Karelo	Bitter gourd	*Momordica charantia*	
46.	Lauka	Bottle guard	*Legenaria siceraria*	
47.	Chhyapi	Shallot	*Allium ascalouicum*	
48.	Pindalu	Co-Co Yam	*Colocasia antiquorum*	
49.	Kakro	Cucumber	*Cucumis sativus*	Pahadi, Hariyo, Seto
50.	Aduwa	Ginger	*Zingiber officinale*	
51.	Besar	Turmoric	*Curcuma domesitca*	
52.	Khursani	Hot Pipper	*Capsicum anum*	Dalle, Akabare, Lamche, Jire, Madise, Hybrid Akabare
53.	Ukhu	Sugarcane	*Saccharum officinarum*	
54.	Silam	Perilla	*Perilla frutescens*	
55.	Philingo	Niger	*Guizotia abyssinica*	
56.	Latte Dana		*Amaranrhus sp.*	
57.	Kurilo	Garden Asparagus	*Asparagus officinalis*	
58.	Alainchi	Big Cardamom	*Amomum subulantum*	

SN	Local Name	English Name	Botanical Name	Local Varieties
59.	Til	Sesame	*Sesamum indicum*	
60.	Methi	Fenu-greek	*Trigonella* sp.	
61.	Marich	Black pepper	*Piper nigram*	
62.	Pan	Betel vine	*Piper betel*	
63.	Pudina	Mint	*Mentha* sp.	
64.	Chiya	Tea	*Thea chinensis*	
65.	Kafi	Coffee	*Coffea arabica*	
66.	Pipla	Long pepper	*Piper longum*	
67.	Badam	Pea nut	*Arachis hypogea*	
68.	Anp	Mango	*Mangifera indica*	
69.	Amba	Gauva	*Pisidium gaujava*	
70.	Mewa	Papaya	*Carica papaya*	
71.	Kera (Kola)	Banana	*Musa Paradisicca*	Local, Dhusure, Mungre, Kurkure, Chille, Jhapri, Malbhog
72.	Suntala	Orange(Mandarin)	*Citrus reticulata*	
73.	Nibuwa	Lemon	*Citrus limon*	
74.	Bhogate	Pummello	*Citrus grandis*	
75.	Tainga (like Bhogate)	Pummello	*Citrus* sp.	
76.	Jyamir	Rough Lemon	*Citrus junos*	Kalijyamir, Setijyamir, Naitejyamir
77.	Aru	Peach	*Prunus persica*	
78.	Alubakhara	Plum	*Prunus domestica*	
79.	Naspati	Pear	*Pyus communis*	
80.	Amala	Indian Gooseberry	*Phylanthus emblica*	
81.	Harro	Maryobalon	*Terminalia chebula*	
82.	Barro	Maryabalon	*Terminalia bellirica*	

SN	Local Name	English Name	Botanical Name	Local Varieties
83.	Aiselu	Himalayan yellow Raspberry	*Rubus ellipticus*	
84.	Kafal	Bay-berry	*Myrica esculenta*	
85.	Amaro		*Spondias pinnata*	
86.	Tarul	Wild yam	*Dioscorea sp.*	
87.	Angeri		*Osbekia sp*	
88.	Chiuri		*Bassira butyraca*	
89.	Kagati	Lime	*Citrus medica*	
90.	Mosam	Sweet Orange	*Citrus cinensis*	
91.	Lapsi		*Choerospondias axillaries*	
92.	Lichi		*Litchi chinensis*	
93.	Katahar	Jack Fruit	*Atrocarpus heterophyllus*	
94.	Bhuinkatahar	Pineapple	*Ananus comosus*	
95.	Salifa	Custard Apple	*Annona squamosa*	
96.	Angoor	Grape	*Vitis vinifera*	
97.	Bel	Bengal quince	*Aegel marmelos*	
98.	Avocado	Avocado	*Persea americana*	

B. Fodder Plants

SN	Local Name	English Name	Botanical Name	Local Varieties
1.	Amriso		*Thysanolaena maxima*	
2.	Kutmiro		*Litsea monopetala*	
3.	Badahar		*Atrocarpus lakoocha*	
4.	Bans	Bamboo	*Dendrocalamus spp., Bambusa spp*	Choyabans, Malabans, Bhalubans, Banabans, Raithuri, Gophabans, Patali etc.

5.	Khanayo		*Ficus cunia*	
6.	Kabhro		*Ficus lacor*	
7.	Nibharo		*Ficus auriculata*	
8.	Khari		*Celtis australis*	
9.	Tanki		*Bauhinia purpurea*	
10.	Syalphusro		*Grewia oppositifolia*	
11.	Koiralo		*Bauhinia variegata*	
12.	Salimo		*Chrysopogan gryllus*	
13.	Kharuki		*Pogonantherum* sp.	
14.	Banso	Crab grass	*Digitaria ciliaris*	
15.	Dudhilo		*Ficus nerifolia*	
16.	Gayo		*Bridela retusa*	
17.	Gineri		*Premna barbata*	
18.	Siris		*Albizzia* spp.	
19.	Amriso		*Thysanolaena maxima*	
20.	Narkat		*Pharagmitis karka*	
21.	Bar		*Ficus benghalensis*	
22.	Gogan		*Saurauia napaulensis*	
23.	Kimbu		*Morus alba*	
24.	Khamari		*Gmelina arborea*	
25.	Padari		*Stereospermum personatum*	
26.	Dabdabe		*Garuga pinnata*	

C. Timber/Fuelwood

S.N.	Local Name	English Name	Botanical Name	Local Varieties
1.	Painyu		*Prunus cerosoides*	
2.	Agrakh / Sakhuwa / Sal		*Shorea robusta*	

3.	Chanp		*Michelia champaca*	
4.	Chilaune		*Schima wallichii*	
5.	Sallo	Pine	*Pinus roxburghii*	
6.	Utis		*Alnus nepalensis*	

D. Others

S.N.	Local Name	English Name	Botanical Name	Local Varieties
1.	Babiyo		*Eulaliopsis pinnata*	
2.	Kapas	Cotton	*Gossypium arboretum*	

Annex 1 c: Coldwater Fish Species in Koshi River Basin

SN	Common Name	Scientific Name
1.	Mahseer	*Tor putitora*
2.	Sahar	*Tor tor*
3.	Katle	*Neolissocheilus hexagonolepis.*
4.	Fageta	*Barilius bendelisis, B. vagra, B. barila, B. barna, B. jalkapoorei*
5.	Patharchatti/kubre	*Chagunius chagunio*
6.	Stone roller	*Garra gotyla, G. annandalei, G. lamta*
7.	Thed/theind	*Labeo angra, L. dero*
8.	Karange	*Puntius sophore, P. ticto*
9.	Buche asala	*Schizothorax molesworthi, S. plagiotomus,*
10.	Chuche asala	*Schizothoraichthys annandalei, S. progastus*
11.	Stone carp	*Psilorhynchus pseudecheneis*
12.	Loach	*Noemacheilus bevani, N. rupicola, N. scaturigina*
13.	Jalkapur	*Clupisoma garua*
14.	Gonch	*Bagarius bagarius*
15.	Sucker catfish	*Glyptothorax cavia, G. horai, G. telchitta, G. trilineatus*
16.		*Pseudecheneis sulcatus*
17.		*Corsscheilus latius*
18.		*Danio aequipinnatus, D. devario, D. rerio*