3. METHODOLOGY

3.1 INTRODUCTION

The DEMP was prepared in accordance with its scope and objectives defined in the ToR and subsequently refined by the TAG. Starting off with desk studies, the study focused on validating, updating and augmenting the findings of the PMP EIA to prepare the basis for developing the DEMP. Additional studies and investigations required for further detailing of the EIA-level EMPs were also conducted. Thereafter, the results from these studies were compiled and analyzed to reassess, confirm and elaborate project impacts identified in the EIA. Using these impacts as the underlying basis, mitigation measures and management plans were formulated and detailed, and requisite implementing, monitoring and auditing mechanisms were established.

Several general guiding principals were observed throughout the preparation of the DEMP. The PMP DPR (EDC, 1995) and related documents (PACO, 1991; PACO, 1992a; PACO, 1992b) were adopted as the technical basis for the DEMP, and no further technical analyses were performed during the present study. Likewise, the PMP EIA, which is presently under the process of approval, was adopted as the basic environmental platform for the DEMP.

3.2 DESK STUDIES

At the outset, desk studies were conducted to comprehend the project and its associated environmental issues. The principal project features were studied from technical reports on the PMP, including those on field investigations (PACO, 1991), additional services (PACO, 1992a), project definition study (PACO, 1992b) and detailed engineering design (EDC, 1995). Likewise, information on the baseline environmental and social conditions of the project area, potential impacts of the project on these conditions and the proposed EMP for implementing mitigation and monitoring measures were derived from the PMP EIA report (WRC, 2011a; WRC, 2011b; WRC, 2011c; WRC, 2011d).

For updated information on the PMP project-area environment, published and unpublished literature, including periodicals, journals, books, reports and sectorial profiles published by governmental and non-governmental organizations, were collected, compiled and reviewed. In addition, reports on EMPs and resettlement and rehabilitation plans of large hydropower projects, particularly those with reservoirs, were studied to gain knowledge on international best practices on proper environmental management. These projects included the Tehri Hydropower Project, India (IIT Roorkee, 2008), Three Gorges Dam Project, China (Lan, 1999; Kretschmer; Heggelund, 2006), West Seti Hydroelectric Project, Nepal (WSH, 2008b),

Trong Son Hydropower Project, Vietnam (TSMB, 2011), Nam Ngum 5 Hydropower Project, Vietnam (DSC, 2007), Bajoli Holi Hydroelectric Project, India (RSET, 2010), etc.

In order to ensure compliance with regulatory requirements and obligations, various acts, policies, rules, regulations and guidelines published by national and international agencies were reviewed and their relevant provisions noted. These documents included national environment-related legislations (GoN, 1997a; GoN, 1997b), national and international guidelines on environmental studies (WB, 1999; ADB, 2003; NPC, 1993), sustainability guidelines (IHA, 2004), policies and manuals of donor agencies (WB, 2001; WB, 2005; ADB, 2006; ADB, 2010), Convention 169 of International Labor Organization (ILO, 1989) and resettlement and rehabilitation policies and practices in Nepal and India (GoI, 2007).

3.3 PROJECT IMPACT AREA DELINEATION

For consistency, the delineation of the project impact areas established in the PMP EIA was maintained for the DEMP as well. Accordingly, the following definitions of the project area and its impact zones was used for the DEMP:

Project area	VDCs/municipalities affected by the reservoir and other project structures
Core project area	Land and settlements facing submergence by the reservoir (up to El. 700 m amsl) or resettlement due to construction of project facilities and infrastructure
Direct Impact Zone (DIZ)	Project areas subject to dislocation of people and subsequent resettlement and rehabilitation *and/or* dislocation of market centers, community facilities, built-up structures and religious and cultural sites, requiring relocation and reestablishment *and/or* irreversible losses to natural resources, requiring reestablishment elsewhere
Indirect Impact Zone (IIZ)	Project areas where people could partially lose their lands, houses and other assets/properties temporarily or permanently and require compensation *and/or* lose dependable natural resource bases, such as forest, grazing land, water source, requiring reinstatement in their areas *and/or* be partially or fully deprived of market centers, community facilities, built-up structures and religious and cultural sites due to their submergence in the reservoir area *and/or* be dislocated due to permanent project structures

In the above definitions, the distinction between DIZ and IIZ lies in the magnitude and extent of impacts. The DIZ essentially comprises the reservoir area, areas to be occupied by the permanent structures and facilities, borrow areas and quarry sites, spoil disposal areas, access roads to various sites, etc.

The project area, as defined above, is shown in Figure 3-1. In all, one municipality and 13 VDCs of Baitadi and 12 VDCs of Darchula fall within the project area.

Settlements of the project area that fall in the DIZ are listed in Table 3-1. As shown, a total of 107 settlements, consisting of 56 from Baitadi and 51 from Darchula, are present within the DIZ. These settlements are spread across one municipality and 97 VDCs. Six VDCs in Baitadi and three in Darchula fall completely within the IIZ.

Figure 3-1: PHD project area

3.4 PROJECT AFFECTED FAMILIES

The definitions of Project Affected Families (PAFs) and Severely Project Affected Families (SPAFs) for the DEMP were adopted from the PMP EIA. Accordingly, PAFs were taken as families affected *either* by the involuntary taking of land that results in relocation or loss of shelter, loss of assets or access to assets or loss of income sources or means of livelihood, whether or not the affected persons must move to another location, *or* by the involuntary restriction of access to legally designated parks and protected areas, resulting in adverse impacts on the livelihoods of the displaced persons. Likewise, SPAFs were considered as those families that would *either* be physically displaced from their residences or commercial establishments *and/or* severely affected due to loss of agricultural lands.

Table 3-1: Settlements within DIZ

SN	Project-affected Municipality/VDCs	Settlements in DIZ	
		Name	No.
Darchula			
1	Bohorigaun	Dewal	1
2	Dadakot	Kamedpani	1
3	Dattu	Bet, Chuchhai, Dattu and Udai	4
4	Gokuleshwar	Baskot, Debal, Dhanakheti, Gajari, Gokuleshwor, Kumali, Nayal, Sansera and Sinyadi	9
5	Kharkada	Bachpali	1
6	Lali	Aurpali, Bagarpata, Bamtad, Bhulhali, Eklegada, Garali, Garudani, Gaujegada, Jangal, Khamtad, Killali, Lali, Maichi, Radam, Ratauda, Salani and Tallo Makanna	17
7	Rithachaupata	Ganet	1
8	Sarmauli	Bayalbata, Bharadkot, Chauda, Chuchebagar and Khetali	5
9	Uku	Amtola, Baku, Dinsi, Jadani, Joljibi, Kuchakot, Kurjyani, Pithi, Saleti, Selpya, Shantipur and Uku	12
10	Dethala	–	0
11	Bhagawati	–	0
12	Shankarpur	–	0
	Total		**51**
Baitadi			
1	Amchaura	Binayak, Jangaltada, Kaiyanpani, Marthala,	4
2	Dasarathchand Municipality	Bakwana, Baram, Baujerasera, Bhekkar, Dalibagar, Jadabagar, Jebalisera, Jhulaghat, Kharyani, Kutiyasera, Majhsera, Matela, Naltadi, Naulegaun, Raktadi, Ratamata, Satpali, Sera, Singtari	19
3	Dilasaini	Darkhet and Naginiserajajar	2
4	Giregada	Ballar, Manail and Tarakot	3
5	Gokuleshwar	Banga Bagar, Betalthala, Chausera, Deojhadi, Kalchaude	5
6	Nwali	Chauda, Salsena	2
7	Pancheshwar	Aptyad, Chamtada, Devkot, Dumnola, Melsipu, Sugarikhal, Dumarikhan, Ganakatya, Lek/Paladi, Rolghat, Siunani, Suryakhal	12
8	Sittad	Amaltad, Chamtada, Desada, Deuli, Grippal, Kanset, Keladi (Sada), Panjyunaya, Sauda	9
9	Rim	–	0
10	Nagarjun	–	0
11	Rodidewal	–	0
12	Shreekedar	–	0
13	Rudreshwar	–	0
14	Kulau	–	0
	Total		**56**

3.5 FIELD SURVEYS AND INVESTIGATIONS

Field surveys and investigations for baseline data collection were conducted at various stages during the preparation of the DEMP. These activities are summarized in Table 3-2 and further elaborated in relevant sections.

Table 3-2: Field surveys and investigations for DEMP

SN	Period	Survey/investigation
1.	June 3 – 27, 2012	Land use and land cover surveys
		Water quality sampling
		Air quality observations
		Solid waste management surveys
		Biodiversity, wildlife and forestry sampling
		Fisheries and aquatic resources sampling
		Medicinal plant sampling
		Household questionnaire survey
		Agricultural survey
2.	September 26 – October 14, 2012	Soil sampling
		Geological surveys for land instabilities
		Water quality sampling
		Air quality observations
		Solid waste management surveys
		Fisheries and aquatic resources sampling
		Medicinal plant sampling
		Video documentation
3.	April 18 – 27, 2013	Additional socioeconomic studies

3.6 TOPOGRAPHY AND LANDSCAPE

The topographical features and landscape of the project area were studied from 1:25,000 and 1:50,000 scale topographic maps prepared by the Department of Survey, GoN, satellite imageries and project area maps included in the PMP DPR (EDC, 1995). To the extent possible, the recorded features were verified through visual observations during field visits.

3.7 CLIMATE AND METEOROLOGY

Climatological studies were conducted to establish meteorological parameters required for formulating management plans for forestry, agriculture, floriculture and medicinal plants. To this end, meteorological data for the project area and its surroundings were collected from climatological records published by the Department of Hydrology and Meteorology (DHM), GoN (DHM, 2009). It should be noted that the PMP DPR (EDC, 1995) also contains meteorological data collected at meteorological stations established at the PHD site in India and Nepal. However, these data cover a limited period (1989 to 1992 in Nepal and 1982 to 1990 in India) and show significant variations. As such, they were not used for generating meteorological parameters for the present study.

DHM operates 25 meteorological stations in the Mahakali Basin and its surrounding areas. Of these, 15 stations (Table 3-3, Figure 3-2) have relatively good precipitation data spanning across 30 years (1976-2005). However, only three of the stations have temperature records. As such, precipitation and temperature data from these stations were used for the present studies (Appendix A).

Using the database from 15 rainfall stations, the spatial and temporal distributions of rainfall in the Mahakali Basin were studied, and isohyet maps for the project area were generated. In view of the limited recorded temperature data available, the mean maximum and minimum temperatures for the basin were estimated from temperature-altitude relations developed for the far-western region and corroborated with the corresponding recorded data at the three stations. Thereafter, isotherms for the entire basin were generated using the aforementioned relationship. In addition, the mean monthly evapotranspiration for the basin was estimated

using the modified Penman-Monteith equation, considering data on mean monthly temperature, relative humidity, wind speed and sunshine hours.

Table 3-3: Meteorological stations in project area and its surroundings

Index	Location	Latitude (N)	Longitude (E)	Altitude (m)
101	Kakerpakha	29°39'	80°30'	842
102	Baitadi	29°33'	80°25'	1,635
103	Patan (West)	29°28'	80°32'	1,266
104	Dadeldhura	29°18'	80°35'	1,848
108	Satbanjh	29°32'	80°28'	2,370
201	Pipalkot	29°37'	80°52'	1,456
202	Chainpur (West)	29°33'	81°13'	1,304
203	Silgadhi (Doti)	29°16'	80°59'	1,360
205	Katai	29°00'	81°08'	1,388
206	Asara Ghat	28°57'	81°27'	650
207	Tikapur	28°32'	81°07'	140
208	Sandepani	28°45'	80°55'	195
209	Dhangadhi (Attariya)	28°48'	80°33'	187
212	Sitapur	28°34'	80°49'	152
214	Kola Gaun	29°07'	80°41'	1,304
217	Mangalsen	29°09'	81°17'	1,345

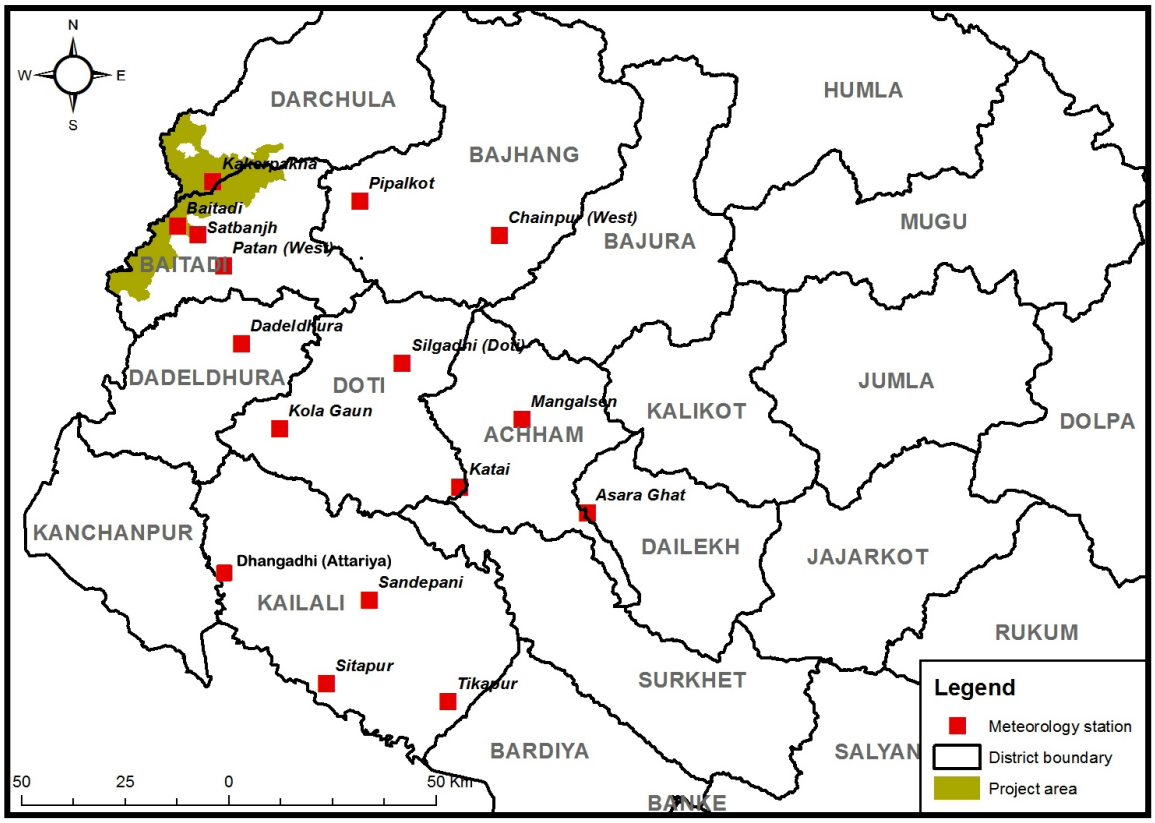

Figure 3-2: Hydrological and meteorological stations in project area and surroundings

3.8 LAND USE AND LAND COVER SURVEYS

Land cover and land use in the project area were analyzed using geographic information systems (GIS) and remote sensing techniques. For this purpose, a recent land use map of the entire project area was prepared using Red Edge imagery (Figure 3-3), with the image geo-referenced using 1:25,000 scale topographic maps in the Modified Universal Transverse Mercator (MUTM) map projection. Primary data for preparing the land cover/use map of the project area were collected through GPS-based land cover/use surveys at 372 sample points and subsequently verified with local residents. Secondary data sets needed for the map related to land use, drainage, contours, administrative boundaries, settlements, roads, etc. were acquired in digital and analog formats from the Survey Department, GoN, and through 1:25,000 scale topographical maps.

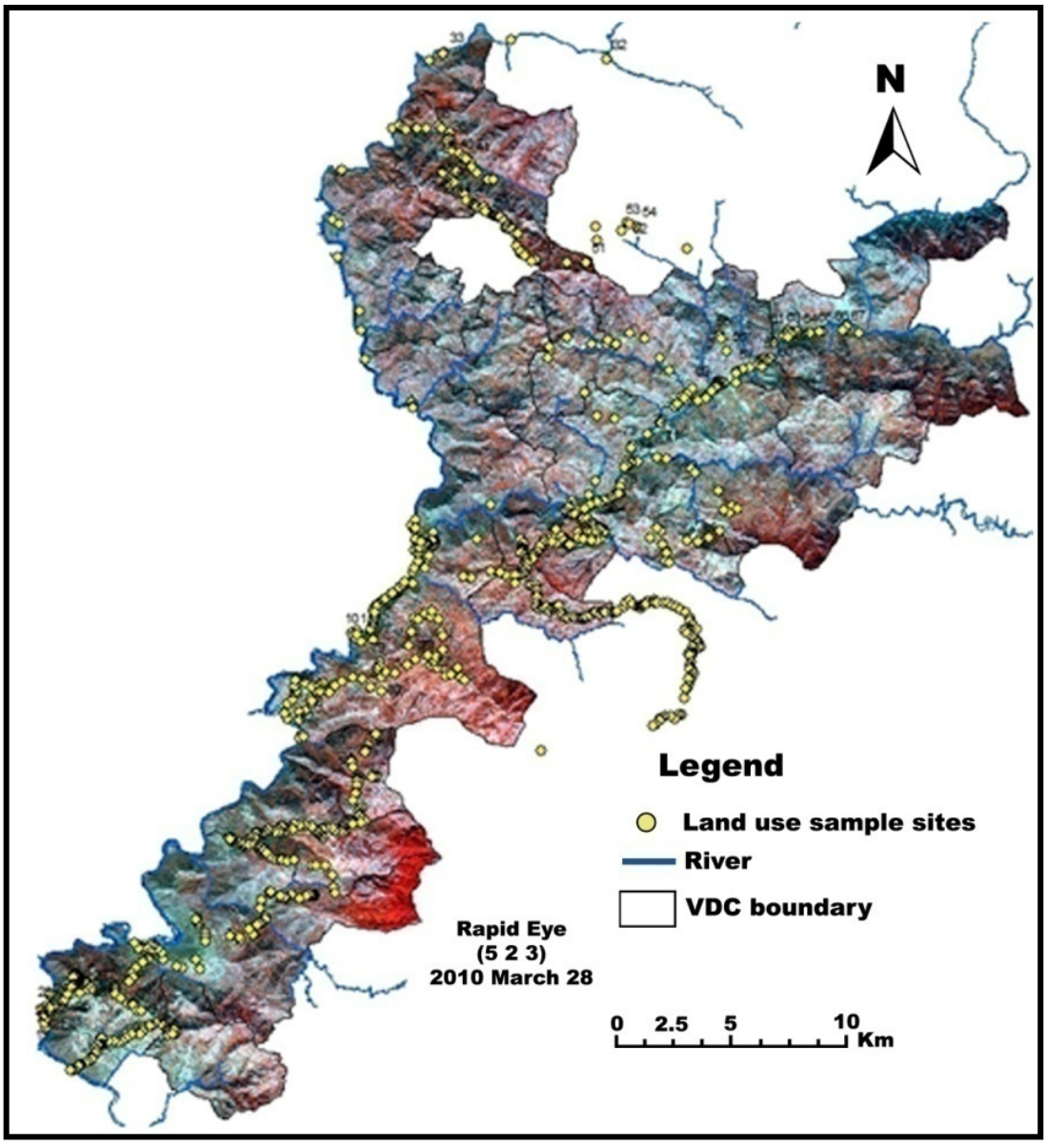

Figure 3-3: Red edge satellite imagery

3.9 LAND STABILITY STUDIES

Land stability studies were conducted to document existing land instabilities in the project area and to identify and classify the potential zones of instabilities resulting from fragile geology and/or reservoir fluctuation. The results of these studies were used to analyze the potential impacts of the identified instabilities, or unstable hazards-prone areas, and propose suitable mitigation measures to safeguard them.

To initiate the land stability studies, detailed geological and geomorphological surveys were conducted to validate and update the baseline geological information of the project area. For this purpose, the available geological information was compiled from the PMP DPR (EDC, 1995), PMP field investigation reports (PACO, 1991) and the PMP EIA (WRC, 2011c). In addition, available regional geological maps (SD/GON, 1984), publications on the regional geology of far-western Nepal (Ganser, 1964; Hashimoto, Ohta, & Akiba, 1973; Kizaki, 1987; UN, 1993), aerial photographs and satellite images were reviewed to verify and update the available information. Based on the updated information, an initial report on the geological conditions of the dam site, reservoir area and other structural sites was compiled, and a preliminary landslide distribution map for the project impact zone was prepared on 1:50,000 topographic base maps.

Following the desk studies, field studies were conducted in the reservoir area along Mahakali and Chameliya rivers to study its geology and geomorphology. As part of these studies, the distribution of lithological rock units, weak or fault zones, bedding/foliation planes, joints, colluviums and alluviums along the survey route were mapped and verified. In addition, the existing hazard sites along the route were mapped, and the geological, geomorphological, hydrogeological and socioeconomic conditions at or around each hazard site were recorded. At each site, the nature, type, scale and dominant mechanism of the slides were noted for further analysis. Each type of rock or soil mass exposed along the survey route was also rated for landslide hazard.

Based on information from the desk and field studies, an inventory of existing landslides, showing their physical, geological, geomorphological and hydrological characteristics, was prepared. The locations of these landslides were also marked on existing geological maps.

A landslide hazard zonation (LHZ) map for the reservoir fluctuation zone was prepared using an empirical approach that classifies the hazard potential of a particular slope through a relative rating scheme that takes into account the major inherent causative factors of slope instability, such as lithology, slope geometry, relative relief, land use/cover and hydrological conditions, and external factors such as rainfall and seismicity (refer Appendix B for details). In order to employ this method for hazard zonation, site-specific causative parameters were checked, analyzed and evaluated at 40 sites along the Mahakali and Chameliya Rivers. The relative hazard rating and hazard classification thus derived for these sites were plotted on geological maps of the project area, and zones of equal hazards were demarcated.

3.10 SOIL STUDIES

Soil studies were conducted to determine the general distribution and basic characteristics of soils present in the project area. For this purpose, an extensive soil investigation program was executed in the project area, and laboratory tests were performed on the extracted soil samples to determine their physical and chemical properties. Thereafter, a soil map of the project area was prepared through interpretation and correlation of field observations and laboratory data. This map was used to delineate soil zones suitable for different land uses.

The soil investigation program was designed considering the close relationship between soils and topography as well as the important influence of climate on the soil characteristics and their suitability for different land uses. In order to model the soil-topography relationship, topography was characterized by landforms, comprising geomorphological units with a characteristic slope. The climate component of the relationship was introduced through the known correlation in Nepal between temperature, a major climatic parameter, and ground elevation. Thus, the soil investigation was based on a soil-landform-elevation relationship.

For modeling the above relationship, a landform map of the project area was prepared through detailed interpretation of digital maps. Different landforms and land units were delineated in this map based on criteria set forth by the Land Resource Mapping Project

(LRMP). In doing so, slope degree classes and aspect of slopes were also taken into consideration. Thereafter, an elevation class map of the project area was prepared, starting from El. 800 to 1800 m with an interval of 200 m. This map was then superimposed on the landform map to prepare a base map depicting the landform-elevation component of the relationship.

The base map was used to identify and locate sites for soil sampling (Figure 3-4). These sites are representative points selected to capture both landform and elevation variations.

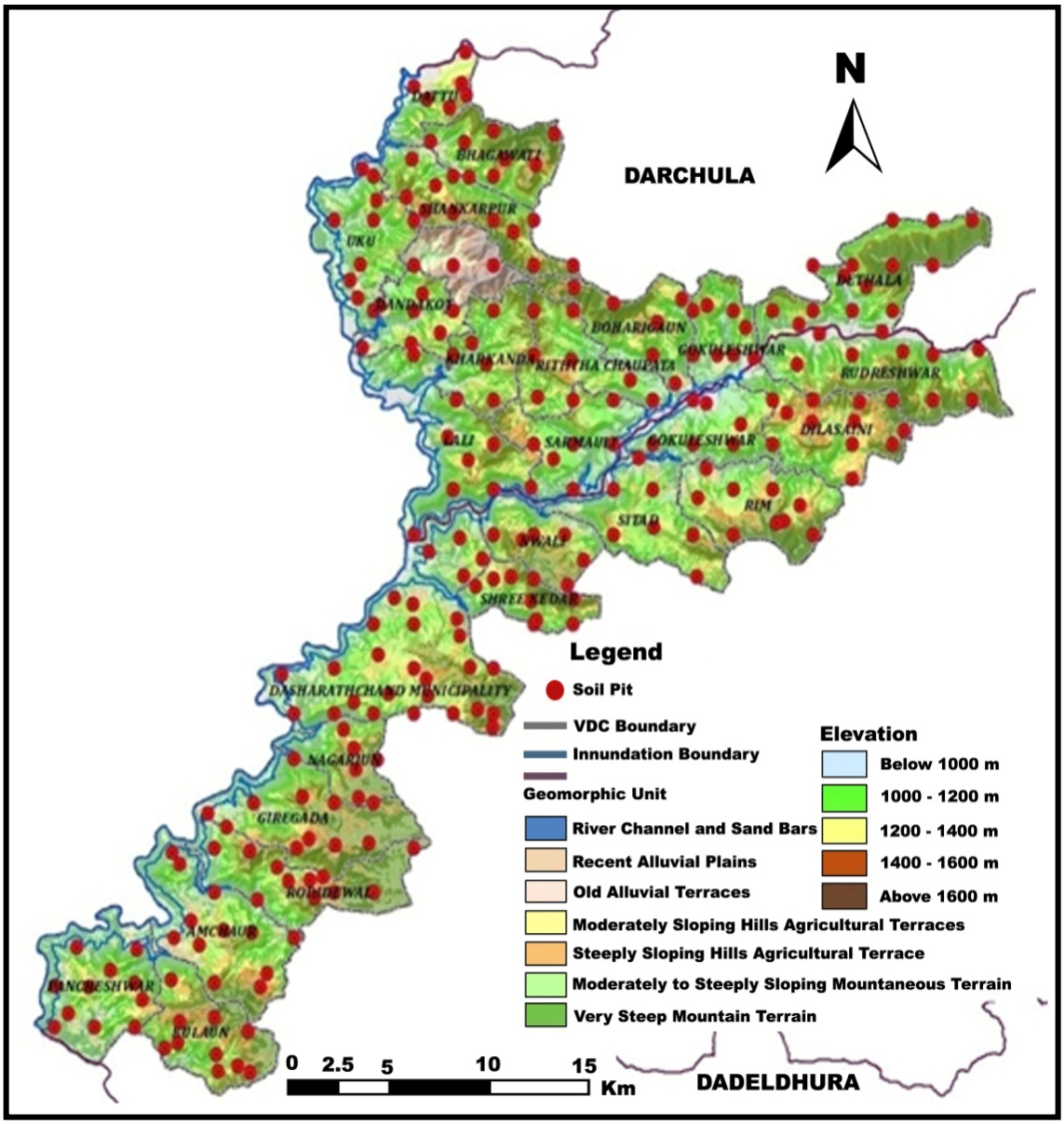

Figure 3-4: Base map with soil-sampling sites

During field investigations, 262 soil profile samples were extracted from the representative points (Table 3-4) through auger boring performed up to the minimum of the following depths: 1 m *or* the depth of weathering *or* the depth of weathered parent material. Similarly, surface soil samples were collected from 407 locations selected at rational spatial horizontal distances based on landforms, the depths of sampling varying between 15 and 25 cm.

Considering three soil samples from each profile sample, a total of 1,193 soil samples were planned. However, owing to site constraints, a total of 1025 soil samples, comprising 786 from profile samples and 407 from surface samples, were collected from different horizons. These samples were stored in soil sample bags with proper identification. For each sampling

site, site-specific information, such as present land use, cropping pattern, internal drainage condition, etc., was recorded for reference in formulation of specific land use plans.

Table 3-4: Details of soil sample for soil analysis

SN	VDC/ Municipality	Number of sample points			Number of samples			
		Profile (P)	Surface	Total	Planned		Collected	
					Profile*	Surface	Profile	Surface
Darchula								
1	Dattu	9	12	21	27	12	23	11
2	Bhagawati	8	14	22	24	14	21	13
3	Shankarpur	10	17	27	30	17	25	17
4	Uku	7	14	21	21	14	11	16
5	Dandakot	6	10	16	18	10	9	12
6	Kharkada	5	9	14	15	9	6	9
7	Lali	10	15	25	30	15	26	15
8	Sarmauli	10	8	18	30	8	25	8
9	Rithachaupata	3	15	18	9	15	8	15
10	Bohorigau	10	11	21	30	11	30	12
11	Gokuleshwar	3	9	12	9	9	8	9
12	Devthala	14	16	30	42	16	36	15
Subtotal of Darchula		*95*	*150*	*245*	*285*	*150*	*228*	*152*
Baitadi								
13	Rudreshwar	8	19	27	24	19	17	19
14	Dilasaini	12	11	23	36	11	26	10
15	Gokuleshwar	4	9	13	12	9	10	8
16	Rim	12	13	25	36	13	30	12
17	Sittad	5	16	21	15	16	11	15
18	Nwali	9	16	25	27	16	24	16
19	Shree Kedar	9	13	22	27	13	18	14
20	Dasarathchand	26	46	72	78	46	64	48
21	Nagarjun	9	11	20	27	11	19	11
22	Giregada	14	26	40	42	26	30	26
23	Rodidewal	14	20	34	42	20	29	20
24	Aamchaura	15	20	35	45	20	36	20
25	Kulau	17	21	38	51	21	40	21
26	Pancheshwar	13	16	29	39	16	35	16
Subtotal B		*167*	*257*	*424*	*501*	*257*	*389*	*256*
Total		**262**	**407**	**669**	**786**	**407**	**617**	**408**
					1193		**1025**	

Laboratory tests on the soil samples were analyzed at Nepal Agricultural Research Center (NARC), Khumaltar, Nepal. These tests were conducted for particle size distribution and textural class, soil reaction (pH), total nitrogen (N), organic carbon (OC), available phosphorus (P), available potassium (K), Calcium (Ca) and Magnesium (Mg). The results of the various laboratory tests were systematically tabulated and were interpreted. Based on these activities, various soil maps of the project area were generated.

* Number of profile samples = P X 3

3.11 AIR AND WATER QUALITY STUDIES

Qualitative and quantitative studies were conducted to collect information on the prevailing air and water qualities in the project area. During these studies, stakeholders' issues relating to air and water qualities were also investigated.

3.11.1 Air Quality

Air quality was assessed qualitatively through visual observations, informal interviews and checklist surveys. Walkover surveys were conducted to identify pollution-generating sources, such as industries, vehicular traffic, etc., in the project area. Air quality issues were discussed with local residents and officials of government and non-government agencies engaged in the health, environment, energy and related sectors. Likewise, checklist surveys on air quality were conducted at Khalanga, Dattu, Melkhet and Gokuleshwar in Darchula District and at Panjyunaya, Gothalapani, Jhulaghat and Dhamkudi in Baitadi District.

3.11.2 Water Quality

For assessing water quality, 12 water samples were collected from rivers and community taps from various locations (Table 3-5) and tested in laboratory for their physical, chemical, biological and biochemical properties. The temperature and pH values of the water samples were also recorded during sampling.

Table 3-5: Water quality sampling

SN	Source	Sampling site	Date
1	Mahakali River	Jhulaghat, Dasharathchand Municipality, Baitadi	June 6, 2012
2		Rol, Pancheshwar VDC (PHD site), Baitadi	June 8, 2012
3		Khalanga Bazaar, Khalanga VDC, Darchula	June 9, 2012
4		Joljibi, Uku VDC, Darchula	June 14, 2012
5	Chameliya River	Karkale, Dethala VDC, Darchula	June 10, 2012
6		Gokuleshwar VDC, Darchula	June 10, 2012
7		Sera, Dasharathchand Municipality, Baitadi	June 14, 2012
8	Community taps	Jhulaghat, Dasharathchand Municipality, Baitadi	June 6, 2012
9		Dhamkudi, Pancheshwar VDC, Baitadi	June 8, 2012
10		Khalanga Bajaar, Khalanga VDC, Darchula	June 9, 2012
11		Gokule, Gokuleshwar VDC, Darchula	June 10, 2012
12		Gothalapani, Dasharathchand Municipality, Baitadi	June 15, 2012

Photo 3-1: Water sampling from community tap at Dhamkudi

Photo 3-2: Water sampling from Mahakali River at Jhulaghat

In addition, the dissolved oxygen (DO) content of water from the Mahakali River, the Chameliya River and their tributaries was recorded using a portable DO-meter (Table 3-6). Water temperatures and pH values were also recorded at the sampling sites.

Table 3-6: DO, temperature and pH measurements

SN	Source	Site	Date
1	Mahakali	Jhulaghat, Dasharathchand Municipality, Baitadi	September 29, 2012
2		Khalanga Bazaar, Khalanga VDC, Darchula	October 2, 2012
3		Joljibi, Uku VDC, Darchula	October 3, 2012
4		Rolghat Pancheshwar VDC, Baitadi	October 6, 2012
5	Chameliya	Panjyunaya, Sittad VDC, Baitadi (200 m upstream of market)	September 30, 2012
6		Gokuleshwar, Gokuleshwar VDC, Darchula (500 m downstream from bridge)	September 30, 2012
7		Karkale, Dethala VDC, Darchula (10 m downstream of bridge)	October 1, 2012
8		Gokuleshwar, Gokuleshwar VDC, Darchula (80 m upstream of bridge)	October 1, 2012
9		Sera, (at Jadabagar bridge)	October 4, 2012
10	Gokule Gad	200 m upstream of confluence with Chameliya	September 30, 2012
11	Bhartola Gad	Dattu, Dattu VDC, Darchula	October 3, 2012
12	Baku Gad	Baku, Uku VDC, Darchula	October 3, 2012
13	Parmoli Gad	Sera (50 m upstream of Chameliya confluence)	October 4, 2012

To supplement the water sampling and testing, household surveys, specific checklist surveys and informal discussions were carried out at the site. The household surveys were aimed at collecting information on drinking water sources, water consumption practices at household level, sanitation, incidence of water-borne diseases, etc. Similarly, the checklist surveys were conducted to generate information on availability of drinking water, consumption practices, water treatment practices, prevalence of water-borne diseases, disease treatment practices, etc. These surveys were carried out at Khalanga, Dattu, Melkhet and Gokuleshwar in Darchula District and Panjyunaya, Gothalapani, Jhulaghat and Dhamkudi in Baitadi District.

3.12 SOLID WASTE MANAGEMENT STUDIES

Studies on solid wastes and their management were carried out through visual observation and interviews with stakeholders. The solid waste disposal sites of major market centers, such as Jhulaghat, Gokuleshwar, Gothalapani and Khalanga, were also visited to study the composition of solid wastes.

In addition, household questionnaire surveys were conducted to collect information on the waste management and sanitation practices at household levels. Specific checklists were also administered for information on waste generation, composition, management practices, etc. These surveys were conducted at Khalanga, Dattu, Melkhet and Gokuleshwar in Darchula District and Panjyunaya, Gothalapani, Jhulaghat and Dhamkudi in Baitadi District.

3.13 FORESTRY, WILDLIFE AND BIODIVERSITY STUDIES

Studies on forestry, wildlife and biodiversity were conducted to validate the related baseline information presented in the PMP EIA (WRC, 2011) and update it to address changes that have occurred in the project area since the EIA study. To this end, relevant findings of the EIA report were thoroughly reviewed, and sampling programs for supplementing the EIA findings were prepared and executed. Finally, the acquired data were selectively combined with those from the EIA to confirm project impacts and devise mitigation measures.

3.13.1 Forest Sampling

Forest sampling was carried out at sample plots laid down at representative forest types and forest covers within the project area (Figure 3-5). Sampling was performed using the nested quadrant technique. Tree measurements were taken in 20 × 20 m quadrants, and smaller plots of 5 × 5 m and 1 × 1 m were laid down within the quadrants to enumerate shrubs and herbs, respectively.

In all, 26 sampling plots were measured for various forest types. At each site, the following forest variables were recorded using specific data formats: crown cover, GPS coordinates, altitude, aspect, topography, tree diameter at breast height, species, pole size trees, number and cover of shrub species and ground cover.

As part of the field studies, key informant interviews (KIIs) were conducted at different locations using a semi-structured questionnaire. The KII participants included staff of District Forest Offices (DFOs) and other line agencies, members of community forest user groups (CFUGs), schoolteachers and local knowledgeable persons. Focus group discussions (FGDs) were also conducted with CFUG members and local persons to gather information on local floral diversity, community, private and leasehold forestry, forest disturbances, fuel energy, forest-based industries, distribution and status of endemic, nationally and internationally protected species, and economically and culturally important species.

3.13.2 Wildlife Sampling

Purposive field sampling was conducted in different habitat types in the project area, with sampling sites selected based on suitable wildlife habitats and project specific sites (Figure 3-5). The presence and absence of faunal species along walking routes was also recorded.

Direct field observations, including opportunistic bird watching and search for herpeto-fauna, were made at the project sites. Forest bird species were recorded from strategic spots. Walking route surveys were conducted at several sites, recording direct and indirect wildlife observations (Appendix E).

The field studies were conducted using specific formats. The presence of wildlife (mammals, birds and reptiles) was measured by recording the GPS (Garmin Etrex GPS) coordinates of indirect (footprints, scats, claw marks, scrape, pellets, droppings and bird calls) and direct sightings, including various habitat attributes.

In addition to field sampling, household and checklist surveys were conducted in the project area to gather information on wildlife. FGDs and KIIs were also conducted with a range of stakeholders, where discussions mainly focused on faunal diversity, habitats, corridors, wetlands, wildlife migration, conservation specific species, rare and vulnerable amphibians and reptile species.

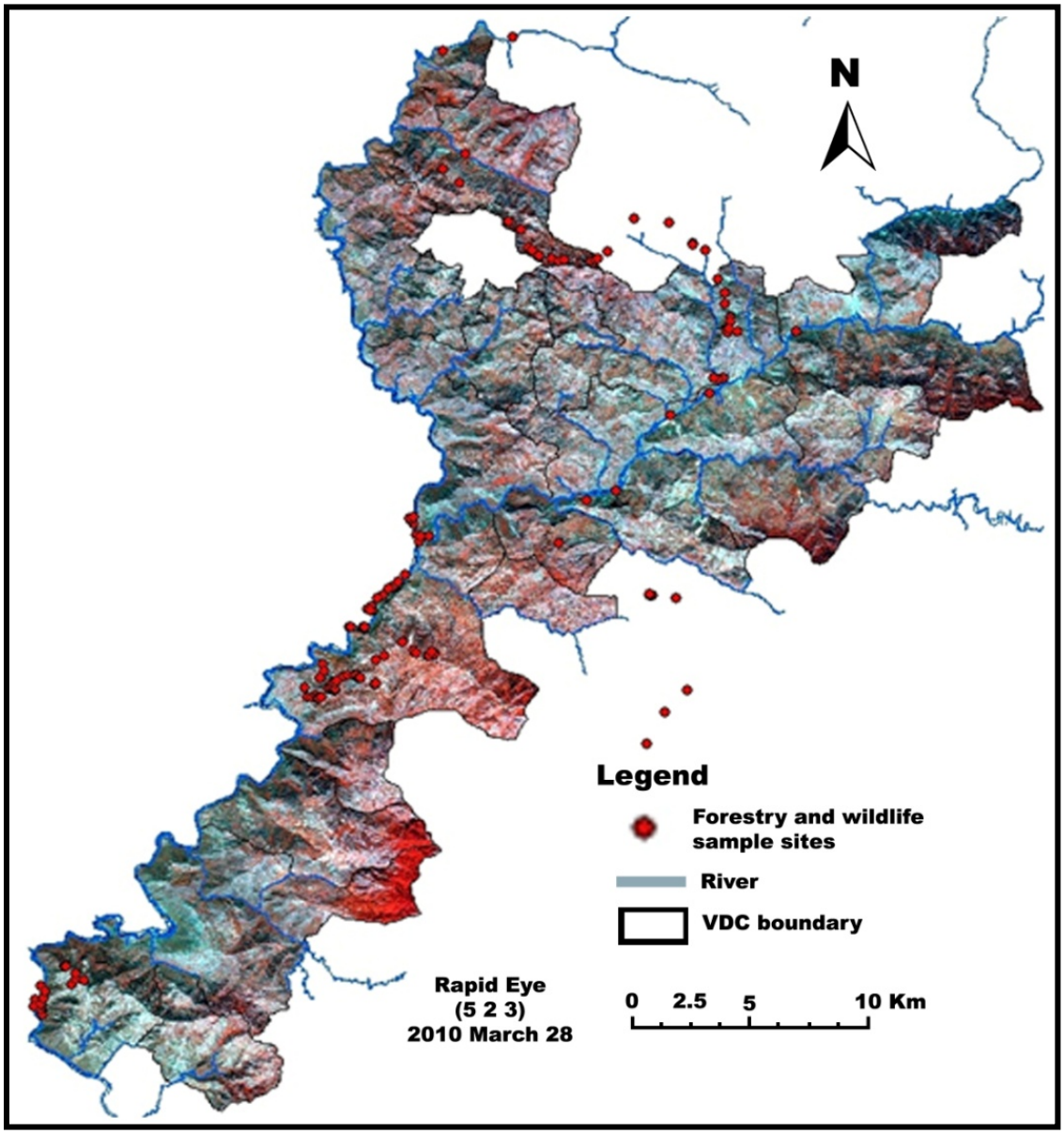

Figure 3-5: Forestry and wildlife sampling sites (same sites???)

3.14 FISHERY STUDIES

Fishery studies were conducted to validate and update the EIA information on fish species and the aquatic ecosystem of the project area. The studies started off with a detailed review of relevant documents, including the PMP EIA (WRC, 2011c) and other publications, to identify issues for the preparation of the DEMP. Thereafter, field investigations, comprising fish sampling, river habitat studies, FGDs and KIIs, were carried out to complement the information available in the EIA.

3.14.1 Fish Sampling

Fish sampling was conducted twice – once in June 2012 to study the pre-monsoon scenario and again in September/October 2012 to study the post-monsoon status. In the first phase, sampling was carried out at four sites: three along the Mahakali River at Joljibi (Mahakali –

Gori Ganga confluence), Sera (Mahakali – Chameliya confluence) and Rol (Mahakali – Saryu confluence), and the fourth at Gokuleshwar on the Chameliya River (Figure 3-6). In the second phase, fish sampling was repeated at Sera and Gokuleshwar, and one sampling each was performed in Gokule Gad (tributary of Chameliya) and Bhartola Gad (tributary of Mahakali) and at Karkale on Chameliya. Thus, a total of nine samplings were performed. Gokuleshwar was selected for sampling to explore the possibility of commercial aquaculture and fish market.

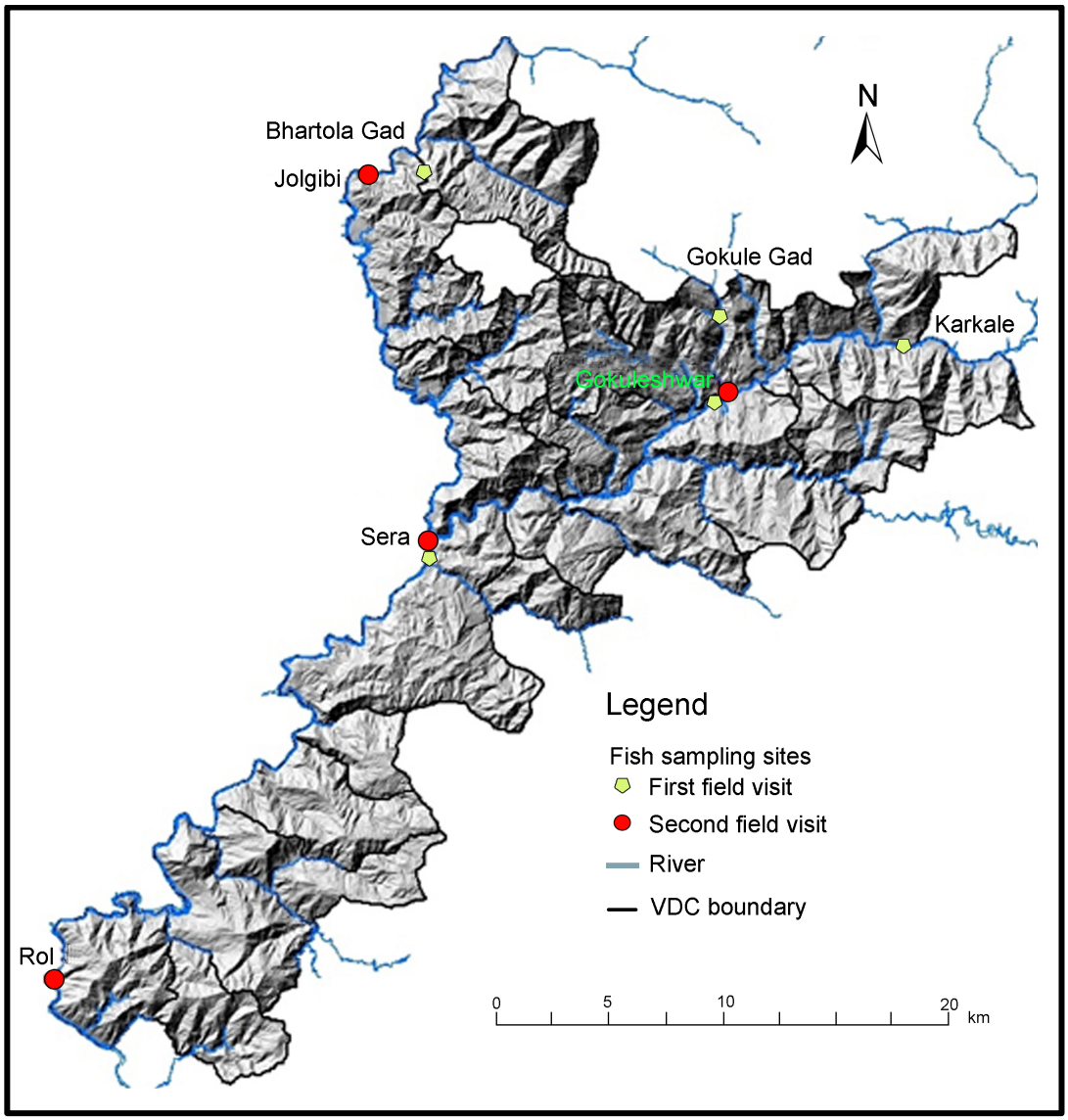

Figure 3-6: Fishery sampling sites

Fish sampling was mainly conducted using cast nets and, at times, using gill nets and other local techniques. At each site, the total length, weight and morphological characteristics of the sampled fishes were recorded. Fishes were identified using standard methods of Talwar and Jhingran (Talwar & Jhingran, 1991), Jayaram (Jayaram, 1999) and Shrestha (Shrestha J. , 1994).

3.14.2 Study of River Habitat

River habitats in the project area were studied through visual observation. Based on these studies, river zonation/habitat characterization was performed using GPS and topographical maps. Possible spawning and rearing sites were noted through direct observations. At all sampling stations, air and water temperatures and pH values were measured with a mercury thermometer and pH-meter, respectively.

3.14.3 FGDs and KIIs

FGDs with local residents, especially those from the fishing communities, were conducted at each sampling station. The discussions, conducted using specific checklists (Appendix E), focused on the availability, diversity, local names, economic value, behavior and migration patterns of fish species.

At each sampling station, KIIs were also held with local fishermen. Government offices and NGOs were also visited for consultation and collection of information on the aquatic life of the Mahakali and Chameliya Rivers and their tributaries.

3.15 STUDIES ON AGRICULTURE AND FLORICULTURE

Current information on the agricultural, horticultural, floricultural and livestock scenarios of the project area were collected to update the EIA findings. The updated information formed the basis for preparation of related management plans.

Most information on agricultural issues was collected through household questionnaire surveys. The principal issues covered in these surveys included landholding patterns and sizes, cropping patterns, production and productivity of major crops/livestock, food self-sufficiency, access to and use of productive inputs (irrigation, improved seeds, fertilizers, marketing infrastructures, etc.), annual cash incomes from sales of agriculture and livestock produce, access of farming communities to basic extension services, potential for increased production and productivity of major agricultural/livestock commodities, etc. Information on land-use patterns, cropping patterns and standing crops in the project area was also noted during walkover surveys between the PHD site and Darchula.

Considerable qualitative information pertaining to key study issues were supplemented with information collected through Participatory Rural Appraisal (PRA) tools and techniques. FGDs were held with concerned stakeholders, mainly the affected community groups, at various locations to discuss key issues related to agriculture, horticultural, floricultural and livestock. Discussions were also held with representatives of concerned stakeholders, viz. district-level government line agencies, political parties, international non-governmental organizations (INGOs), NGOs and the civil society. Informal interactions were also held with local stakeholders (Appendix G).

3.16 STUDIES ON MEDICINAL PLANTS

Studies on medicinal plants were conducted to examine their diversity and distribution in the project area, to establish their ethno-botanical uses and economic values and to explore the potential for their commercial farming, marketing and usage in industrial productions. Using the information collected from these studies, an inventory of medicinal plants in the project area was prepared for use in the preparation of management plans (Appendix F).

The study began with collection of basic information on medicinal plants in the project area. For this purpose, a specific questionnaire administered to officials of government and non-government organizations (NGOs), social workers, politicians, businessmen and traditional healers – *Baidya*s, *Jhakri*s, *Kabiraj*s and ayurvedic doctors (Appendix F). An interaction program was also organized at the ayurvedic health service center at Joljibi, Uku VDC, to discuss issues related to medicinal plants.

Thereafter, extensive sampling of medical plants was carried out in the project area (Figure 3-7). For this purpose, the area was stratified according to vegetation cover, and the nested plot method was employed for vegetation sampling for each strata. Multi-level sampling was performed, with major units chosen randomly and minor units sampled randomly from each major unit. Measurements were taken in the 1 × 1 m plots (minor units).

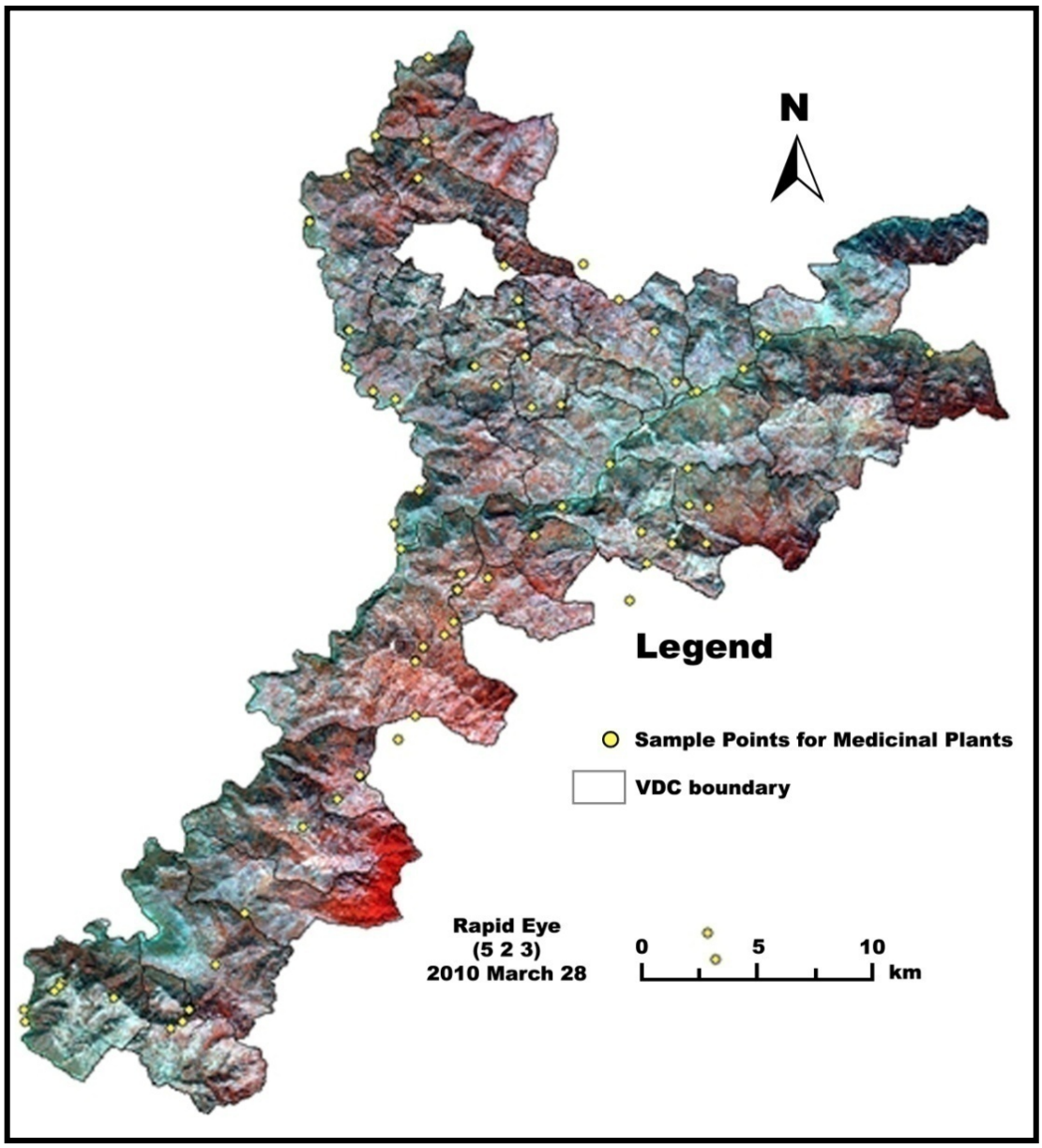

Figure 3-7: Sampling sites for medicinal plants

3.17 SOCIOECONOMIC STUDIES

Socioeconomic studies on the project area were conducted to validate and update data and information included in the PMP EIA (WRC, 2011d). These studies included an initial desk study followed by field investigations that included household questionnaire surveys, FGDs and KIIs.

At the outset, the EIA report was reviewed to comprehend the socioeconomic and cultural conditions of the project area. In addition, the latest district profiles, development plans and demographic data of the project districts were collected and reviewed to identify changes in the project areas since the EIA.

During field investigations, household questionnaire surveys were conducted in the DIZ and IIZ to collect data and information on the socioeconomic and cultural conditions of the project area and to solicit the opinions and suggestions of the local populace on the PMP. For this purpose, a questionnaire was designed considering the specific issues reported in the EIA and the particular requirements of the DEMP. This questionnaire was pretested at the site and administered by a trained team of enumerators under close supervision of research assistants and a senior sociologist.

The household surveys covered 204 households in 44 DIZ settlements and 501 households in 105 IIZ settlements (Table 3-7, Table 3-8 and Figure 3-8). Thus, a total of 705 randomly selected households were surveyed in 149 settlements. This representative sample size was determined using standard sampling techniques and is deemed to statistically represents the population of project area households with a 95% confidence level (Appendix H).

Table 3-7: Number of sampled settlements

SN	District	Settlements			Sampled settlements		
		DIZ	IIZ	Total	DIZ	IIZ	Total
1	Baitadi	51	381	432	25	63	88
2	Darchula	52	295	347	19	42	61
	Total	103	676	779	44	105	149

Table 3-8: Sample size and distribution

SN	Municipality/VDC	Sample size		
		DIZ	IIZ	Total
Baitadi				
1	Dasarathchand Municipality	49	74	123
2	Aamchaura	14	17	31
3	Kulau		21	21
4	Giregada	7	20	27
5	Gokuleshwar	8	16	24
6	Nwali	4	14	18
7	Nagarjun		9	9
8	Pancheshwar	8	12	20
9	Rim		21	21
10	Rudreshwar		28	28
11	Shreekedar		14	14
12	Sittad	16	25	41
13	Dilasaini	5	20	25
14	Rodidewal		29	29
	Total of Baitadi	*111*	*320*	*431*
Darchula				
1	Uku	25	5	30
2	Kharkada	4	17	21
3	Gokuleshwar	18	9	27
4	Dadakot	4	11	15
5	Dattu	6	9	15
6	Dethala		21	21
7	Bohorigaun	10	21	31
8	Bhagawati		20	20
9	Ritthachaupata	4	28	32
10	Lali	12	13	25
11	Shankarpur		20	20
12	Sarmauli	10	7	17
	Total of Darchula	*93*	*181*	*274*
	Total of project area	**204**	**501**	**705**

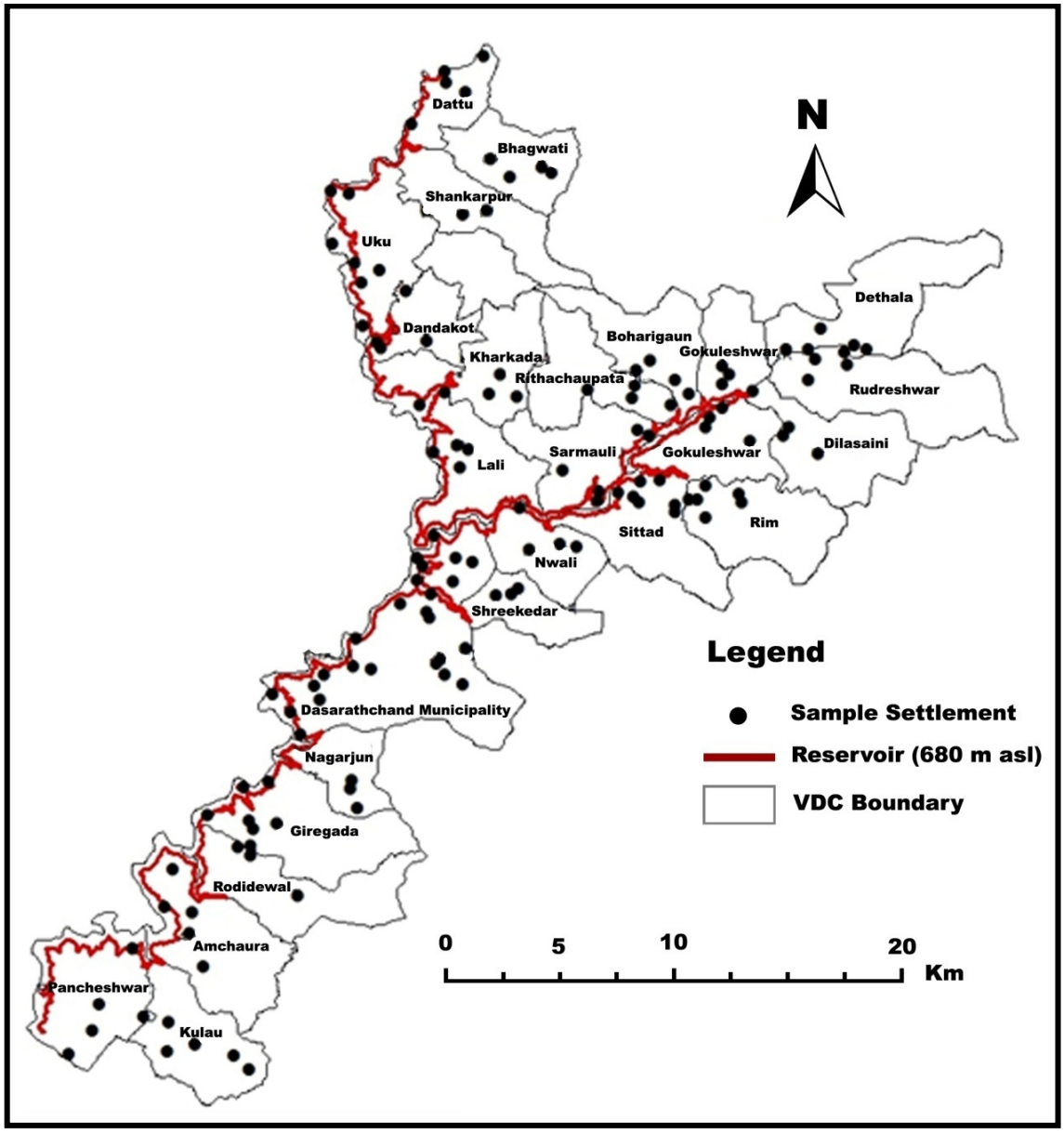

Figure 3-8: Sampled settlements

3.18 IMPACT IDENTIFICATION AND EVALUATION

As the activities described in the previous sections were completed, the various impacts of PHD identified in PMP's EIA were reassessed and validated. To maintain consistency with PMP's EIA, the identified impacts were evaluated based on the EIA guidelines published by the National Planning Commission, GoN (NPC, 1993). As per these guidelines, the intensity of impacts was qualified in terms of four parameters, viz. significance, magnitude, extent and duration, defined in Table 3-9.

3.19 VIDEO AND PHOTO DOCUMENTATION

Still photos and video documentation of approximate one hour will be prepared in Nepali and English. The video will be of high quality so that it can be telecast on national and international television. All the activities conducted in preparing DEMP will be incorporated in the video along with interviews taken with PMP staffs, political leaders, social workers, expert, knowledgeable persons and relevant stakeholders.

Table 3-9: Parameters for impact identification and evaluation

Parameter	Qualifier	Condition
Significance	Significant	Impact considerable, changes baseline condition
	Insignificant	Impact minor, does not affect baseline condition considerably
Magnitude	Low (L)	Value of resource usable with no or minimum inconvenience to public
	Moderate (M)	Value of resource usable with inconvenience to public
	High (H)	Value of resource reduced far below publicly-acceptable level
Extent	Site-specific (S)	Impact limited to project area
	Local (L)	Impact extends to watershed
	Regional (R)	Impact extends beyond watershed
	National (N)	Resources affected at national scale
	Trans-boundary (T)	Resources of more than one country affected
Duration	Short-term (ST)	Impact lasts for 3 years after project initiation
	Medium-term (MT)	Impact continues for periods between 3 to 20 years
	Long-term (LT)	Impact lasts beyond 20 years