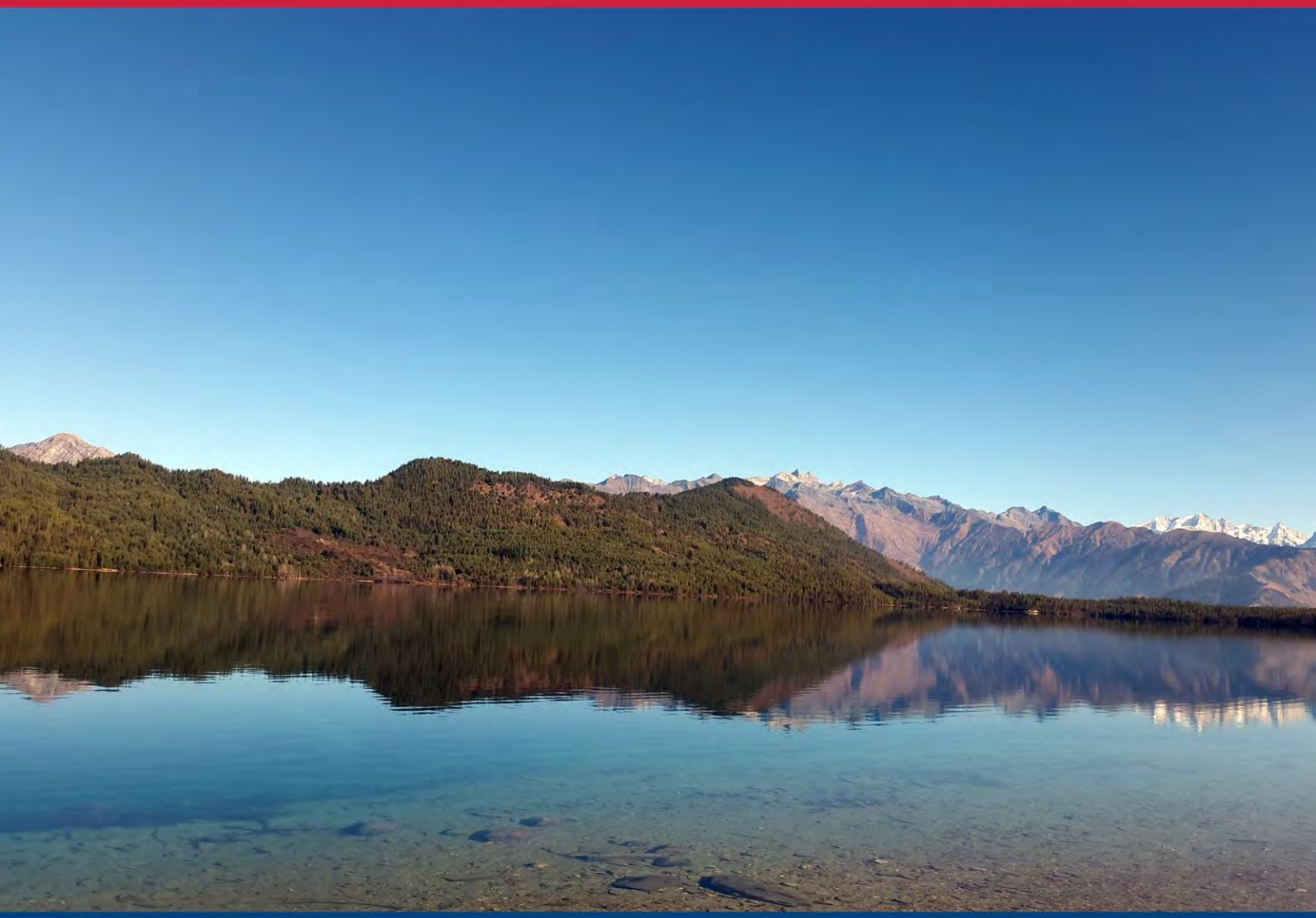
RARA KHATYAD WATERSHED PROFILE



STATUS, CHALLANGES AND OPPORTUNITIES FOR IMPROVED WATERSHED MANAGEMENT

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Cover photo: A scenic view of Rara Lake in the Rara-Khatyad Watershed, Mugu Karnali.

Photo credit: USAID Paani Program

RARA KHATYAD

WATERSHED PROFILE:

STATUS, CHALLENGES AND OPPORTUNITIES FOR IMPROVED WATER RESOURCE MANAGEMENT

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ABBREVIATIONS

BCTS	:	Brahmin/Chhetri/Thakuri
BZFC	:	Buffer Zone Community Forest
BZMC	:	Buffer Zone Management Committee
CAPA	:	Community Adaptation Plan of Action
CBAPU	:	Community-based Antipoaching Unit
CBS	:	Central Bureau of Statistics
CBOs	:	Community-based Organizations
CFUGs	:	Community Forest User Groups
CIP	:	Community Irrigation Project
CSOs	:	Community Service Organizations
DADO	:	District Agriculture Development Office
DANAR	:	Dalit Alliance for Natural Resources Nepal
DCC	:	District Coordination Committee
DDC	:	District Development Committee
DDRC	:	District Disaster Risk Reduction Committee
DEECC	:	District Environment and Energy Coordination Committee
DFO	:	District Forest Office/Officer
DFRS	:	Department of Forest Research and Survey
DSCO	:	District Soil Conservation Office/Officer
DSCWM	:	Department of Soil Conservation and Watershed Management
EAP	:	Emergency Action Plan
EFLG	:	Environmetally Friendly Local Governance
EIA	:	Environmental Impact Assessment
EWS	:	Early Warning System
FECOFUN	:	Federation of Community Forestry Users, Nepal
FEDO	:	Feminist Dalit Organization
FEDWASUN	:	Federation of Drinking Water and Sanitation Users, Nepal
FGD	:	Focus Group Discussion

GON	:	Government of Nepal
GP	:	Gaunpalika or rural municipality (new federal administrative unit; formerly Village Development Committee)
Ha	:	Hectare
HIMAWANTI	:	Himalayan Grassroots Women's Natural Resource Management Association
IEE	:	Initial Environmental Examination
IRBM	:	Integrated River Basin Management
IUCN	:	International Union for Conservation of Nature
IWMI	:	International Water Management Institute
KII	:	Key Informant Interview
km	:	Kilometer
kw	:	Kilowatt
LAPA	:	Local Adaptation Plan of Action
LSGA	:	Local Self-Governance Act
MOE	:	Ministry of Energy
MOFSC	:	Ministry of Forest and Soil Conservation
MOAD	:	Ministry of Agriculture Development
MOE	:	Ministry of Environment
MOFALD	:	Ministry of Federal Affairs and Local Development,
MOI	:	Ministry of Irrigation
MOPPT		Ministry of Physical Planning and Transportation
MOFALD	:	Ministry of Federal Affairs and Local Development
mm	:	Millimeter
MSC	:	Multi-stakeholder Consultation
MUS	:	Multiple Uses of Water Tecnhnologies
NEFIN	:	Nepal Federation of Indigenous Nationalities
NFIWUAN	:	National Federation of Irrigation and Water Users' Association
NP	:	Nagarpalika (new federal administrative unit; district level)
NPC	:	National Planning Commission

NRM	:	Natural resource management
NTFP	:	Non-Forest Timber Products
PAANI	:	Program for Aquatic Natural Resource Improvement
Sec.	:	Second
SWAT	:	Soil and Water Assessment Tool
USAID	:	United State Agency for International Development
VDC	:	Village Development Committee
WECS	:	Water and Energy Commission Secretariat
WWF	:	World Wildlife Fund
°C	:	Degree Celsius

ACKNOWLEDGEMENTS

Water is the single most important natural resource underpinning Nepal's economy and livelihoods. Inclusive, sustainable management of water resources depends on strengthening community resilience and protecting healthy, biodiverse ecosystems in the face of both development and climate change.

This discussion draft watershed profile is the result of many people working together. Most significant were the generous contributions of time, thoughtful attention, and ideas of members of many cooperatives, forest user groups, water user groups, and, especially, the communities dependent on aquatic biodiversity and local water management. Leaders from Khatyad Rural Municipality and Chhayanath Municipality engaged deeply in the assessment and prioritization and committed themselves to collaborate and integrate the priority agenda into local planning processes.

The USAID Paani Program—युएसएड पानी परियोजना—is grateful for the privilege of having been invited to support the above efforts. The Paani Program (Paani) is a consortium of DAI, WWF, SILT, SNV and NESS that works closely with Nepal's Water and Energy Commission Secretariat (WECS) and draws on support from the WECS' member agencies. Paani enriched the watershed profile by compiling and reviewing secondary data and by collaborating with FECOFUN, who carried out surveys to assess community perceptions and biophysical conditions. Thanks are also due for several other collaborating government agencies, civil society organizations, and federations for their consistent cooperation and contributions to prepare this watershed profile. These groups include FECOFUN, FEDWASUN, NFIWUAN, NEFIN, HIMAWANTI, FEDO, DANAR, many irrigation/community forest user groups, and Khatyad Rural Municipality, Chhayanath Rara Municipality and other government agencies who gave their full cooperation and support at the national, district and local levels. Any errors in this discussion document are those of the Paani team.

EXECUTIVE SUMMARY

This profile assesses the status, major challenges and opportunities for water resource management and aquatic biodiversity for the multiple users within the Rara Khatyad watershed, which lies fully within Province No. 6 of Nepal, also known as Karnali Province.

The USAID Paani Program — also known as युएसएड पानी परियोजना— facilitated the preparation of this profile, in close coordination with the Government of Nepal and local stakeholders and with support from the United States Agency for International Development (USAID). The USAID Paani Program aims to increase the knowledge, engagement and benefits of local water users in target river basins to build local capacity to water resource management.

This watershed profile provides critical baseline information for local government, community, civil society, and private sector stakeholders within the Lower Karnali watershed to strengthen water resource management to benefit human development and protect the natural resource base upon which well-being depends. This profile also helps local stakeholders to design and test interventions to strengthen community resilience and conserve freshwater biodiversity, for which additional resources are available through the Paani local grants program.[1]

The Rara Khatyad watershed (Figure 1) falls within the Karnali River Basin and includes parts of the Mugu district in western Nepal. This watershed stretches over 308 km^2 with a population of 16,919 and population density of 55 people per km^2. All of the watershed is categorized topographically as high mountain. Under the new federal system of governance, the watershed will be administered primarily by Khatyad gaunpalika (GP) in the west, which covers 87% of the watershed, and Chhayanath Rara nagarpalika (NP) in the east (12%). A tiny portion of the watershed (1%) overlaps into Soru GP to the north. Rara Lake and Rara National Park, two popular tourist destinations and important biodiversity areas, are located in the eastern half. Rara Lake is entirely contained within Chhayanath Rara GP, while approximately 50% of the national park lies in the same unit.

[1] It should be noted that the research for this watershed profile, and the other profiles under the Paani initiative, was conducted before and after the country elected to move to a federal system of government. This change means that former governmental units, such as village development committees (VDCs), are being superseded by new units such as the municipality (*nagar palika)*, rural municipality (*gaun palika*), and province.

Watersheds as a unit of analysis do not align with past or current administrative units; however, as our research began and ended after this change, you will note references to both the new and old forms – VDC, *gaun palika* (GP) and *nagar palika* (NP). When we refer to liaising with or providing support to local governments, we are making reference to the units of the new federal system.

Watersheds occasionally sit within a single province, which presents a particular incongruence when offering recommendations for action. However, for biological and socio-economic research, a watershed is optimal because it provides a discrete area in which to examine the effects of climate change and human-environmental interactions. As all rain water and snow melt drain toward a primary river, the watershed provides an integrated perspective of environmental and socio-economic change.

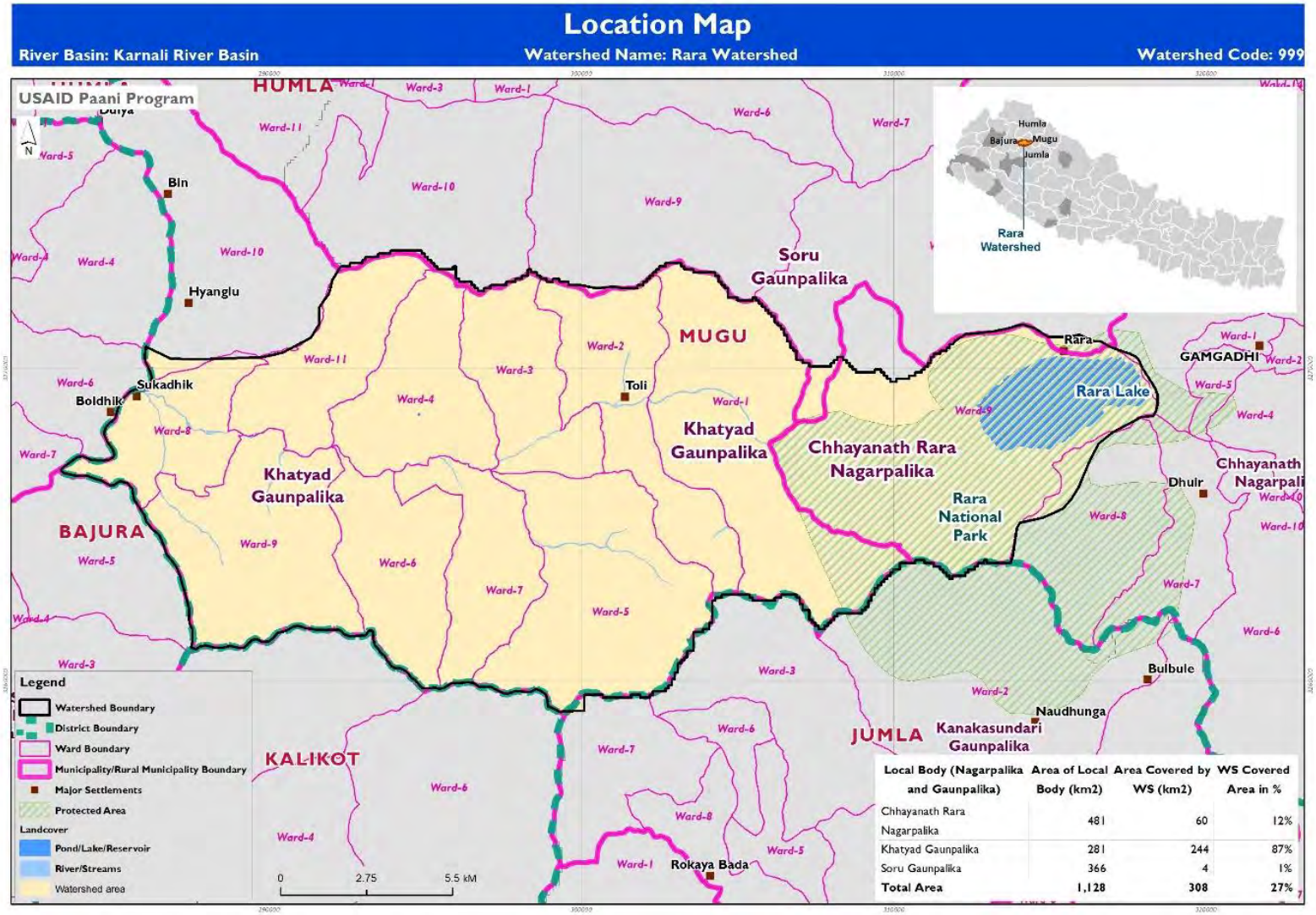

Figure 1: Location Map of Rara Khatyad watershed

The main waterway, Khatyad Khola, originates in Rara Lake and is nourished by several tributaries that are both snow and rain fed. While many households depend on the river for irrigation and other daily water needs, flow in recent years has been negatively affected by deforestation, road construction, climate change, intensive agriculture, and steep slope cultivation. Each of these factors has increased the likelihood and incidence of landslides in the watershed, exacerbated increasingly by intense rainfall and prolonged periods of no rain that impact communities and aquatic habitats.

Rara Lake is of special importance to the watershed not only for the resources it provides to the communities surrounding it, but also for its biodiversity and recreation potential. The lake and its tributaries provide a wide range of fish that are crucial to local nutritional diets and attractive to sport fishing groups – although fishing is currently banned in the lake and only permitted on rivers. Rara Lake also contains numerous species of plankton and algae that serve as the foundation for aquatic life in this area.

Priority issues for the Rara Khatyad watershed

Based on a series of community consultations, stakeholder and literature reviews, the Paani team identified five priority issues in the Rara Khatyad watershed and offers recommendations, which are described in detail below (Table 1).

Table 1: Priority issues and impacts on aquatic biodiversity in Rara Khatyad watershed

SN	Issue or threat	Impacts
I	Improper road construction	Road development is a high priority in the area, which is remote and far from larger market centers and medical services. However, road construction is undertaken without prior and proper environmental impact assessments. Heavy equipment damages the fragile hillsides and oftentimes precipitates landslide events and weakens the local geological structure.
II	Declining fish numbers	Infrastructure development (primarily roads) and destructive fishing practices (e.g., poison or electric current) affect aquatic habitats and fishery operations, resulting in declining fish numbers in the Khatyad River and its tributaries.
III	Drying water sources, reduced snowfall	Due to reduced snowfall in the watershed, water sources (e.g., wells and springs) have correspondingly declined, affecting agricultural production.
IV	Solid waste management	Increasing tourism to the area has raised the amount of waste that is generated in the watershed. Without a proper disposal infrastructure, much of this waste is deposited into nearby waterways that impact water quality.
V	Human and wildlife conflicts	Wildlife feeds on local cereal crops, placing an added burden on local farmers to produce enough grain for sale and consumption.

VI	Wildlife poaching, excessive grazing, and illegal harvesting of non-timber forest products (NTFPs)	Medicinal herbs are a major source of income in the watershed, but overharvesting at current rates threatens the long-term viability of many species and contributes to soil erosion and biodiversity loss. Similarly, wildlife poaching in and near Rara National Park has sparked conflict between park officials and local residents.

I. Improper road construction

After the arrival of the newly elected government at the local level, budgets been substantially increased for building roads in Khatyad GP. However, much of this road network has been developed without undertaking appropriate environmental impact assessments of the areas in which the roads are built. The result has been an increasing incidence of landslides in the watershed, destroying personal property and aquatic habitats.

Recommendations:

- Raise awareness and build capacity of local government and contractors about the Environment Friendly Local Governance (EFLG) framework;
- Enforce existing road construction guidelines to protect areas within the national park;
- Provide training and support for low-cost stabilization techniques for slopes and river banks using bioengineering methods and river bank planting; and
- Form committees of concerned citizens to advocate for environmentally friendly road construction.

II. Declining fish numbers

Infrastructure development, intensifying fishing interests, and degraded aquatic habitats have contributed to declining fish numbers. Furthermore, increasing use of pesticides by local farmers has raised the level of chemicals leeching into local water bodies, which over time may impact fish health and reproduction.

Generally, knowledge of conservation principles is low in the watershed, and some education will be necessary in the future to obtain support and commitment from local stakeholders.

Recommendations:

- Develop high-value fishing opportunities in the Karnali basin to attract tourists and bring attention to Nepal's fishing cultural heritage;
- Train local fishing groups in modern angling skills;
- Promote game fishing development for youth;
- Establish a fish hatchery in the watershed along the Khatyad Khola;
- Discourage recreation fishing in Rara Lake, as it will negatively impact the breeding stock of snow trout over time;
- Establish fish sanctuaries on feeder streams and the tail water of Rara Lake to replenish fish stocks as needed; and
- Promote eco-friendly tourism around Rara Lake to take advantage of the pristine wilderness of the area.

III. Drying water sources, reduced snowfall

The loss of water sources affects every aspect of life in the Rara Khatyad watershed: cultural, domestic and agricultural. In Murma Gaun, as just one example among many, residents say 50% of water springs have either declined or disappeared in the past decade. Chief among the causes of this change is reduced snowfall in the area, which is needed to replenish aquifers and water bodies.

Recommendations:

- Raise awareness about multiple use of water technologies (MUS) – such as sprinkler irrigation and drip irrigation – that maximize water use efficiency;
- Plant trees and shrubs in the springshed and on barren land in the community to retain more rainwater and reduce run-off that can recharge natural springs;
- Initiate mapping of spring sources and implement springshed management related activities; and
- Facilitate construction of snow and rainwater harvesting ponds in the watershed area.

IV. Solid waste management

With the growth in tourism related to fishing and trekking, alternative employment opportunities have increased in the watershed. But amidst these economic benefits, solid waste levels have also risen sharply. Municipalities in the watershed are not equipped with proper infrastructure or resources to address this issue, so waste continues to be dumped in nearby waterways, impacting water quality, wildlife, and vegetation. These waste issues are particularly salient for Rara Lake, a declared RAMSAR site. Furthermore, hotels located near the lake contribute to a system whereby pollution of nearby water and land too easily occurs.

Recommendations:

- Prepare RAMSAR site management plan for Rara Lake;
- Provide training to the community to increase awareness about solid waste management, including the need to segregate biodegradeable and non-biodegradeable solid waste;
- Install dustbins along the popular footpaths around Rara Lake and coordinate disposal of this waste with local communities;
- Initiate a garbage accounting system at the entry and exit points of Rara National Park;
- Develop solid waste management plans for Khatyad GP and Chhayanatha Rara NP;
- Promote collaboration with Rara National Park and its buffer zone committees to reduce waste and improve waste management;
- Improve monitoring of waste disposal from hotels and restuarants inside the National Park; and
- Facilitate the relocation of hotels (when possible) to new sites further away from local waterbodies.

V. Human and wildlife conflicts

Numerous forms of human and wildlife conflict threaten to inspire conflict among neighbors, government, and park officials if not properly addressed. Wildlife feeds on local cereal crops, placing an added burden on local farmers to produce enough grain for sale and consumption. Struggling households around the Rara National Park complain they do not receive sufficient benefits from the lakes and forest and often harvest from these places illegally. Some animals with protected status inside the park (e.g., boars and monkey) threaten humans and livestock, which causes conflict between households and park

officials. However, many residents note that the recently-implemented fee system for collecting firewood and dried pine grass has increased incomes for many.

Recommendations:

- Improve communication between households and the National Park to establish more flexible policies for benefit sharing of local natural resources;
- Simplify and streamline the compensation system for the families of wildlife victims and farms impacted by wildlife encroachment; and
- Support buffer zone communities by mobilizing funds from the National Park earmarked for this purpose.

VI. Wildlife poaching, excessive grazing, and illegal harvesting of NTFPs

Rara National Park is charged with conserving biodiversity and maintaining the unique landscapes of the park. A lesser known objective of the park includes promoting socio-economic development for buffer zone communities. However, struggling households in the area continue to engage in livestock overgrazing, timber smuggling, and non-timber forest product (NTFP) poaching in order to make ends meet.

As a RAMSAR site, the national park assumes responsibility for protecting local wetlands. Local residents report that wildlife numbers are decreasing in Rara National Park and existing policies are rarely enforced to punish the offenders. Offenders often cite lack of awareness of existing policies and claim ignorance of law and economic hardship to explain their offense. The same situation persists in fishing as well, where destructive practices are rising (e.g., poison and electric current) and fish numbers are in sharp decline.

Recommendations:

- Establish a community-based anti-poaching group to monitor illegal fishing activity and animal and NTFP poaching;
- Prepare guidelines for community-based anti-poaching groups to reference and enforce; and
- Promote alternative livelihood options of local communities linked to eco-tourism. These activities would support the local economy by improving livelihoods and providing employment opportunities, such as local homestays for travelers, horse-trail rides to Murma Top, and bird watching expeditions in the wetlands

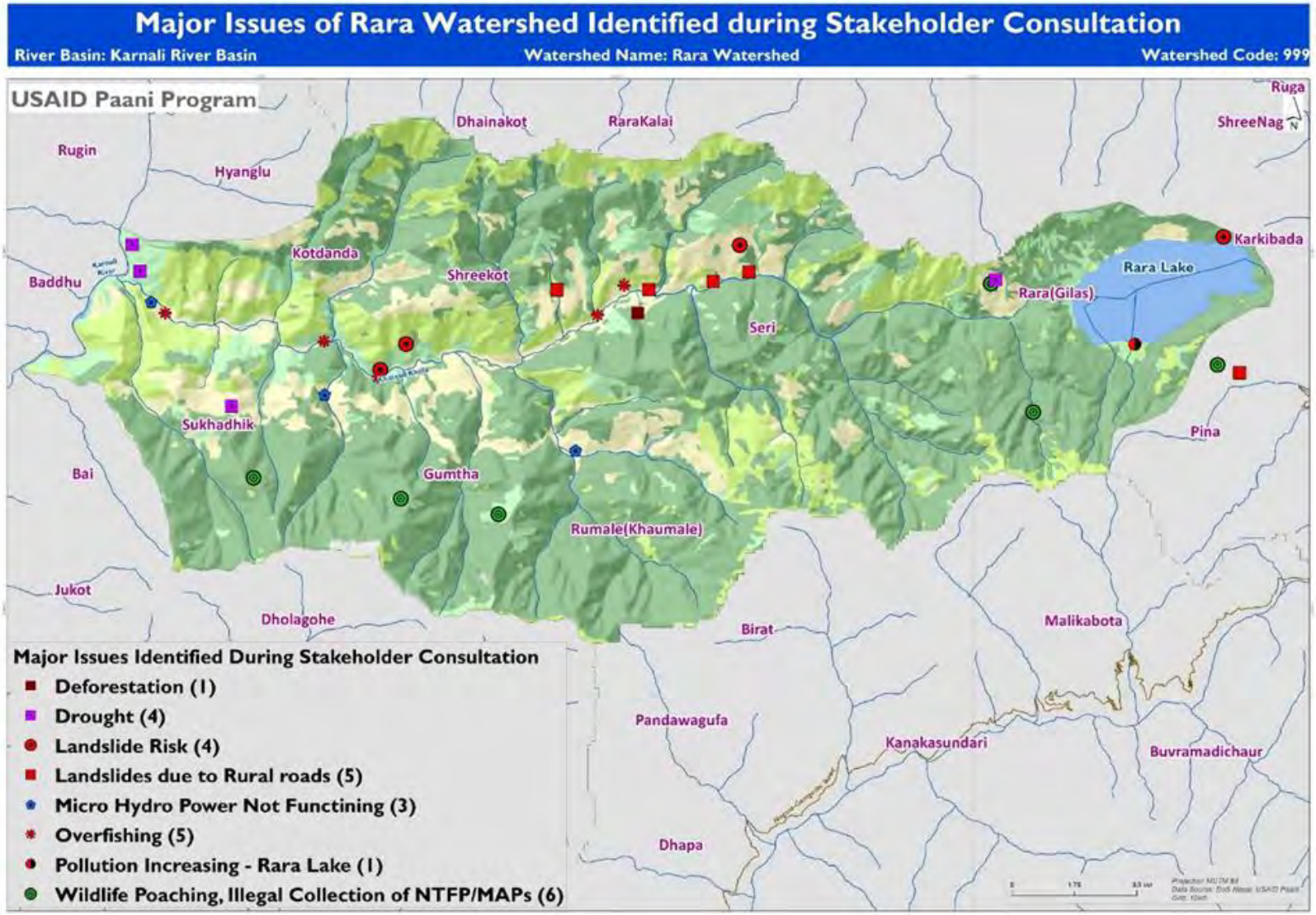

Figure 2: Environmental issues by location in the Rara Khatyad watershed, as identified by stakeholders

1. THE RARA KHATYAD WATERSHED: NATURE, WEALTH AND POWER

The Lower Karnali watershed Profile is organized around three interrelated themes that influence the management and overall health of the watershed: **nature** (environment and natural resources), **wealth** (socioeconomics and infrastructure—the many ways that people use nature), and **power** (governance and institutions—the ways that the different people and groups make decisions together about the watershed and its uses) [2]. The analysis draws on multiple data sets associated with these themes to identify critical issues and opportunities for this watershed. We introduce this watershed in terms of its local natural and social dimensions. Then we examine how climate change and other drivers threaten and impact local livelihoods and biodiversity.

In 2016-17, the Paani program conducted a series of literature reviews, household surveys, focus group discussions, and key informant interviews to characterize the watersheds, including the identification of priority threats and opportunities. Through exit workshops the Paani team shared preliminary results with multiple stakeholders, based on which priority issues and environmental assets were identified by location and impact groups. During the exit workshop, the Paani team also identified champions among stakeholders and local government agencies for leveraging funds and expertise to support water resources management initiatives.

Paani took the critical feedback and suggestions to identify priority issues and actions, and with the participants, developed a 20 year vison for improving watershed management. The representatives of newly-elected local bodies also expressed eagerness to allocate their resources in support of activities in all aspects of watershed conservation.

Related annexes

Annex 1: Methodology

[2] The full text from which this report's structure was taken (NATURE, WEALTH, & POWER 2.0: Leveraging Natural and Social Capital for Resilient Development) is available here: https://rmportal.net/library/content/nwp-2.0

2. NATURE

This section examines the environmental and natural resource dimensions of the watershed, including climate and weather, hydrology, biodiversity, fisheries, and land use within the Rara Khatyad watershed, paying special note to trends and changes that may threaten the health and sustainability of these assets.

2.1. RARA KHATYAD WATERSHED

The Rara Khatyad watershed covers 308 km^2 and ranges from 3,056 m at its highest point in Khatyad GP to 1,145 m at its lowest point in the southern region close to Jumla Village Development Committee (VDC). The primary natural resource in the watershed is Rara Lake, which attracts many tourists each year to enjoy its pristine beauty. But the lake also occupies a central role in supporting the biodiversity of the area. A wide range of plankton and algae comprise the nutritional foundation for fish and fauna throughout the area. Rara Lake averages 100 m deep, and the rocks around the lake are comprised of schists and amphibolite. Twenty streams flow into the lake, but there is only one outlet at the western end, which becomes Khatyad Khola.

The Khatyad Khola flows westward from Rara Lake, from which point it eventually joins the Karnali River and flows southward to India. Twenty-five streams flow into the Khatyad (Figure 3), which provides the main source of irrigation and micro hydropower in Khatyad GP.

Forests also play a vital role for maintaining watershed health and supporting the livelihoods of households in Rara Khatyad. The array of medicinal and aromatic plants provides local residents with an important alternative income source. The forest are managed primarily by 60 community forest user groups, who assume responsibility for ensuring sustainable use.

Sixty percent of the watershed population is Brahmins/Chhetri/Thakuri (BCTS), followed by Dalit (21%), Janajati (18.5%), and Madhesi (>1%). The main livelihood of the area is agriculture, and farmers grow staple crops such as wheat, millet, barley, and paddy. Medicinal and aromatic plants harvested from forets are sold to companies licensed for extraction. Livestock is the second most common livelihood, consisting of mostly goat, sheep and buffalo.

Like many places in Nepal, outmigration is rising, especially for young men who flock to Kathmandu, India, and the Middle East in search of better pay and opportunity. A growing presence of trekkers in the fall and spring seasons is inspiring a concomitant rise in hospitality (hotels and restaurants) along the main trails and Rara Lake. A potential for ecotourism could easily complement the trekking sector through homestays and traditional product sales.

Related annexes
Annex 2: Population

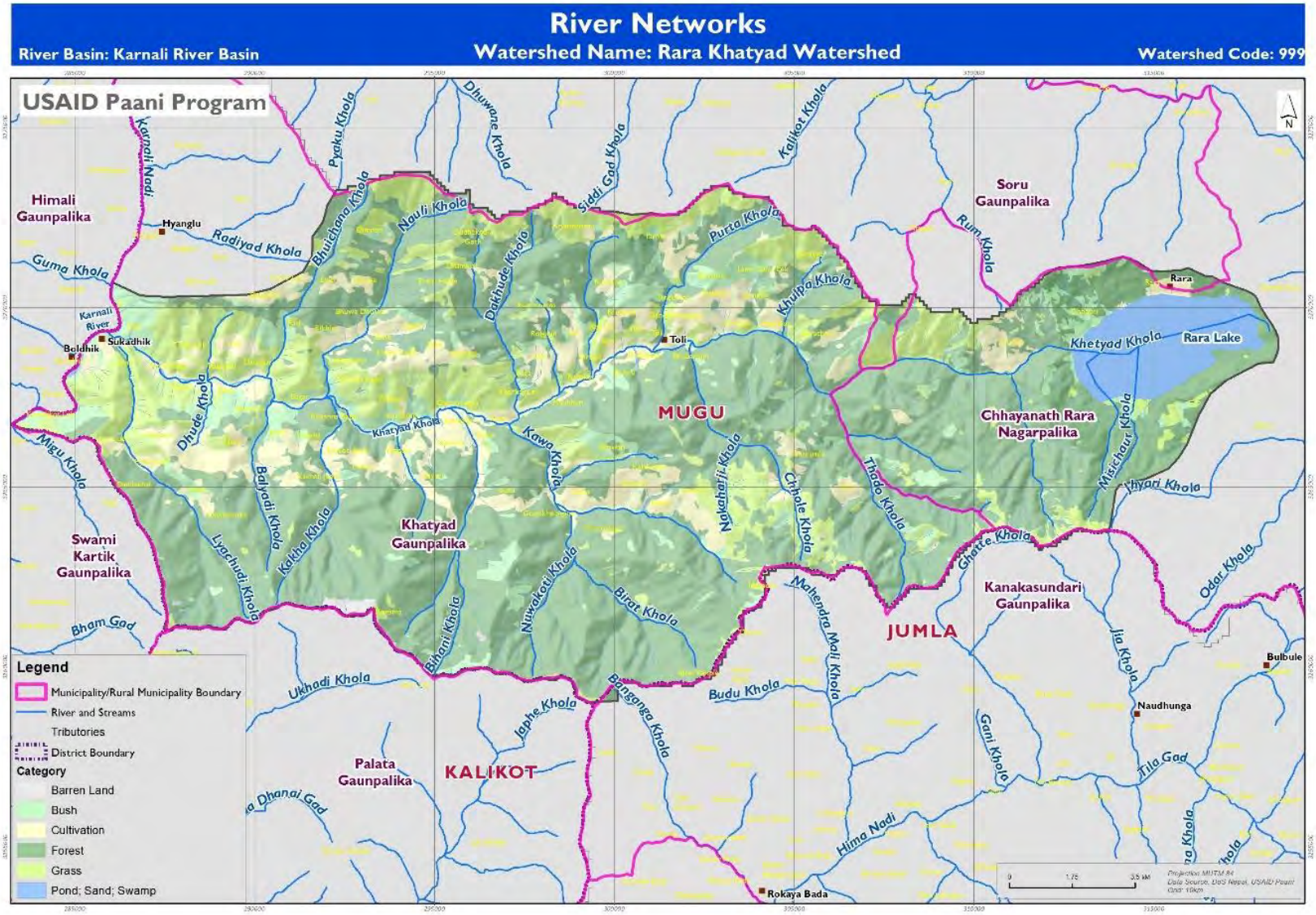

Figure 3: River network in the Rara Khatyad watershed

2.2. WATER AVAILABILITY AND QUALITY

Rara Lake and the Khatyad River are the two primary water bodies in the watershed. Rara Lake is surrounded by conifer forests and filled by 20 tributaries that drain into its catchment area. Rara is the largest lake in Nepal (1,039 m^3) and contains three endemic species of snow trout. The lake edges are enclosed by reeds (Phragmites), bushes (Juncus) and sedges (Fimbristylis) that help retain water and provide estuary for local birds. In the southeast corner of the lake stands Thakur Nath temple. Local residents believe Thakur Nath controls the lake levels by damming or opening the lake as needed.

Twenty-five streams flow into Khatyad Khola, as it makes its way west from the edge of Rara Lake. This water provides irrigation and drinking water to residents, and powers several mills and micro hydropower schemes down river. Nine wetlands provide year-round irrigation and drinking water to some communities (Annex 4).

Using SWAT modelling developed by IWMI, water discharge rates of the Khatyad Khola were estimated with measurements taken on the Khatyad Khola near its release point from Rara Lake. Maximum discharge was observed in August and minimum rates in January with an average annual discharge rate of 2.55 m^3/s. Table 2 presents discharge rates for other selected rivers in the Rara Khatyad watershed.

Table 2: Discharge rates of selected rivers and streams in the Rara Khatyad watershed

Name	Latitude	Longitude	Discharge rate (m^3/sec)
Rara Exit	29.52909015	82.06219265	11.8
Trilok	29.52229	82.04847	419.33
Kawa Khola	29.50770607	81.90421225	503
Toli Khola	29.51301135	81.85389338	112
Putta Khola	29.52879361	81.94737462	114
Gajeda	29.51644188	81.99673435	329.57
Chimadungi	29.511885	81.90668123	40.66

Water availability and access

Household (HH) surveys (n= 633) found that 1.7% of households have water on the premises, while 88.5% of households need less than 30 minutes to obtain sufficient daily water. The remainder of households (9.8%) require more than 30 minutes per day. Of those households requiring more than 30 minutes per day, 16.7% of Janajati, 15.4% of BCTS, and 8.1% of Dalit are travelling at least 30 minutes per day to collect water for HH use. This means that out of total Janajati households, 83.3% invest less than 30 minutes to collect water every day for household use. Likewise, out of total BCTS households, 84.6% invest less than 30 minutes to collect water every day for household use, and the remaining 15.4 % of the BCTS households need at least 30 minutes to collect water everyday. Similarly, 91.9% of the

Dalit households invest less than 30 minutes to collect water every day for household use, and the remaining 8.1% of the Dalit households need at least 30 minutes to collect water every day.

On the question of access, 96.3% of households overall reported having equal access to public water resources in the watershed. When disaggregating these numbers by caste/ethnicity, we find that 3.7% of Janajati households claimed unequal access to water compared to 6.0% of Dalit families and 3.1% of BCTS families. The reasons given for unequal access included caste-based discrimination, long distances to water collection points, and rising water scarcity in certain areas of the watershed.

Water quality tests were taken in several locations using an Akvo Caddisfly kit. Water quality in the watershed was determined by testing a range of parameters, including pH, nitrate nitrogen and nitrate nitrogen, ammonium, phosphate. Dissolved oxygen was found to be low near the Rara Lake exit, which may be due to the high nutrition load in that area, but within acceptable ranges in other locations. Favorable dissolved oxygen levels were reported in all areas, which is crucial to fish survival. High ammonia levels were detected at Kawa Khola and Putta Khola while high pH values were found at Putta Khola alone. Table 3 below summarizes the water quality findings using the following rating system: higher than 100 (poor); between 75-100 (fair); and below 75 (good).

Table 3: Fresh water quality index of the Rara Khatyad watershed

SN	Location	Dry	Monsoon	Dry season rating	Monsoon season rating
1	Rara Exit	65.444	65.822	Good	Good
2	Gajeda	324.854	87.092	Poor	Fair
3	Dovan	37.743	264.785	Good	Poor
4	Panche Khola	NA	101.490	NA	Poor
5	Masanna Bagar	NA	126.754	NA	Poor
6	Rara Lake (East bank)	NA	71.215	NA	Good
7	Rara Lake (South bank)	NA	40.506	NA	Good

Focus group discussions in Rara Khatyad revealed concerns about water conflicts in the future. With spring disappearing and/or drying up, periods of drought become more difficult for farmers to contend. Lower rainfall in the watershed has also allowed weeds to become more dominant, forcing some farmers to turn to chemical pesticides to cope with the new conditions. Furthermore, microhydro projects and water mills are also running at sub-optimal levels due to low water availability. In this context, many residents expressed fears about conflicts over water and misgivings about the local government's ability to resolve these conflicts satisfactorily.

GESI concerns: In many parts of Rara Khatyad, the practice of *chhaupadi* is still enforced among women. This practice forbids women to enter the house and restricts their mobility during menstruation, including the act of fetching water for the family. Morever, these restrictions limit women's access to water for hygiene and increase women's risk of infection from improper care.

Related annexes
Annex 11: Water quality

2.3. LAND USE AND LAND COVER

Located in a "high mountain" zone, the land cover of Rara Khatyad is largely alpine: 49.2% of its land cover is forest dominated by hardwoods and conifers. Twenty-five percent of the watershed is used for grazing livestock, while 20.3% is cultivated for crops. Lakes, rivers, ponds, and barren land account for the remaining area (Figure 4).

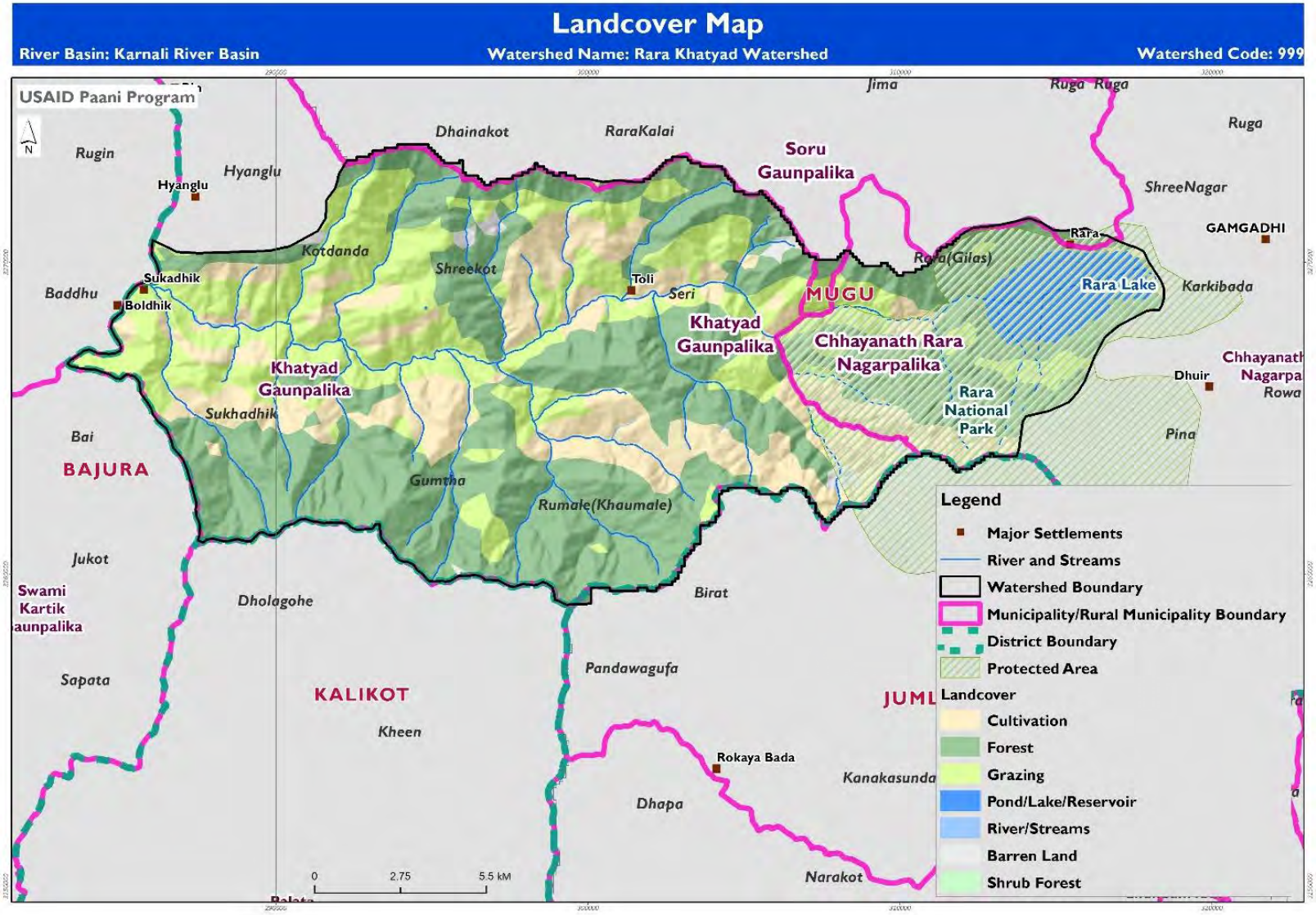

Figure 4: Land use and land cover in the Rara Khatyad watershed

Looking more closely at forest types, GIS mapping finds that 68% of the trees are mixed hardwood, followed by Banjh oak (19.2%), pine (7.4%), and fir (2.7%). The remaining dominant species include sal, cedar, and sisau. Table 4 illusrates how these species are distributed in Rara Khatyad

From 2000-2016, forest cover declined (Figure 5). According to data from Global Forest Watch, the watershed lost 33 hectares of forest (or 4.2%) while no forest gain has been recorded in any areas. The forest loss appears concentrated around Rara Lake, raising concerns about preserving this important buffer zone.

Table 4: Forest cover and type map of Rara Khatyad watershed

Forest Types	Area (Sq KM)	% Coverage
Mixed hardwood	52.65	68.0%
Sal Forest	0.30	0.4%
Pine Forest	5.76	7.4%
Sisau (sisam)	0.55	0.7%
Banjh Oak (Quercus)	14.93	19.3%
Himalayan Fir (Abies)	2.06	2.7%
Deodar Cedar	1.20	1.5%
Total Forest Cover	**77.46**	**100.0%**

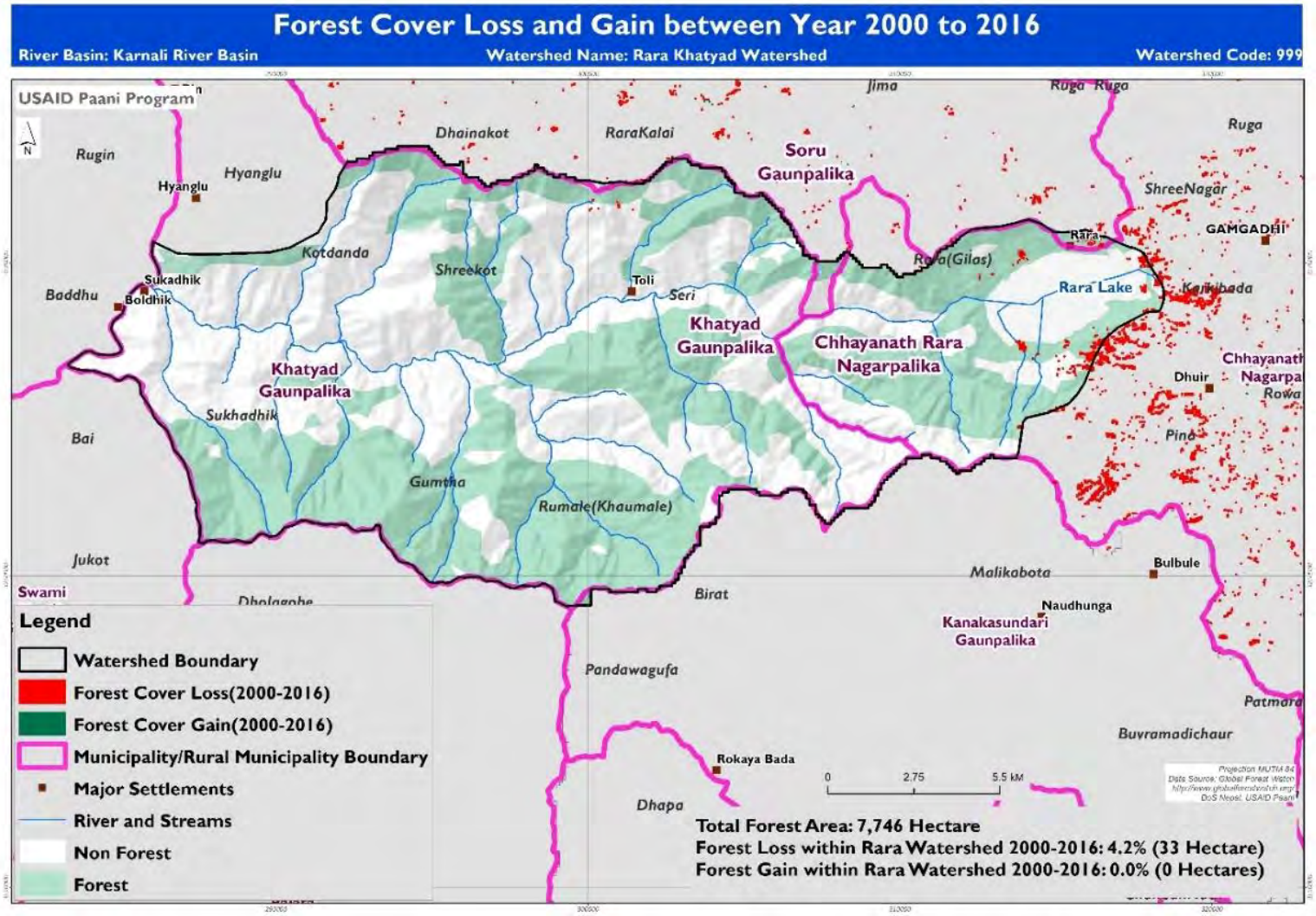

Figure 5: Forest loss and gain map of Rara Khatyad watershed

2.4. BIODIVERSITY AND INVASIVE SPECIES

Rara Lake holds special significance in terms of biodiversity for three endemic fish species and one endemic frog that originated here: snow trout (*Schizothorax nepalensis*), snow trout (*Schizothorax macrophthalmus*), Rara snow trout (*Schizothorax raraensis*), and Rara Lake frog (*Paa rarica*).

The floral diversity of the watershed is considerable: 170 species are found in Rara National Park alone. Among the better known species are the rhododendron (Rhododendron arboretum), brown oak, and several species of pine: blue pine (Pinus excelsa), west Himalayan spruce (Picea smithiana), black juniper (Juniperus indica) and Himalayan cypress (Cupressus torulosa). Numerous medicinal herbs also grow that many residents harvest for sale and personal use. The more well-known species include:

- Neopicrorhiza scrophulariiflora (Nepali name: Kutki) – for cold, sinusitis, headache, diarrhea, and anemia
- Paris polyphylla (Satuwa) – used to treat fevers, headaches, burns, and many livestock diseases
- Aconitum spicatum (Bikh) – cough, fever, and lung and intestinal infection
- Bergenia ciliate (Pakhanbed) – kidney stones and other gastrointestinal disorders

Fuller lists of species are available in Annex 5.

Several rare and/or endangered species of wildlife take sanctuary in Rara National Park, including the Himalayan black bear (Ursus selenarctos thibetanus), red panda (Ailurus fulgens), musk deer (Moschus chrysogaster), leopard cat (Prionailurus bengalensis), Assamese monkey (Macaca assamensis), and grey wolf (Cansis lupus).

As in many parts of Nepal, avian life is rich and diversified, and the Rara Khayad watershed is no exception. More than 230 species of birds have been recorded by scientists and local residents. Of these, 49 are migratory birds who rely on wetlands for protection and reproduction. Some of the more well-known year-round species include the Ruddy Shelduck (Tadorna ferruginea), coot (Fulica atra) Eurasian woodcock (Scolopax rusticola), brown dipper (Cinclus pallasii), and wood snipe (Gallinago nemoricola). Winter-time migratory species to the watershed include the gadwall (Anas strepera), mallard (Anas platyrhynchos), northern shoveler (Anas clypeata), common teal (Anas crecca), tufted duck (Aythya fuligula), and common golden eye (Bucephala clangula).

Rara National Park is an especially important refuge for the Cheer pheasant (Catreus wallichii), white-throated tit (Aegithalos niveogularis), and Kashmir nuthatch (Sitta cashmirensis).

As noted above, three speices of fish and one frog are endemic to the watershed. However, local residents rely on a large variety of species for sale and household consumption. Through FGDs and KIIs, the Paani team found seven species of fish in Rara Lake, and 23 species in the watershed (Annex 6). The snow trout (Nepali name: Asala) remains the most important and plentiful fish, but its numbers are declining according to local residents. The snow trout migrates to the area from March to April and breeds in the area from May to July. Regarding invasive species, Eurasian watermilfoil (Myriophyllum spicatum) can be found in Rara Khatyad; however, this species is not considered invasive in Nepal.

Related annexes

Annex 5: Forests and plant life
Annex 7: Fish and aquatic life
Annex 8: Faunal biodiversity

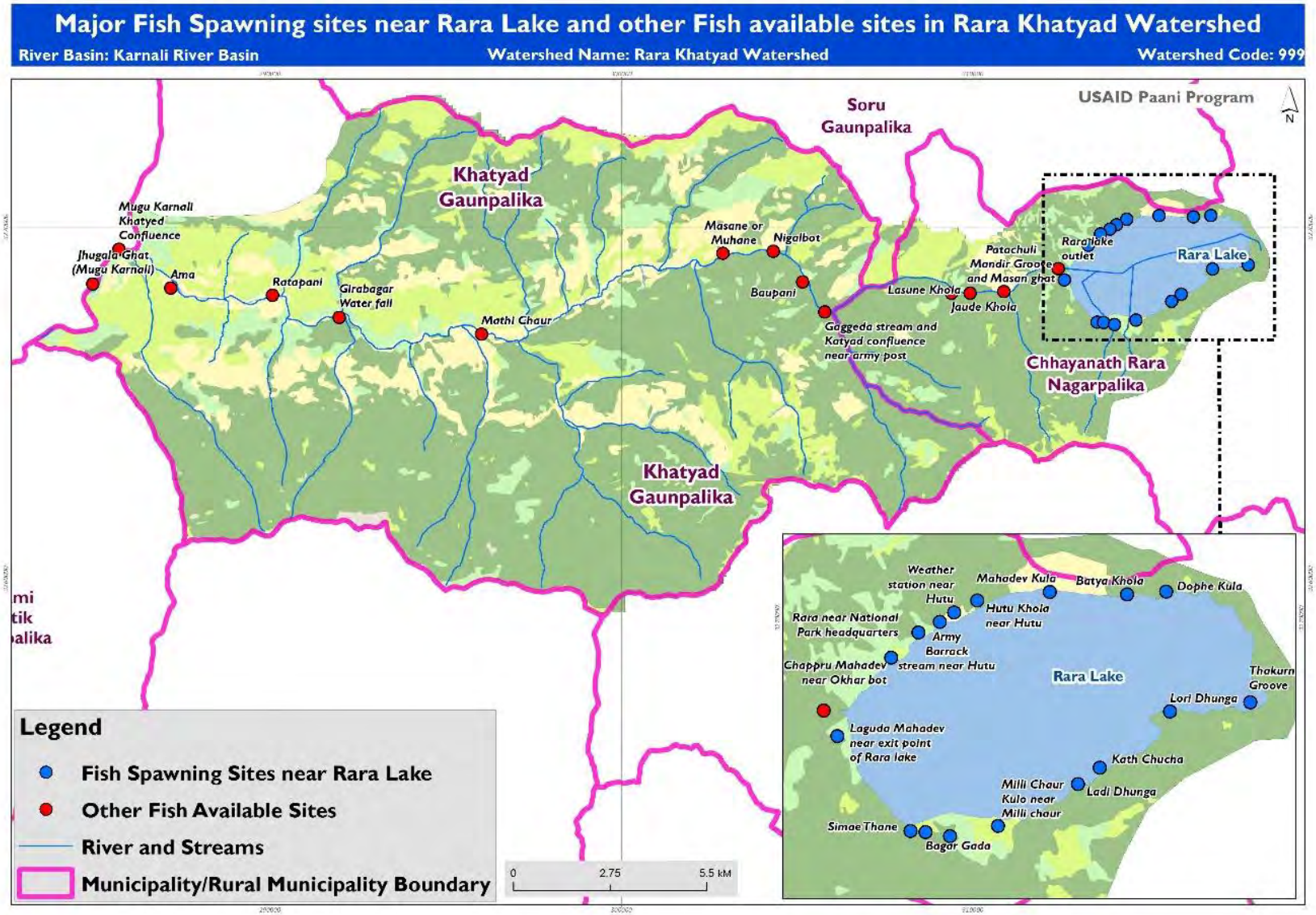

Figure 6: Popular fishing and fish spawning sites in Rara Lake and the Khatyad Khola

2.5. CLIMATE AND PHYSIOGRAPHY

There are four prominent climatic seasons in Nepal: winter (December-February), spring/pre-monsoon (March-May), summer/monsoon (June-September) and autumn/post-monsoon (October-November). Temperature and rainfall variations persist not only by season but also by altitudinal gradients.

2.5.1 TEMPERATURE

Tempurature estimates were made using data collected from one station within the watershed (at Rara) and one station situated just south (Jumla). The data from Jumla is more consistent, as the Rara station temperature record has many gaps.

In addition to the seasonal temperature variations, differences in topography also induce spatial variations of temperature. Long-term temperature data recorded in the Rapti, Karnali and the Mahakali River basin were used to determine the temperature change rate with respect to the elevation change. Temperature was observed to decrease at an average rate of 4.4 °C, 4.6 °C, 4.6 °C and 4.8 °C per 1 km rise in altitude in winter, pre-monsoon, monsoon and the post-monsoon seasons respectively. Similarly, the annual average temperature wass observed to decrease at the rate of 4.9 °C per 1 km rise in altitude.

The long-term average monthly temperature variation (daily average) in Rara Khatyad watershed is shown in Figure 8. The average monthly temperature of the watershed varies from 3°C, in winter, to about 15°C in summer. Similarly, the maximum and minimum monthly temperatures vary from -4°C to 10°C, in winter, and from 11°C to 19°C in summer.

The long-term average annual temperature varies from -0.4°C in the east to 15°C, in the west. The average topographic elevation of the watershed decreases from east to west, so it follows that the western part of the watershed is warmer than the eastern part (Figure 8).

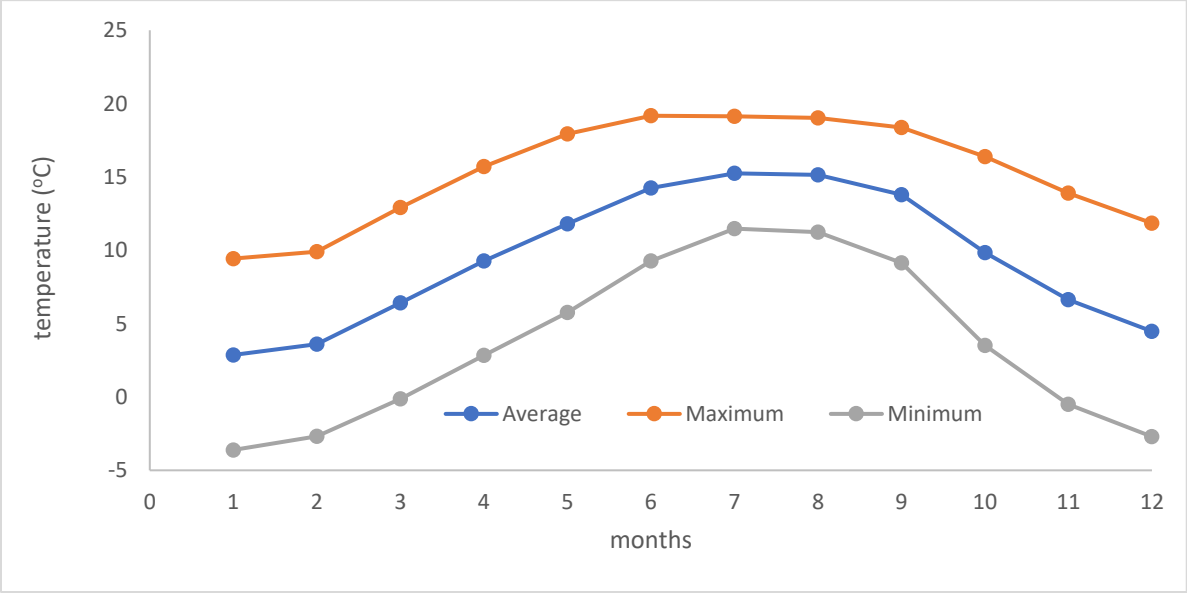

Figure 7: Monthly average temperatures in the Rara Khatyad watershed

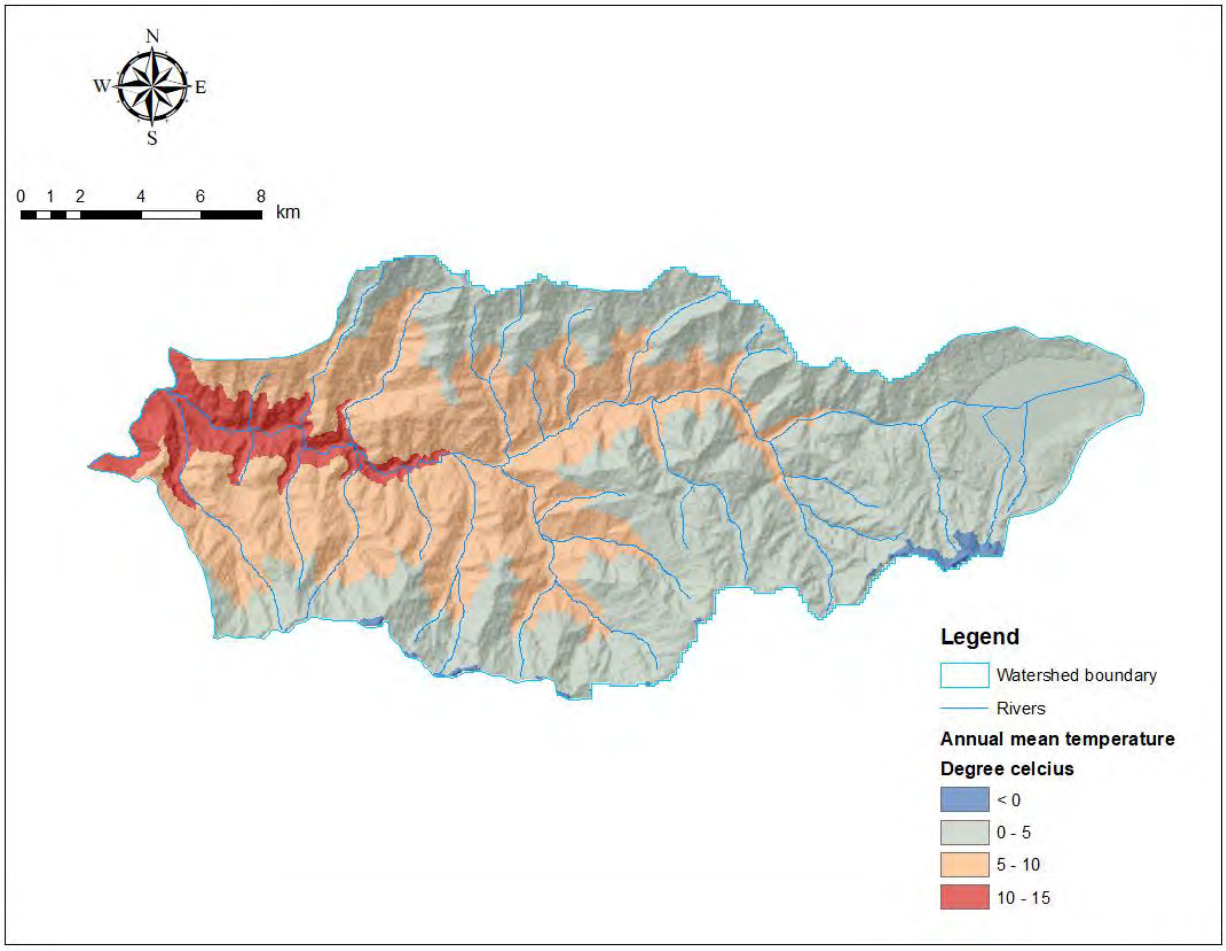

Figure 8: Mean annual temperature (ºC) distribution in Rara Khatyad watershed

2.5.2 RAINFALL

Rainfall estimates and projections were made using data collected from a station in Rara (the only station in the watershed) and a second station in Thirpu, located 17 km from the southern boundary in Mugu district.

The Theissen polygon method was used to estimate the average rainfall in the Rara Khatyad watershed. The comparison between the estimated average monthly rainfall in the watershed and the observed average monthly rainfall at Rara and Thirpu are shown in Figure 9. The figure shows that during wet season the eastern part of the watershed receives higher rainfall than the southwestern part. Thus, the watershed may receive a lower amount of overall rainfall than the amount recorded at Rara.

The highest and lowest monthly rainfall amounts are observed in August and November, respectively, and the seasonal averages are as follows:

Winter (Dec-Feb): 100 mm
Pre-monsoon (Mar-May): 158 mm
Monsoon (Jun-Sep): 462 mm
Post-monsoon (Oct-Nov) 34 mm

The average annual rainfall for the watershed is estimated at 755 mm.

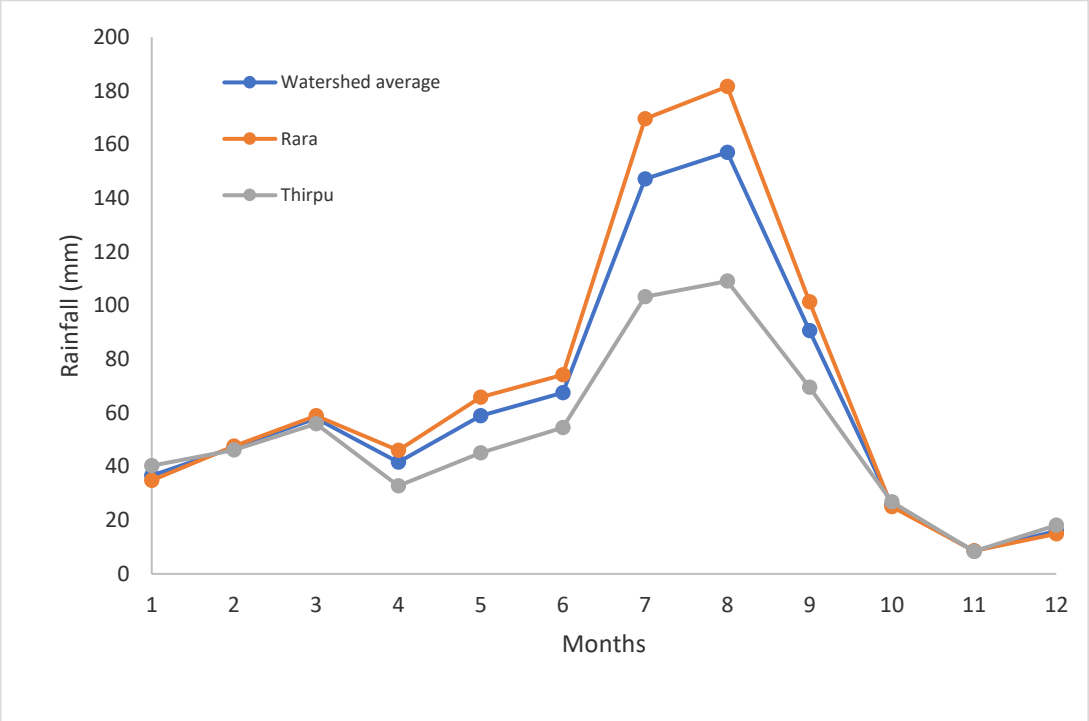

Figure 9: Long-term average monthly rainfall (in mm) estimated for the Rara Khatyad watershed

Evaluating rainfall and temperature over time reveals the impacts of climate change and suggests how the watershed, its residents, and biodiversity may be affected in the coming decades. Both rainfall and temperature are seen to be increasing; however, these changes vary spatially and seasonally.

Looking specifically at temperature in the watershed, the increasing trend varies seasonally (Figure 10): winter and post-monsoon are observed to increase at 0.02°C per year, while pre-monsoon and monsoon are increasing at 0.04°C per year. The average maximum rate of temperature increase for the entire watershed is +0.04°C per year.

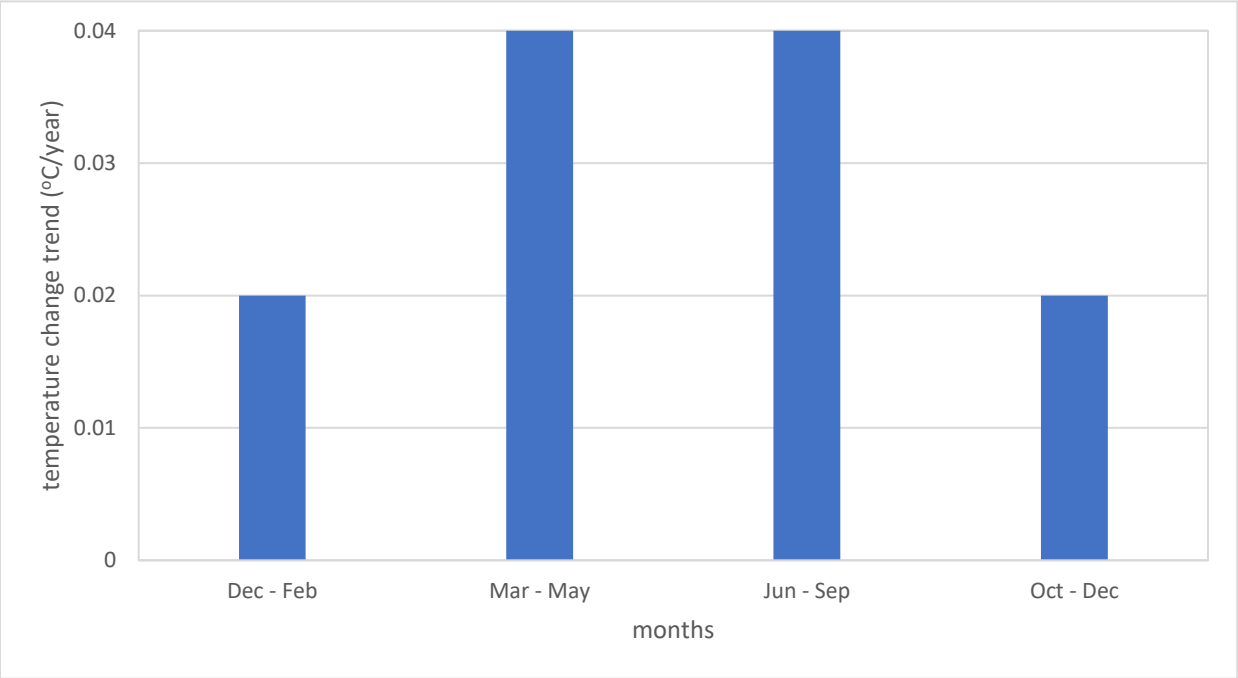

Figure 10: Temperature change trends by season (°C/year) in Rara Khatyad watershed

Rainfall trends are presented in Table 5 and Figure 11. The rate of change varies from -10 mm/year in the southern reaches of the watershed to 20 mm/year in the northern part. As with temperature, however, these trends are not consistent and suggest that households and agriculture will have to cope with unpredictable rainfall amounts and increasingly intense rainfall events throughout the year.

Table 5: Summary of seasonal rainfall trends observed in the Rara Khatyad watershed

Season	Months	Rainfall change rate mm/year	Remarks
Winter	Dec - Feb	-0.8 to 0	Eastern
		0 to 0.8	Western
Pre-monsoon	Mar - May	-3 to 0	Entire watershed
Monsoon	Jun – Sep	-10 to 0	Eastern
		0 to 10	Western
Post monsoon	Oct - Nov	0 to 1	Eastern
		-1 to 0	Western

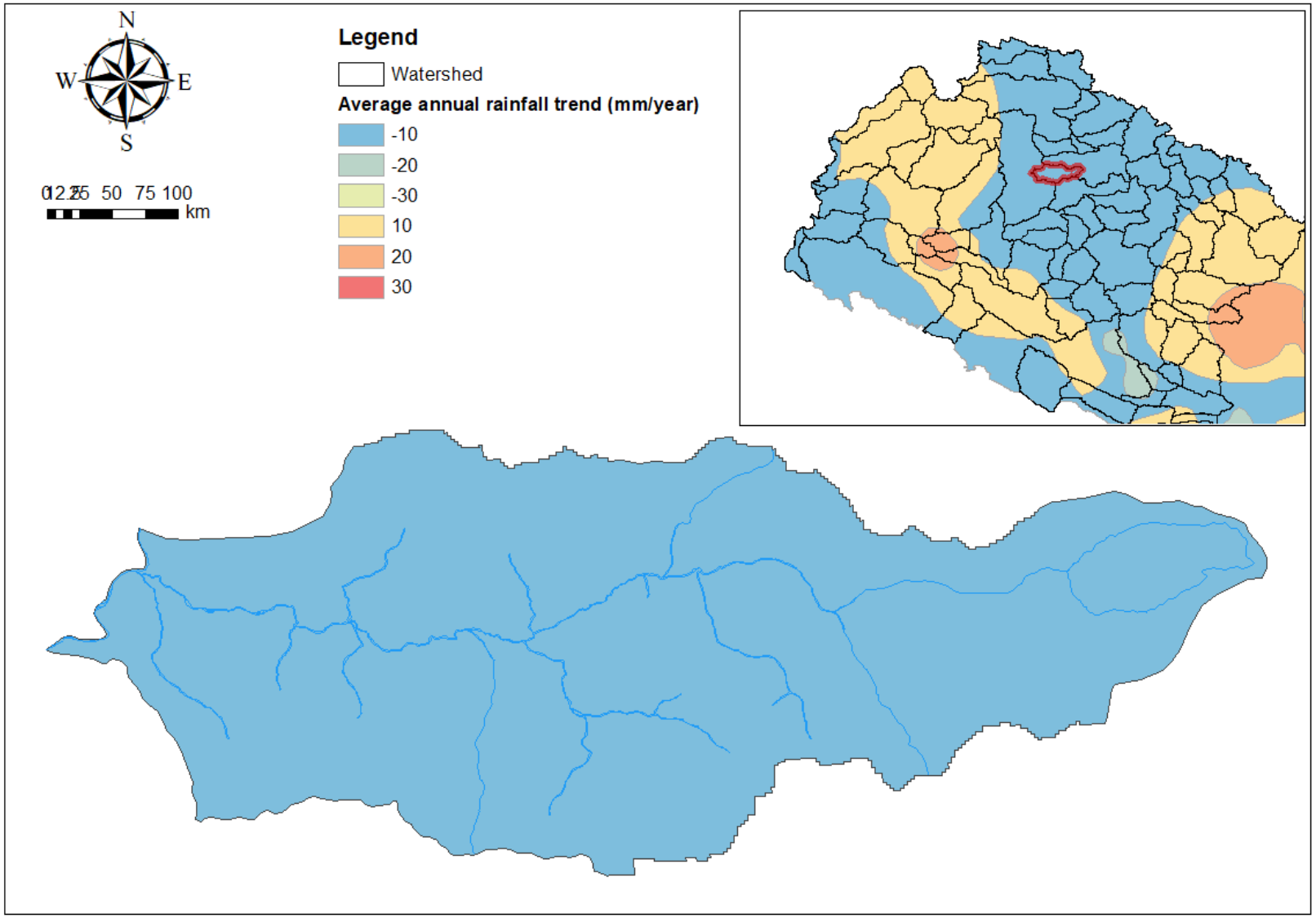

Figure 11: Long-term annual mean rainfall trends (mm/year) observed in the Rara Khatyad watershed

2.6. CLIMATE RESILIENCE AND DISASTER RISK REDUCTION

Given its high elevation and sharp topography, the area around the Rara Khatyad watershed is vulnerable to the effects of climate change, particularly in regard to its disposition toward natural hazard events like floods and landslides. As Table 6, illustrates, the frequency and intensity of these natural hazards has been increasing in recent decades.

Table 6: Notable natural hazard events in the Rara Khatyad watershed

Year	Disaster and epidemic outbreak	Place	Effects
1874	Landslide	Rikhiya	Rikhiya village swept away by flood
1934	Flood	Birabagar	Floods and landslides decimate Birabagar and nearby settlements
1984	Fire	Rikhiya	Fire destroyed all houses of Rikhiya Village
1989	Earthquake	Khatyad	Earthquake in the watershed destroyed many homes
1992	Cholera	Birabagar and Rikhiya	Death of ten people
1993	Drought	Birabagar and Rikhiya	Reduced production of crops
1998	Flood	Jama	Flooding in Jama claims one hectare of land
2002	Flood	Bhaune Khola	Flooding in Bhanue Khola destroys irrigation canal
2004	Flood and Diarrhoea	Bihani Khola	Flood destroyed 1.5 hectares of agricultural land in Jama, suffered village people due to diarrhoea outbreak
2007	Landslide	Bihani Kola	14 cows and buffalo lost
2008	Decrease in snow fall stated	Birabagar and Rikhiya	Apple production reduction, increased insects, less production of crops, less irrigation water available, drying up of water sources
2009	Hailstorm	Jama	Hailstorm damaged crops in Jama
2010	Hailstorm	Gamtha	Hailstorm damaged crops in Gamtha
2014	Landslide	Gander Khola	Landslide in Gander Khola destroyed several houses
2013	Disease spread in goat an sheep	Birabagar and Rikhiya	Large numbers of goat and sheep dead due to disease

Year	Disaster and epidemic outbreak	Place	Effects
2015	Hailstorm	Birabagar and Rikhiya	Hailstorm damaged crops in Birabagar
2016	Landslide	Gamtha	Landslide in Gamtha killed several livestock
2008	Decrease in snow fall	Gamtha	Apple production reduction, increased insects, less production of crops, less irrigation water available, drying up of waters sources
2017	Flood	Matwada	Flooding destroyed settlements in Matwada

Source: Focus Group Discussion (FGD) 2018

Local response to climate change has been slow in the Rara Khatyad watershed and few climate-resilient activities have been observed. One VDC (Sukhdhik) has implemented a Local Adaptation Plan of Action (LAPA). This LAPA reveals several climate change-related areas that need to be addressed, including natural hazards, forest degradation, agricultural productivity, and information gaps on available technology.

There is no early warning system operating in the Rara Khatyad watershed. Local households rely on FM radio for disaster-related information.

3. WEALTH

The population of the Rara Khatyad watershed is 16,919, 60% of whom identify as BCTS, 24% as Dalit, and 16% as Janajati (or indigenous). Agriculture is the overwhelmingly dominant form of livelihood (95.7%), followed by hospitality, livestock and a host of other labor-focused occupations (Table 7).

Only 37% of households (n=633) hold a bank account in an established financial institution. Of those who do not hold a bank account, 27% said lack of money and 69% said lack of financial literacy prevented them from using these institutions. There are 18 saving and credit cooperatives available in the watershed, with collective annual transactions of USD 144,479 and investments worth USD 51,760.

Table 7: Primary livelihoods by household in the Rara Khatyad watershed

SN	Livelihood	Percentage
1	Hospitality	1.11
2	Poultry	0.32
3	Agriculture	95.73
4	Off-farm (Handicrafts, retail shop, tea shop, micro-enterprise)	0.32
5	Herbal and medicinal plant sales	0.16
6	Wage labor	0.63
7	Livestock	0.79
8	Pension or social security	0.16
9	Fishing	0.32
10	Service sector	0.47
	Total	**100.00**

Source: Paani Survey 2018

Climate change impacts on the watershed have made agricultural productivity increasingly precarious in the watershed; thus, households have begun adopting climate-smart practices and technologies to cope with these changes (Table 7).

Table 8: Climate-smart practices and technologies adopted by household in the Rara Khatyad watershed

SN	Practice or technology	Percentage[3]
1	Gabion boxes	11.8
2	Re-forestation/afforestation	80.9
3	Household resettlement	5.5
4	Water source conservation	48.2
5	Drip irrigation or sprinkler irrigation	0.9
6	Alternative livelihood options	4.5
7	Information sharing about impending hazard conditions	3.6
8	Bio-fencing	7.3
9	Using improved or hybrid seeds	18.2
10	Irrigation canal construction or maintenance	10.0
11	Tunnel farming	17.3
12	Solar-pump irrigation	0.9
13	Plastic or cement ponds for water	2.7

3.1. FISHING PRACTICES

No households rely on fishing as a primary livelihood source because fishing in Rara Lake and nearby is prohibited. Along the further reaches of the Khatyad Khola, some households practice traditional methods to harvest fish for personal consumption or sale in local markets. Of the 633 households surveyed, 378 (59.7%) said they fished at some point during the year. Among the traditional fishing methods observed in the watershed were casting nets, dip nets, gradient traps, and loop lines. Three percent of the households that fished admitted using electric current, which is forbidden by law.

3.2. AGRICULTURAL PRODUCTIVITY

Cropping practices in the Rara Khatyad watershed are largely determined by altitude, climate, and the availability of irrigation. Farmers use traditional methods and the observed use of modern inputs such as fertilizers and improved crop varieties was only nominal.

All the major crops (i.e., rice, wheat, millet, barley, and potato) can be grown in the watershed, while a large variety of lesser crops are grown for sale and to round out local diets, such as: oats, maize, mustard, cabbage, radish, cucumber, and cauliflower. In a few select areas, apples, aprictots, and walnuts can be grown.

[3] These numbers add up to more than 100 because many households have adopted more than one climate-smart technology.

The collected holdings of agricultural land in the watershed is 6,500 ha, which amounts to an average land holding of 0.85 ha per household, which is a quite low on a national scale. Of that 6,500 ha, only 663 ha (10.2%) are irrigated; the rest is rain fed.

Farmers may utilize technical support through an agricultural service center in Shreekot. Occasionally, the center will distribute seeds and conduct soil tests for pests and disease. There is no market center for agricultural products yet developed, so most sales occur through local markets.

Production levels in Rara Khatyad lag behind what is needed in terms of nutritional demand in the area (Table 9). While more than 17,000 ropani (19.7 ropani = 1 hectare) are dedicated to cereal crops, only 28,983 quintals (1quintal = 100 lbs) of cereal are produce, leaving little for farmers to sell in the marketplace after meeting household demands for food.

Table 9: Crop production by area and production in the Rara Khatyad watershed

Crop type	Area (in ropani)	Production (in quintals)
Cereal	17,168	28,983
Pulses	2,459	3,501
Mustard	187	121
Vegetable	2,986	7,899
Fruits	598	1,059

Not surprisingly, perhaps, Mugu district (where the watershed is located) ranks lowest in the country in terms of food security. In 2015, a drought resulted in crop losses equaling USD 21,000. Survey results reflect these harsh conditions: 75% of households have six months of food reserves and less (table 10). Comments made during focus group discussion related this problem to decreasing snowfall in the region and the increasing presence of crop pests.

Table 10: Food sufficiency by household in the Rara Khatyad watershed

Length of food reserves	Percentage of HH
< 3 months	23
4-6 months	52
7-9 months	13
10-12 months	12
TOTAL	**100**

3.2.1. SOIL MANAGEMENT AND FERTILITY

Households in the watershed voiced loud concern over soil fertility: 85.2% said that fertility had declined over the past decade, and 88.9% said overall agricultural productivity had declined. They attributed the decline to landslides, soil erosion, and improper road construction. Morever, the quality of land in the watershed is generally low quality compared to many other parts of Nepal: 48% is considered marginal, 21% low production, 25% productive, and only 6% high production.

The decline in soil fertility combined with decreasing water sources has meant that local varieities of rice no longer grow in the watershed. But in some areas, such as Birabagar and Majhchaur, increasing temperatures have enabled some farmers to grow oranges and bananas.

In this challenging context, more farmers are turning to chemical pesticides to fight pests and fertilize crops, raising concerns about agricultural runoff into nearby waterways.

3.3. INFRASTRUCTURE

The design and construction of infrastructure, such as irrigation and hydropower, has an impact on the health of the watershed. For example, poorly designed irrigation can increase benefits to one group of farmers while reducing the amount of water available to other farmer populations. Similarly, hydropower plants that divert or impound water will restrict the amount of water available for aquatic life that people depend on for their livelihoods. As demonstrated by these examples, it is important that the design, construction and operation of infrastructure projects account for the full range of social, economic, and environmental conditions within the watershed. Sustainable infrastructure should provide equitable distribution of benefits with minimal long-term, environmental impacts.

In the Karnali Basin, the development priorities follow the "five B's": baato (road), bijuli (electricity), ban (forest), bichar (ideas), and bazaar (markets).

3.3.1. HYDROPOWER

There are 8 micro hydropower plants in the Rara Khatyad watershed area, but two are currently inoperative due to unresolved mechanical issues and one is under construction. Of the five still in operation, they generate collectively 160 kW of electricity (Table 11).

The Birbagar project, currently under construction, has drawn support from the Asian Development Bank (ADB) through collaboration with Nepal's Alternative Energy Promotion Center (AEPC). Environmental impact assessments of this project indicate that aquatic life will be affected along a 1 km stretch above and below the dam.

These projects have inspired some conflict between operators and local residents over water use. At the Bihani Khola project in Gamtha, residents complained that the project unnecessarily lowered the amount of water available for irrigation. Because the conflict could not be resolved, the project ceased operation soon afterward.

Table 11: Micro-hydropower projects in the Rara Khatyad watershed

SN	Name	Location	Capacity (kW)	Status
1	Khatyad-1	Khattyad-2, Seri	35	In operation
2	Khatyad-2	Khattyad-3, Srikot	60	In operation
3	Bhogoti Khola	Khattyad-5, Kawa	25	In operation
4	Bihani Khola	Khattyad-7, Gamtha	25	Inoperative; maintenance required
5	Aama Peltric Set	Khattyad- 8, Aama	5	Inoperative; maintenance required
6	Riga	Khattyad-8, Riga	10	In operation
7	Ghattekhola	Khattyad-11, Rikhiya	20	In operation
8	Birabagar	Khattyad-11, Birabagar	500	Under construction

3.3.2. MINING

The development focus on irrigation, hydropower, and road building in the Rara Khatyad watershed has meant a corresponding rise in mining from riverbeds (Table 12). Sand and stone are extracted for construction purposes, while silicon, shilajeet (pitch) and limestone are taken for commercial sale. However, according to interviews with government officials and local leaders, extraction levels are deemed sustainable at the present time.

Table 12: Mining sites in the Rara Khatyad watershed

SN	NP or GP	Ward/location	Type
1	Khatyad	Gaurikhola	Sand
2	Khatyad	Rina	Limestone
3	Khatyad	Radikhola	Sand
4	Khatyad	Baljada	Stone
5	Khatyad	Pipaldandi	Limestone
6	Khatyad	Saina, Kharka	Stone
7	Khatyad	Saina, Kharka	Sand
8	Khatyad	Garali Khola	Sand
9	Khatyad	Adari Gad	Stone

10	Khatyad	Sera	Red soil
11	Khatyad	Rawa	Silcon
12	Khatyad	Naid Khola	Calcium carbonate
13	Khatyad	Chhote and Nair	Calcium carbonate
14	Khatyad	Danfe	Calcium carbonate

3.3.3. ROADS

There are no strategic or national roads in the watershed, but 169 km of rural roads have been constructed by local GPs and NPs, in addition to 92 km of foot trails. Many of these rural roads were constructed between 2010-2012 through a World Food Programme (WFP) initiative (Table 13; figure 12).

Unfortunately, many of these roads reportedly were developed without proper environmental assessment prior to construction and have thus increased the likelihood and occurrence of landslides in the watershed. Use of environmental assessments has increased in recent years, and Gabion boxes were observed in many places to stabilize areas of weak road.

Leaders from Chhyanath Rara NP expressed plans for developing rural roads that will traverse parts of Rara National Park, which raised concerns from park officials who voiced apprehension about proper environmental assessment. Landslides not only damage property but also degrade aquatic habitats in rivers below.

Informants in Gamtha reported that road building in this area tends to disproportionately affect marginalized groups, who often live in areas that are vulnerable to landslides.

Table 13: Key roads in the Rara Khatyad watershed

SN	Locations connected	Length (km)
1	Seri – Juika - Riga	22.0
2	Chimadungri - Kalakanda	32.0
3	Seri – Narange - Gilaha	21.0
4	Kawa – Chimadhungri	16.0
5	Gamtha - Sukhthik	17.0
6	Gothekhola - Jyutha	2.0
7	Khamale	3.0
8	Chintu - Barantu	7.0
	TOTAL	**120.0**

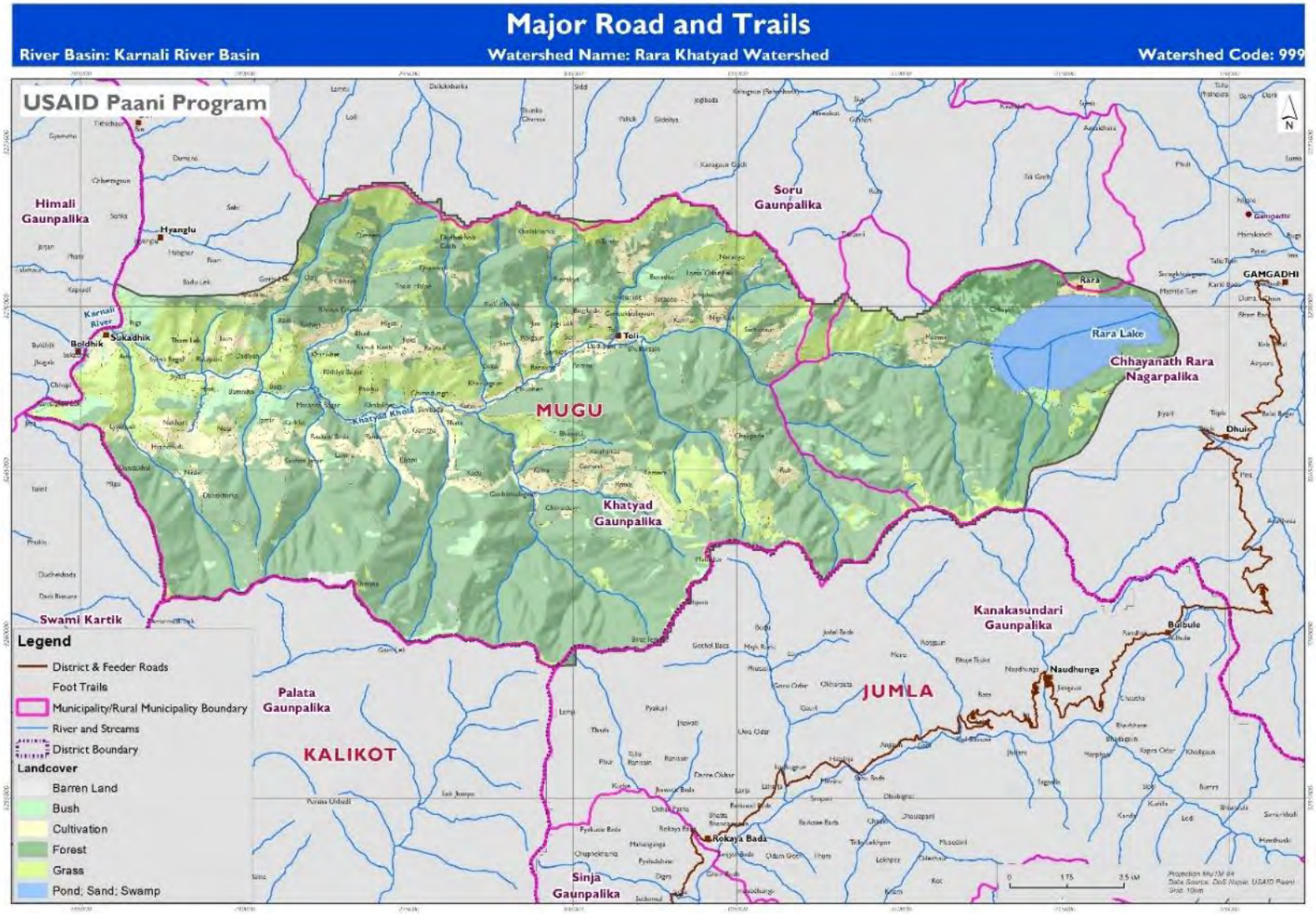

Figure 12: Road network in the Rara Khatyad watershed

3.3.4. IRRIGATION

The high elevation of the Rara Khatyad watershed means that irrigation is especially necessary for agricultural and household water use. There are 68 irrigation schemes in the watershed, serving 7,390 households and providing water to 1,382 hectares of land (Table 14). All of these schemes follow a customary system of management wherein all households contribute labor to maintain the system, or pay a tax if they are unable to provide that labor.

In Seri, the community elects a person (*Nayak*) who manages the system to facilitate equitable flow to all of the households within that scheme. The Nayak (known as Baidar in Jamma) also resolves local conflicts over water access, either finding a workable solution or taking the case up to the government level for more formal resolution or compensation, as the case may dictate.

The District Irrigation Office supports the community by providing technical support and construction materials, and by supporting repair and rehabilitation work as needed.

Water for the irrigation system is almost evenly divided between the river (50.4%) and rainfall (45.8%). Only 2.1% use harvest rainwater for irrigation.

Table 14: Irrigation schemes by type, land irrigated and households served in the watershed

Type	Number	Total agricultural land (ha)	Irrigated land (ha)	HH benefited
Canal (cement and rod)	57	1,428	1,252	6,269
Pipe	1	5	5	5
Nahar (earthen)	10	165	125	1,116
Total	**68**	**1,597**	**1,382**	**7,390**

3.4. SOLID WASTE AND MANAGEMENT

Households, slaughterhouses, and hotels and restaurants are the primary sources of solid waste in the area. Construction materials and pesticides are also becoming more common as non-point pollution sources.

Inside Rara National Park, plastic waste from tourists and trekkers is becoming more abundant. A growing number of restaurants and hotels in and around the park is also a source of concern, particularly for how the lack of sewerage in the area may affect Rara Lake over time.

While many GP and NP government officials said that waste management was an important policy of their annual planning, there was little implementation evident. In Khatyad GP, the local government has adopted a "one house, one bio-fertilizer" program to encourage more responsible waste disposal.

At the household level (Table 15), 65.1% said they burned their solid waste, while 42.2% used it for compost, 16.6% used available dumping sites, and 6.5% admitted dumping waste directly into nearby water bodies.[4] Regarding waste water, 68.2% said they reused household water in the family garden.

Table 15: Solid waste and waste water disposal practices by percentage in the Rara Khatyad watershed

Type	Method of disposal	Percentage of HH adopting this method
Solid waste	Landfill	27.8
	Dumping	16.6
	Composting	42.2
	Incinerate	65.1
	Dump in river or canal	6.5
	Nothing	4.3
Waste water	Septic tank	16.0
	Sewer system	39.3
	Garden	68.2
	Water bodies/open spaces	8.1
	Dispose in yard	6.5

[4] These numbers add up to more than 100 because many households use more than one mode of waste disposal.

4. POWER

In this section of the report, we detail and analyze the social, institutional, and regulatory structures through which water resources management, aquatic biodiversity management, and adaptation to climate change are planned and operationalized within the Rara Khatyad watershed. Analysis indicates there is a need to better understand how current institutional arrangements related to, for example, tourism or waste management (or not), improve resource sustainability and benefit sharing with local populations.

4.1. ACCESS AND INCLUSION

In this section, we review issues of access and inclusion in regard to natural resource use and management in the Rara Khatyad watershed.

4.1.1. ACCESS TO WATER FOR DOMESTIC AND AGRICULTURAL USE

Drying water sources are a major cause for concern in the Rara Khatyad watershed. While the issue of drying springs is still not perfectly understood, local residents attribute their disappearance to landslides and reduced snowfall over the past decade.

In the watershed, 83% of households have piped water as their primary source, while 15% rely on public stone taps. For those households with piped water, 94.5% draw that water from springs and the remainder have a private water source.

Regarding local perceptions of water access, surveys found general satisfaction: only 3.7% of respondents claimed unequal access.

The Constitution of Nepal stipulates that the federal, state, and local levels of government exercise the power of the State of Nepal pursuant to article 56(2). Certain legislative and executive powers have been vested in local level government (nagarpalika and gaunpalika), such as environmental conservation and biodiversity, local roads, agriculture, irrigation, drinking water supply, small hydropower, disaster risk reduction, and conservation of watersheds and wildlife (Schedule 8). At the same time, the federal, state, and local levels of government hold concurrent power on a range of other issues, including forest and jungle management, water use, ecology and biodiversity (Schedule 9). The willingness and ability of government entities to exercise these powers within the cooperative model of federalism have significant implications for the conversation of freshwater biodiversity and community resilience.

As one example of a promising development in these terms, the village assembly of Khatyad GP has listed conservation of drinking water sources as a priority for its constituents -- "one tap for every household." To date, the government has allocated 9 million rupees (or USD 90,000) for this project.

The new governance responsibilities under a federal structure suggest the time is appropriate to work closely with local authorities to develop plans to promote improved watershed health. The following agencies are the main agencies responsible in the Rara Khatyad watershed for water resource management:

- Water Supply and Sanitation Division Office (Gamgadi, Mugu)
- District Irrigation Sub-division Office (Gamgadi, Mugu)
- District Administration Office, (Gamgadi, Mugu)

- Buffer Zone Management Committees (Hutu, Mugu)
- Rara National Park (Hutu, Mugu)
- Various user groups (e.g., forests, water and sanitation)

4.1.2. ACCESS TO EARLY WARNING SYSTEMS (EWS) AND DISASTER RISK REDUCTION

Section 2.6 listed the various natural hazards that occur in the Rara Khatyad watershed. Of those events, flooding, landslides and avalanches are of the greatest concern for their ability to impose immediate and significant loss and damage to life and property.

There is no EWS system currently operating in the watershed, but the value of such a system is easy to appreciate. Additional minutes and hours to prepare for impending disaster could minimize the impact of future disasters.

Residents and local officials in Rara Khatyad noted that an EWS system as employed in other parts of Nepal would not be sufficient in their watershed. Due to the steep slopes in the watershed, an EWS should include rainfall forecasting so that downstream residents could be informed even of the potential for flood and landslides.

Some local planning disaster risk and reduction planning is underway in the watershed. Khatyad GP has announced its intention to relocate unsafe settlements in Riga, Thara, Kiteni, Jeuwari, Karmasi, Sewlibagar, and Gadhe Khola. Five million rupees (~USD 50,000) has been allocated for this work. Similarly, Chhayanath Rara NP has initiated a fund with an initial amount of USD 10,000 earmarked for disaster planning and remediation efforts.

4.1.3. ACCESS AND INCLUSION IN LOCAL NRM PLANNING

User groups for community forestry and water and sanitation provide an important forum for local stakeholders to share responsibility for and benefits accrued from natural resources in the Rara Khatyad watershed.

As such, natural resource management (NRM) groups have voiced concerns echoed throughout this report: unsustainable road building, increasing pollution and unmanaged solid waste, and increasing climate change impacts.

Household participation in NRM groups is impressively high: 91.5% claim affiliation with at least one group. Disaggregating membership by caste/ethnicity, surveys find that 100% of Janajati households, 93.4% of BCTS, and 82.2% of Dalits belong to an NRM group

National guidelines require that 33% of members in a user group be either female or from a socially marginalized group. All user groups in the watershed currently exceed this standard. However, on the topic of gender, only 17.5% of leadership positions in these groups are to be female, when national mandates stipulate 33% minimum.

To address these issues of women in leadership, Khatyad GP is requiring public construction committees to have 40% female membership, and it will provide a 5% public construction wiaver to those committees that are comprised of all women. Ideally, initiatives like these will become more common and long-standing inequities of gender discrimination confronted and overcome.

Related annexes
Annex 13: Commuity forest user groups

4.1.4. ACCESS TO BENEFIT SHARING IN THE WATERSHED

NRM user groups in Rara Khatyad are taking novel approaches to addressing issues of unequal benefit sharing. Community forest user groups, for example, allocated 35% of their annual budget to capacity building for women and marginalized groups. Examples of capacity building include financial literacy training, and collecting and adding value to NTFPs. Similarly, buffer zone management committees reserve between 30-50% annual for the same purposes.

4.2. COMMUNITY ACTION AND RESPONSE

This section provides detail on community planning and response to climate change and disaster risk, how communities collaborate for improved natural resource management, and the status of local compliance with existing environmental policies and regulations. Taken together, these aspects of community action reveal significant information about a watershed population's ability to adapt to future challenges.

4.2.1. CLIMATE CHANGE ADAPTATION AND DISASTER RISK REDUCTION

As more than 95% of the population in Rara Khatyad is dependent on climate-sensitive agriculture, variations in temperature and precipitation are causing serious livelihood distress to communities in the watershed. For example, red rice cultivation is no longer productive for farmers. To adapt to these changes and others, climate-smart technologies can strengthen cropping and livestock systems and promote greater resilience overall.

However, uptake and use of these technologies has been generally low in the watershed: only 22% of households surveyed said they had adopted a climate-smart technology or practice for their homes and/or work. Among the practices reported and observed were referred afforestation, resettlement of vulnerable communities in terms of disaster risk, water source protection, drip irrigation improved seed varieties, water recharge ponds, and Gabion boxes to fight soil erosion. The list collected from household survey is presented in Table 16.

Table 16: Adaptation practices in the watershed area

Adaptation practice or technology	% of households adopting
Gabion wire construction	11.8%
Afforestation	80.9%
Resettlement to secure place	5.5%
Water Source Conservation	48.2%
Drip irrigation/sprinkler system use	0.9%
Adopting alternative livelihood options	4.5%
Early warning system support	3.6%
Bio Fencing	7.3%
Improved /hybrid variety use	10.0%
Irrigation canal construction and maintenance	10.0%
Tunnel farming (Vegetable)	17.3%
Solar lift irrigation system adoption	0.9%
Drought tolerant variety use	8.2%

Shallow tube well	0.0%
Plastic/Cement pond construction	2.7%

Table 17: Climate change and adaptation highlights from the Rara Khatyad watershed

Location	Initiative	Remarks
Khatad GP	Fruit growing	Apples, lemons and Schezwan pepper cultivation encouraged
	Disaster risk reduction	Promoting awareness about fire control and fire line construction
Chhyhanath NP	Climate change mitigation program	USD 5,000 allocated
	Forest and soil conservation program	USD 54,000 allocated to promote environmental-friendly practices

Related annexes

Annex 13: Community user forest groups

4.2.2. COMPLIANCE WITH LAWS AND POLICY PROVISIONS

While there are national laws and policy that require proper environmental assessment prior to mining and construction, local residents reported that compliance with these provisions was generally low in the watershed. When asked why compliance was low, respondents said that low literacy among the population and general lack of knowledge regarding policy specifics were responsible.

Via surveys and KIIs, it was determined that much of the non-compliance witnessed in the Rara Khatyad watershed was owed not to disregard for policy, but rather general lack of knowledge and unawareness. For example, the Aquatic Animal Protection Act forbids certain forms of fishing such as electric current. But when questioning fisherman about using electric current, it was discovered that none knew they were in violation of the law. However, in some cases, it was found that some individuals do knowingly violate the law, in particular fishing in protected areas of Rara National Park and poaching animals from this area.

Similarly, non-compliance with solid waste regulations has resulted from a lack of approved or reliable systems for proper disposal. Members of the buffer zone management committees said they were unable to provide proper monitoring and enforcement of existing solid waste policy.

On the topic of wetland management and protection, the nine wetlands of the watershed were declared a RAMSAR site, which requires local governments to implement measures to promote conservation. However, local leaders in Khatyad GP and Chhyanath NP admitted they had been unable to fulfill these obligations due to a lack of resources and capacity. This situation suggests that international mandates like RAMSAR, though well-intentioned, draw their actual strength from the host country's ability to support them.

4.3. GOVERNANCE

Governance and its responsiveness to community needs and aspirations provide a key focal point for managing natural resources sustainably, strengthening community resilience, and conserving freshwater biodiversity.

Through the Local Government Operations Act 2014, local bodies are invested with the authority to regulate planning related to biodiversity, water sources, and natural resources. Exercising this authority, ideally, fulfills the guarantee of the right of every Nepali to live in a clean and healthy environment (Constitution of Nepal, article 30(1)). Accordingly, the Paani team observed many local governments working to implement provisions into their annual budgets to address a wide range of environmental issues specific to the Lower Karnali watershed: disaster risk reduction, solid waste management, anti-poaching measures, and sustainable development processes.

Watersheds, however, present a unique challenge to local governance. As Rara Khatyad extends over three municipalities, there is not a regulatory framework in place to help local governments coordinate efforts and collaborate on biodiversity and natural resource issues. However, it should be noted that this lack also presents a promising opportunity.

Wetlands and Rara National Park offer one potential opportunity for such cooperation between local governments and the development of collaborative frameworks. According to the National Wetlands Policy 2012, local governments are invested with authority to conserve wetlands and sustain the viability of traditional knowledge in support of that goal. One of the provisions in this policy calls for establishing a wetland fund that municipalities can establish and agree to use in a collaborative manner.

In this regard, establishing a wetland fund would also benefit from active participation from leadership at Rara National Park and among the various user groups in the watershed.

5. MAJOR ISSUES AND CHALLENGES

Stakeholders in the Rara Khatyad watershed were asked to list their environmental concerns, particularly in relation to sustainability and livelihoods.

The list below presents the issues and challenges as identified by that group in an entry multi-stakeholder consultation (MSC) workshop. The list and map (Figure 13) were drawn up after the Paani team presented its initial major findings about the Rara Khatyad watershed. The workshop participants were selected from a wide range of backgrounds representing local residents, civil society groups, and government agencies.

The major issues in the Rara Khatyad watershed:

- Rising unmanaged waste water and solid waste disposal;
- Forest degradation contributing to water pollution;
- Unmanaged and environmentally unsustainable road construction;
- Drying water sources;
- Increased flow of tourists without proper systems to manage this increase;
- Declining fish numbers; and
- Reduced snowfall and attendant environmental impacts.

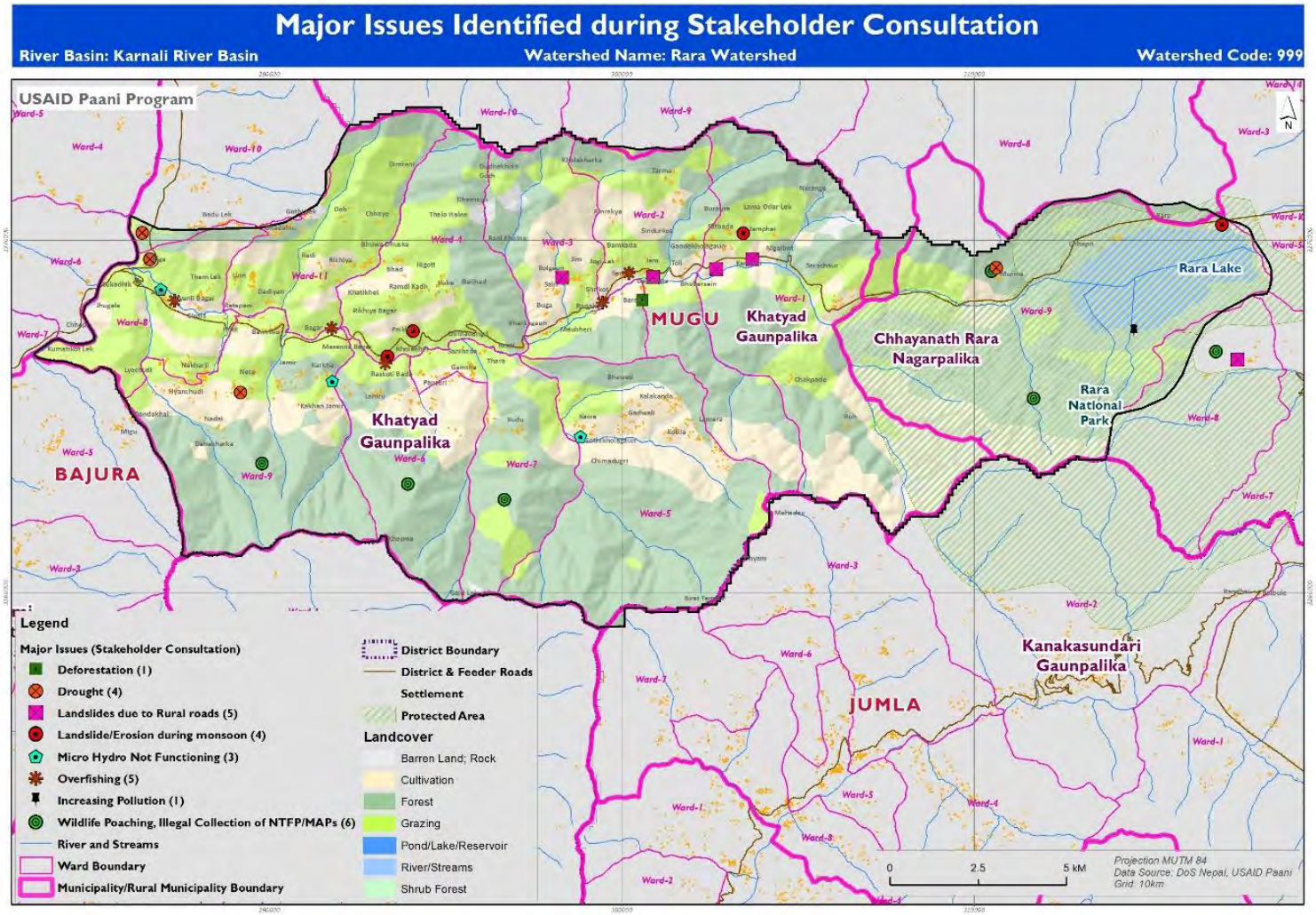

Figure 13: Environmental issues in the Rara Khatyad watershed as mapped by stakeholders

6. PRIORITIZING ENVIRONMENTAL THREATS AND OPPORTUNITIES

The environmental issues identified in section 5 were then discussed 18 months later at an exit workshop with a focus on the specific impacts and potential opportunities for addressing these impacts (Table 18). Through this exercise, the Paani team noted that the capacity and awareness among all members in the workshop had increased significantly since the start of the research.

Table 18: Environmental issues, impacts and opportunities to address in the Rara Khatyad watershed

SN	Issue	Impacts	Opportunities
I	Improper road construction	Road development is a high priority in the area, which is remote and far from larger market centers and medical services. However, road construction is undertaken without prior and proper environmental impact assessments. Heavy equipment damages the fragile hillsides and oftentimes precipitates landslide events and weakens the local geological structure.	• Raise awareness and build capacity in local government and contractors about the Environment Friendly Local Governance (EFLG) framework; • Provide training and support for low-cost stabilization techniques for slopes and river banks using bioengineering methods and river bank planting; and • Form committees of concerned citizens to advocate for environmentally friendly road construction.
II	Declining fish numbers	Infrastructure development (primarily roads) and destructive fishing practices (e.g., poison or electric current) affect aquatic habitats and fishery operations, resulting in declining fish numbers in the Khatyad River and its tributaries.	• Develop high-value fishing opportunities in the Karnali basin to attract tourists and bring attention to Nepal's fishing cultural heritage; • Train local fishing groups in modern angling skills; • Promote game fishing development for youth; • Establish a fish hatchery in the watershed along the Khatyad Khola; • Discourage recreation fishing in Rara Lake as it will negatively impact the breeding stock of snow trout over time;

SN	Issue	Impacts	Opportunities
			• Establish fish sanctuaries on feeder streams and the tail water of Rara Lake to replenish fish stocks as needed; and • Promote eco-friendly tourism around Rara Lake to take advantage of the pristine wilderness of the area.
III	Drying water sources, reduced snowfall	Due to reduced snowfall in the watershed, water sources (e.g., wells and springs) have correspondingly declined, affecting agricultural production.	• Raise awareness about multiple use of water technologies (MUS) – such as sprinkler irrigation and drip irrigation – that maximize water use efficiency; • Plant trees and shrubs in the springshed and on barren land in the community to retain more rainwater and reduce run-off that can recharge natural springs; • Initiate mapping of spring sources and implement springshed management related activities; and • Facilitate construction of snow and rainwater harvesting ponds in the watershed area.
IV	Solid waste management	Increasing tourism to the area has raised the amount of waste that is generated in the watershed. Without a proper disposal infrastructure, much of this waste is deposited into nearby waterways that impact water quality.	• Provide training to the community to increase awareness about solid waste management, including the need to segregate biodegradeable and non-biodegradeable solid waste; • Install dustbins along the popular footpaths around Rara Lake and coordinate disposal of this waste with local communities; • Initiate a garbage accounting system at the entry and exit points of Rara National Park; • Develop solid waste management plans for Khatyad GP and Chhayanatha Rara NP; • Promote collaboration with Rara National Park and its buffer zone committees to reduce waste and improve waste management; • Improve monitoring of waste disposal from hotels and restuarants inside the National Park; and • Facilitate the relocation of hotels (when possible) to new sites further away from local waterbodies.

SN	Issue	Impacts	Opportunities
V	Human and wildlife conflicts	Wildlife feed on local cereal crops, placing an added burden on local farmers to produce enough grain for sale and consumption.	• Improve communication between households and the National Park to establish more flexible policies for benefit sharing of local natural resources; • Simplify and streamline the compensation system for the families of wildlife victims and farms impacted by wildlife encroachment; and • Support buffer zone communities by mobilizing funds from the National Park earmarked for this purpose.
VI	Wildlife poaching, excessive grazing, and illegal harvesting of NTFPs	Medicinal herbs are a major source of income in the watershed, but overharvesting at current rates threatening the long-term viability of many species and contributes to soil erosion and biodiversity loss. Similarly, wildlife poaching in and near Rara National Park has inspired conflict between park officials and local residents.	• Establish a community-based anti-poaching group to monitor for illegal fishing activity and animal and NTFP poaching; • Promote alternative livelihood options of local communities linked to eco-tourism. These activities would support the local economy by improving livelihoods and providing employment opportunities, such as local homstays for travelers, horse-trail rides to Murma Top, and bird watching expeditions in the wetlands.

7. VISION AND MISSION STATEMENT FOR THE RARA KHATYAD WATERSHED

This Rara Khatyad watershed profile has been prepared through various consultative processes, actively engaging with stakeholders from media, civil society organizations, government agencies, government offices, and environmental research institutions.

7.1. VISION STATEMENT FOR THE RARA KHATYAD WATERSHED

At the exit MSC workshop held in September 2018, participants were divided into three groups (nature, wealth and power) to draft separate statements for the watershed as they wished to see it 20 years from now. These three statements were then combined for a single vision statement:

रारा खत्याड जलाधारको दुरदृष्टि:
व्यवस्थित ताल, संरक्षित जैविकविविधता पर्यापर्यटनको आधार ।
समन्यायिक र समावेशीता सुनिश्चत भएको समृद्ध रारा खत्याड जलाधार ॥
Translation of watershed vision prepared in multistakeholder workshop:
To a future with well-managed lakes and rich biodiversity as the foundation of a thriving eco-tourism sector with inclusive and equitable benefit sharing for all.

7.2. COMMITMENTS TO CONSERVING THE RARA KHATYAD WATERSHED

Table 19: Action commitments by theme in the Rara Khatyad watershed

SN	Issue	Activities	Responsible organizations
1	Waste management	Awareness raising and capacity building	Yuwa Sanjal Khatyad GP
2	Watershed conservation	Establish a nursery for producing seeds and plants	Yuwa Sanjal Khatyad GP
3	Plant/tree pest control	Replanation and reduced use of pesticides	Yuwa Sanjal Khatyad GP
4	Medicinal herbs conservation	Establish a medicinal herbs processing center in coordination with Rara National Park and the District Forest Office	Yuwa Sanjal Khatyad GP

SN	Issue	Activities	Responsible organizations
5	Fish and aquatic biodiversity conservation	Restrict the use of pesticides near Rara Lake, reduce waste generation, and prohibit use of destructive fishing practices	Yuwa Sanjal Khatyad GP
6	Environmental laws, policies and provisions	Formulate policy in coordination among local governments to promote enhanced watershed conservation	All local governments
7	Fisheries	Raise awareness on importance of aquatic biodiversity conservation in the watershed area	NIFUWAN, Paani Program, and local governments
8	Flood, landslide, and soil erosion control	Raise awareness about need to replant barren areas	FECOFUN and all local governments
9	Water	Identify water quality challenges and develop plans to address these challenges	Local governments in coordination with user groups
10	Solid waste	Raise awareness on solid waste management and household waste generation	Local governments in coordination with Mothers Groups
11	Soil conservation	Promote and implement a terrace improvement program and annual and seasonal fruit planation (e.g., apples, walnuts, citrus)	Agricultural Information Center
12	Crop conservation	Promote use of bio-pesticides and bio-fertilizer to control pests	Agriculture Information Center
14	Lake management	Promote sanitation and waste management around the lake	Agricultural Information Center Khatyad GP
15	Reductions in agricultural productivity	Establish a nursery and plantation in the watershed	Khatyad GP
16	Soil erosion due to improper road construction	Enforce existing environmental measures for responsible road construction (e.g., EIA, IEE)	Khatyad GP
17	Protect Rara Lake	Declare formally Rara Lake's protected status and devise policy in support of this status	Khatyad GP
18	Gender-based violence	Raise awareness about the prevalence and effects of gender-based violence	Women and Children's Development Office
19	Low income opportunities for women	Provide skill development trainings to open up new income opportunities for women to pursue	Women and Children's Development Office
21	Watershed conservation	Formulate and implement policies and laws to strengthen conservation efforts	Khatyad GP

SN	Issue	Activities	Responsible organizations
22	Drying water springs	Promote replantation and spring conservation	Khatyad GP and relevant stakeholders
23	Waste management	Promote waste management measures near hotels and market places	Khatyad GP and relevant stakeholders
24	Medicinal and aromatic plants	Promote conservation of medicinal and aromatic plants to insure sustainable production and harvests	Khatyad GP and relevant stakeholders
25	Fish	Enforce existing policy that prohibits illegal fishing practices	Khatyad GP and relevant stakeholders
27	Micro-hydro projects	Raise awareness on need to make efficient use of electricity and monitor potential for corruption	Electricity Office and relevant stakeholders
28	Wildlife and NTFP poaching	Create media campaign to advocate for responsible harvesting of wildlife and NTFPs from buffer zones and within the National Park	National Park, Forest Office and CFUGs
29	Soil erosion	Publish and broadcast news and notice on soil conservation and awareness raising on laws and policy	Local governments and non-government organizations
30	Solid waste and drainage management	Awareness raising, separation of degradable and non-degradable solid waste and laws and policy formulation	Rara National Park, Forest Office, Buffer Zone Management Committees, and CFUGs

8. RECOMMENDATIONS

Based on the data collected by the Paani Program Team through surveys, FGDs, and KIIs, and through consultation with various stakeholders at the exit workshop, the following recommendations are offered for improving biodiversity and freshwater conservation in the Rara Khatyad watershed:

- Raise awareness and build capacity in local government and contractors about the Environment Friendly Local Governance (EFLG) framework;
- Provide training and support for low-cost stabilization techniques for slopes and river banks using bioengineering methods and river bank planting; and
- Form committees of concerned citizens to advocate for environmentally friendly road construction.
- Develop high-value fishing opportunities in the Karnali basin to attract tourists and bring attention to Nepal's fishing cultural heritage;
- Train local fishing groups in modern angling skills;
- Promote game fishing development for youth;
- Establish a fish hatchery in the watershed along the Khatyad Khola;
- Discourage recreation fishing in Rara Lake as it will negatively impact the breeding stock of snow trout over time;
- Establish fish sanctuaries on feeder streams and the tail water of Rara Lake to replenish fish stocks as needed;
- Promote eco-friendly tourism around Rara Lake to take advantage of the pristine wilderness of the area;
- Raise awareness about multiple use of water technologies (MUS) – such as sprinkler irrigation and drip irrigation – that maximize water use efficiency;
- Plant trees and shrubs in the springshed and on barren land in the community to retain more rainwater and reduce run-off that can recharge natural springs;
- Initiate mapping of spring sources and implement springshed management related activities;
- Facilitate construction of snow and rainwater harvesting ponds in the watershed area;
- Provide training to the community to increase awareness about solid waste management, including the need to segregate biodegradeable and non-biodegradeable solid waste;
- Install dustbins along the popular footpaths around Rara Lake and coordinate disposal of this waste with local communities;
- Initiate a garbage accounting system at the entry and exit points of Rara National Park;
- Develop solid waste management plans for Khatyad GP and Chhayanatha Rara NP;
- Promote collaboration with Rara National Park and its buffer zone committees to reduce waste and improve waste management;
- Improve monitoring of waste disposal from hotels and restuarants inside the National Park; and
- Facilitate the relocation of hotels (when possible) to new sites further away from local waterbodies. Improve communication between households and the National Park to establish more flexible policies for benefit sharing of local natural resources;
- Simplify and streamline the compensation system for the families of wildlife victims and farms impacted by wildlife encroachment;
- Support buffer zone communities by mobilizing funds from the National Park earmarked for this purpose;
- Establish a community-based anti-poaching group to monitor for illegal fishing activity and animal and NTFP poaching;

- Promote alternative livelihood options of local communities linked to eco-tourism. These activities would support the local economy by improving livelihoods and providing employment opportunities, such as local homstays for travelers, horse-trail rides to Murma Top, and bird watching expeditions in the wetlands;
- Prepare RAMSAR site management plan for Rara Lake;
- Develop capacity of local and provincial governments to develop more comprehensive conservation laws and to enforce these laws more strongly;
- Enforce existing road construction guidelines to protect areas within the national park; and
- Prepare guidelines for community-based anti-poaching groups to reference and enforce.

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ANNEXES

ANNEX 1: PROFILE METHODOLOGY

The overall objective of the watershed profiling process is to develop and enrich a shared understanding among key stakeholders about the major issues that affect local watershed health and water resource management. This watershed profile reflects the collective understanding and aspirations of people in the Rara Khatyad watershed and concerned institutions so they can provide baseline information to help identify priorities for project design and implementation. Moreover, the profile can support the development of tools for watershed planning and approaches for collaborative management moving forward. The profile serves as a foundation for:

- Building consensus and common understanding among the Rara Khatyad watershed's stakeholders on the current situation and future;
- Establishing a benchmark for activities targeting human and ecological communities in the watershed by describing the existing interaction between people and nature;
- Identifying potential priority areas for stakeholders to plan and work together on local-level activities to improve watershed management of the Rara Khatyad area where the USAID Paani Program and other projects can provide support; and
- Providing a platform for consultation and advocacy for Rara Khatyad watershed stakeholders through which they can participate in decision-making at the river basin and policy levels.

The watershed area was delineated using GIS tools during the watershed prioritization stage. This profile was prepared by drawing on a range of data sources including,

1. Secondary literature and information related to biophysical conditions, socio-economic characteristics, infrastructure, vulnerability and disaster risk, and freshwater biodiversity of the watershed;

2. An entry multi-stakeholder consultation [MSC] workshop was conducted to

    a) Share preliminary results of watershed conditions;

    b) Identify priority threats, vulnerabilities, and biodiversity values by location and impact groups; and

    c) Prepare detailed plans for the key informant interviews (KII), focus group discussions (FGD), and water quality and water discharge measurements;

3. Household (HH) surveys to assess the differential impacts of various environmental issues;

4. FGDs to assess the severity of environmental threats and significance values associated with Paani focal interests; and

5. KIIs to explore the causes and intensity of the particular environmental issues in the watershed. Different guiding checklists designed around Paani focal interest areas and cross cutting areas were used while conducting surveys including governance, gender and social inclusion and policy.

The consolidated data collected through these methods was presented to group leaders at the exit MSC workshop to provide the participants with a shared foundation for identifying and prioritizing watershed health issues in Rara Khatyad watershed. We also used this information to identify possible solutions and champions for leveraging knowledge and support through partnerships with local agencies and organizations.

All total 633 HHs surveys were conducted in locations selected during the entry MSC, as participants indicated specific issues and challenges appropriate to their respective areas.

To complement the surveys, we conducted 8 FGDs and 7 KIIs to investigate the key issues identified by households. Citizen scientists were mobilized for water quality test and discharge measurement.

Paani conducted water quality test for two times in dry and monsoon season 2018. The program tested Ph value, iron, nitrogen nitrite, nitrite nitrate, ammonia, phosphate, and conductivity, turbidity, dissolved oxygen, temperature and discharge of water. Paani used different tools and methods for testing water quality and discharge. Paani used AKVO Flow application for testing water quality. For this purpose, Paani trained citizen scientists and then conducted the test mobilizing them.

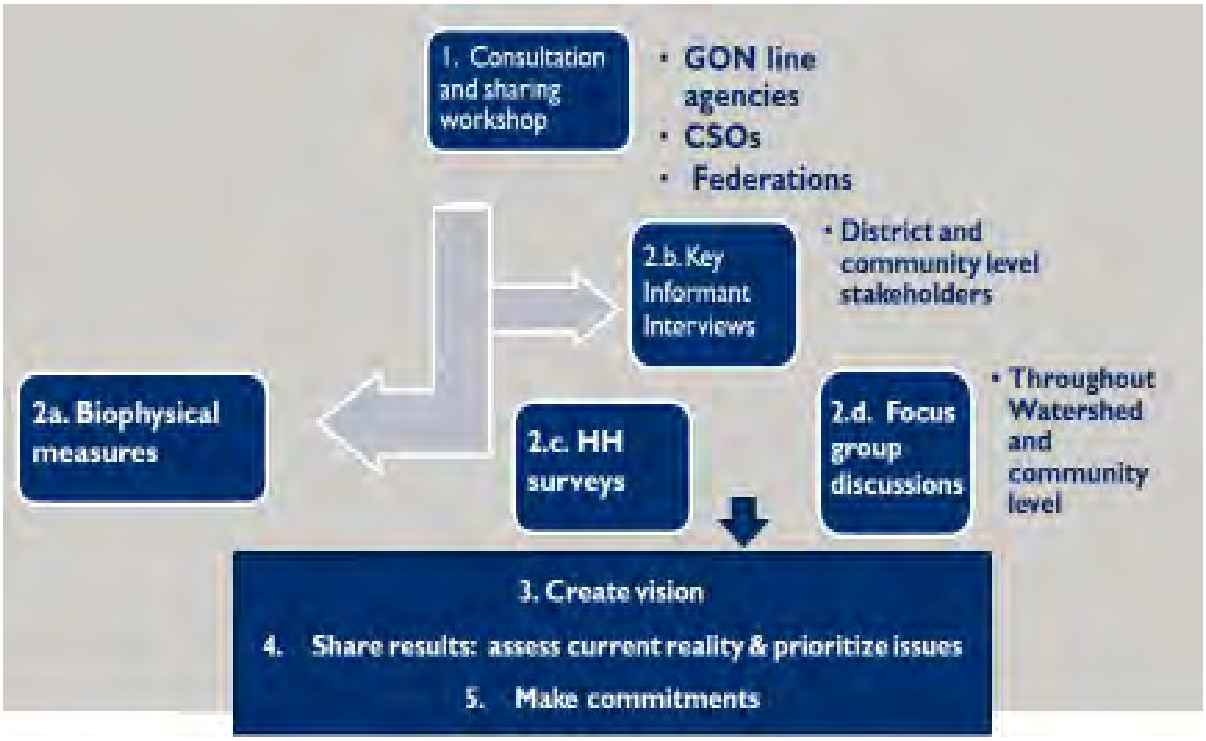

Figure 14: Steps of watershed profiling process

ANNEX 2: POPULATION

Table 20: Population in the Rara Khatyad watershed by sex and caste/ethnicity

Category		Total	Percentage
Sex	Male	8,386	50.5
	Female	8,210	49.5
Caste/ethnicity	BCTS	9,958	60.0
	Dalit	3,523	21.2
	Janajati	3,069	18.5
	Madhesi	66	0.4
	Total	16,596	100

Table 21: Migration destinations outside Nepal for persons from the Rara Khatyad watershed

SN	Destination Area	Number	Percent
1	India	605	79.2
2	Middle East	136	17.8
3	Europe and America	5	0.7
4	Far East	2	0.3
5	Other	16	2.1
	Total	**764**	**100**

Source: Profile of Khatyad RM, 201

ANNEX 3: TEMPERATURE AND PRECIPITATION

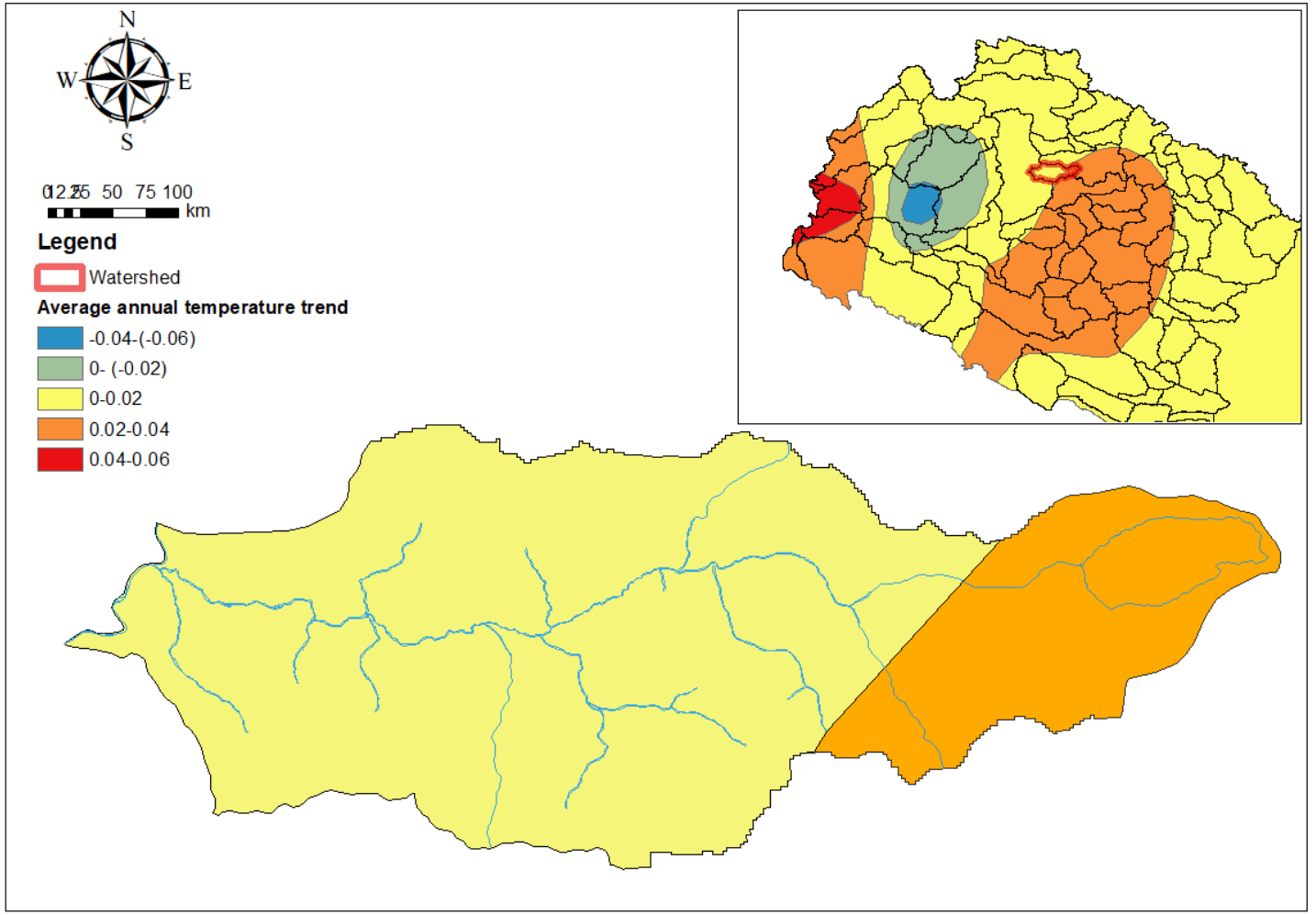

Figure 15: Annual mean temperature change trend in Rara Khatyad watershed

ANNEX 4: LAKES, STREAMS, RIVERS, AND SUB-WATERSHEDS

Table 22: List of wetlands in the Rara Khatyad watershed

SN	Name	Uses
1	Rara Lake	Fish sanctuary, boating
2	Bagad Jiula	Irrigates paddy fields
3	Khesma	Irrigation and drinking water
4	Chhote	Drinking water
5	Gamtha	Irrigation and Drinking water
6	Nilasain Daha	Irrigation and drinking water
7	Mani Daha	Irrigation and drinking water
8	Nauli Daha	Irrigation and drinking water
9	Rig Daha	Irrigation and drinking water

Table 23: Types of water bodies in the Rara Khatyad watershed

SN	Name	Type	Origin Place	Uses
1	Putta Khola	Stream	Ghatte Khola	Water mill, irrigation
2	Khatyad Khola	Stream	Rara Lake	Water mill, irrigation, micro hydropower
3	Ghatte Khola	Stream	Aadegaad River	Water mill, irrigation
4	Adarigad Khola	Stream	Tallpanni Mul	Drinking water
5	Ghatte Khola	Stream	Bikeri Ghutghute	Water mill, irrigation
6	Chuchche Khola	Stream	Chuchche	Irrigation
7	Dudhe Khola	Stream	Chuda	Water mill, irrigation
8	Bhune Khola	Stream	Gudgude	Irrigation
9	Byani Khola	Stream	Byani	Water mill, irrigation
10	Paikhu Khola	Stream	Paikhu	Irrigation
11	Khapade Khola	Stream	Khola Khet	Irrigation
12	Bhittar Khola	Stream	Rina Ranke	Water mill

13	Dogadi Khola	Stream	Bayale	Water mill, irrigation
14	Bhqgoti Khola	Stream	Paudi	Water mill, irrigation
15	Nauli Khola	Stream	Nauli	Drinking water, water mill, irrigation
16	Ghatte Khola	Stream	Danphejur	Drinking water, water mill, irrigation
17	Khopade Khola	Stream	Khopade	Irrigation
18	Mungraha Khola	Stream	Phing Khola	Irrigation
19	Bihani Khola	Stream	Khesma	Drinking water, irrigation
20	Kawa Khola	Stream	Dhaulabid	Drinking water, water mill, irrigation
21	Beni Khola	Stream	Bhitraban	Water mill, irrigation
22	Ruwa Khola	Stream	Bhitraban	Water mill, irrigation
23	Dosalna Khola	Stream	Adari Khola	Irrigation
24	Ghatte Khola	Stream	Par Khola	Water mill, irrigation
25	Launigad Khola	Stream	Siyala	Water mill, irrigation

ANNEX 5: FORESTS AND PLANT LIFE

Table 24: Forest types by area and percentage in the Rara Khatyad watershed

Type	Area (sq km)	Percentage
Mixed hardwood	52.7	68.0
Sal	0.3	0.4
Pine	5.8	7.4
Sisau (sisam)	0.6	0.7
Banjh Oak (Quercus)	14.9	19.3
Himalayan Fir (Abies)	2.1	2.7
Deodar Cedar	1.2	1.5
Total	**77.5**	**100.0**

Table 25: List of non-flowering plant species in the Rara Khatyad watershed

SN	Scientific name	Scientific family
1.	Batrachospermum moniliforme	Batrachospermaceae
2.	Chaetopora incrassata Hazen	Chaetophoraceae
3.	Stigeoclonium elongatum (Hassall)	Chaetophoraceae
4.	Chara exelsa T.F. Allen	Characeae
5.	Chroococcus minutus (Kütz.) Näg	Chroococcaceae
6.	Dinobryon sociale (Ehrenberg)	Chrysophyceae
7.	Actinotaenium cruciferum (De Bary) Teiling	Desmidiaceae
8.	Cosmarium annulatum (Nägli) De Bary	Desmidiaceae
9.	Leptolyngbya rivulariarum (Gomont) Anagnostidis	Leptolyngbyaceae
10.	Pseudanabaena mucicola (Naumann. & Huber-Pestalozzi)	Pseudanabaenaceae
11.	Rivularia hansgirgii Schmidle	Rivulariaceae
12.	Calothrix gloeocola Skuja	Rivulariaceae
13.	Aphanothece stagnina (Sprengel) A. Braun	Synechococcaceae
14.	Anabaena lapponica Borge	Nostacaceae

15.	Dinobryon sociale (Ehrenberg)	Dinobryaceae
16.	Tribonema minutus (Klebs) Hazen	Tribonemataceae
18.	Eurhynchium praelongum (Hedw.) Schimp	Brachytheciaceae
20.	Pteridium aquilinum (L.) Kuhn	Dennstaedtiaceae
21.	Ophioglossum petiolatum Hook	Ophioglossaceae
22.	Equisetum diffusum D. Don	Equisetaceae

Table 26: List of flowering plant species in the Rara Khatyad watershed

SN	Species name	Family
	HERBS	
1	Pleurospermum dentatum C.B. Clarke	Apiaceae
2	Artemisia carvifolia Buch	Asteraceae
3	Gnaphalium affine D. Don	Asteraceae
4	Berberis aristata DC	Berberidaceae
5	Berberis asiatica Roxb	Berberidaceae
6	Thlaspi andersonii (Hook. f. & Thomson) O. E. Schulz	Brassicaceae
7	Euonymus porphyreus Loes.	Celastraceae
8	Anaphalis busua (Buch. – Ham) DC	Compositae
9	Taraxacum officinale	Compositae
10	Fimbristylis complanata (Retzius)	Cyperaceae
11	Hippophae salicifolia D. Don	Elaeagnaceae
12	Eriocaulon nepalense Prescott ex Bongard	Eriocaulaceae
13	Caragana brevispina Royle ex Benth	Fabaceae
14	Agrostis stolonifera Linn	Gramineae
15	Themeda hookeri (Grisebach)	Gramineae
16	Myriophyllum spicatum L.	Haloragaceae
17	Juncus leucanthus Royle ex D. Don	Junaceae
18	Elsholtzia strobilifera (Benth.) Benth	Lamiaceae
19	Thymus linearis Benth.	Lamiaceae
20	Utricularia australis R. Br.	Lentibulariaceae
21	Plantago erosa Wall	Plantaginaceae
22	Heteropogon contortus (L.) P. Beauv. ex Roem. & Schult.	Poaceae
23	Arundo donax Linn.	Poaceae
24	Calamagrostis emodensis Griseb	Poaceae
25	Capillipedium assimile (Steud.) A. Camus	Poaceae
26	Danthonia cumminsii Hook. f.	Poaceae
27	Poa alpina L.	Poaceae
28	Polygonum aviculare Linn.	Polygonaceae
29	Rheum australe D. Don	Polygonaceae
30	Rumex acetosa L	Polygonaceae

SN	Species name	Family
31	Primula denticulata Sm	Primulaceae
32	Aconitum spicatum (Bruhl) Stapf	Ranunculaceae
33	Oxygraphis polypetala (Royle) Hook. f. & Thomson	Ranunculaceae
34	Ranunculus hirtellus Royle ex D. Don	Ranunculaceae
35	Cotoneaster nitidus Jacque	Rosaceae
36	Fragaria nubicola Lindl. ex Lacaita	Rosaceae
37	Potentilla argyrophylla Wall. ex Lehm	Rosaceae
38	Bergenia ciliata (Haw.) Sternb	Saxifragaceae
39	Hemiphragma heterophyllum Wall	Scrophulariaceae
40	Paris polyphylla Sm	Trilliaceae
41	Trillidium govanianum (D. Don) Kunth	Trilliaceae
42	Nardostachys grandiflora DC	Valerianaceae
43	Valeriana jatamansii Jones	Valerianaceae
	SHRUBS	
44	Lonicera myrtillus Hook. f. & Thomson	Caprifoliaceae
45	Euonymus porphyreus Loes	Celastraceae
46	Rhododendron anthopogon D. Don	Ericaceae
47	Rhododendron lepidotum Wall. ex G. Don	Ericaceae
48	Ribes glaciale Wall.	Grossulariaceae
49	Hippophae salicifolia D. Don	Elaeagnaceae
50	Myrsine semiserrata Wall	Myrsinaceae
51	Jasminum humile L	Oleaceae
52	Rhamnus purpureus Edgew	Rhamnaceae
53	Prinsepia utilis Royle	Rosaceae
54	Rosa macrophylla Lindl	Rosaceae
55	Rosa sericea Lindl.	Rosaceae
56	Sorbus foliolosa (Wall.) Spach	Rosaceae
57	Rosa sericea Lindl	Rosaceae
58	Sorbus foliolosa (Wall.) Spach	Rosaceae
59	Daphne bholua Buch.-Ham. ex D. Don	Thymelaeaceae
	TREES	
60	Pistacia chinensis subsp. integerrima (J. L.Stewart) Rech	Anacardiaceae
61	Betula utilis D. Don	Betulaceae
62	Cupressus torulosa D. Don in Lamb	Cupressaceae
63	Juniperus indica Bertol	Cupressaceae
64	Rhododendron arboreum Sm	Ericaceae
65	Rhododendron campanulatum D. Don	Ericaceae
66	Quercus semecarpifolia Sm	Fagaceae
67	Aesculus indica (Colebr. ex Cambess.) Hook	Hippocastanaceae
68	Juglans regia L	Juglandaceae
69	Abies spectabilis (D. Don) Mirb	Pinaceae
70	Cedrus deodara (Roxb. ex D. Don) G. Don	Pinaceae
71	Larix himalaica Cheng & L. K. Fu	Pinaceae
72	Picea smithiana (Wall.) Boiss	Pinaceae

SN	Species name	Family
73	Pinus wallichiana A. B. Jacks	Pinaceae
74	Tsuga dumosa (D. Don) Eichler	Pinaceae
75	Prunus cornuta (Wall. ex Royle) Steud	Rosaceae
76	Sorbus cuspidata (Spach) Hedl	Rosaceae
77	Populus ciliata Wall. ex Royle	Salicaceae
78	Salix daltoniana Andress	Salicaceae
79	Viburnum cotinifolium D. Don	Sambucaceae
80	Viburnum nervosum D. Don	Sambucaceae
81	Taxus wallichiana Zucc	Taxaceae

ANNEX 6: HOSPITALITY AND TOURISM

Table 27: List of hotels and restaurants in the Rara Khatyad watershed, including establishment capacity and number of annual visitors

SN	Name	Proprietor	Location	# of rooms	# of beds	Visitors annually	
						National	Foreign
1	Maya Prithvi Hotel	Prithvi Budha	Banupaani	6	4	500	
2	Lekali Hotel	Maina Budha	Banupaani	7	5	400	
3	Smirtika Hotel	Amar Raj Baniya	Jama	6	10	500	30
4	Ratna Hotel	Harikrishna Dahal	Jama	9	12	100	50
5	Upadhyaya Hotel	Hom Pd. Upadhyaya	Jama	4	5	200	
6	Sushan Guest House	Lal Bdr Malla	Jama	8	10	800	100
7	Amrita Hotel	Amrita	Chintu	4	7		15
8	Kawa Hotel	Padam Rokaya	Chintu	3	4		10
9	Lahure Hotel	Ram Lal Budha	Rautadi	5	10	5,000	500
10	Devraj Hotel	Debraj Sharma	Gamtha	5	2	5,000	600
11	Malina Hotel	Ram Krishna Karki	Ritha	6	12		

SN	Name	Proprietor	Location	# of rooms	# of beds	Visitors annually	
12	Subidha Guest House	Kali Bdr Rokaya	Majhchaur	4	8	1,200	20
13	Chandra Hotel	Chadu Bdr Dangar	Ramtadi	2	4	200	5
14	Dangar Hotel	Man Bdr Dangar	Ramtadi	2	4	205	7
15	Baniya Hotel	Chhammu Dangar	Ramtadi	2	4	180	9
16	Village Heritage Hotel	Raju Karki	Hutu, Rara	12	20	5,000	90
17	Dafe Hotel	Gopal Bdr Bam	Hutu, Rara	15	25	4,000	122
18	Homestay Hotel	Debi Krishna Rokaya	Majh Ghatta	10	20	3,000	10
17	Dafe Hotel	Gopal Bdr Bam	Hutu, Rara	15	25	4,000	122
			TOTALS	**125**	**191**	**30,285**	**1,690**

ANNEX 7: FISH AND AQUATIC LIFE

Table 28: Fish species found in the Rara Khatyad watershed

SN	Species	Common name	Nepali name	Rara or Khatyad Khola
1	Schizothorax richardsonii	Snowtrout	Bude asala	Khatyad
2	Schizothoraichthys labiatus	Kunar snowtrout	Chuche asala	Khatyad
3	Garra annandalei	Annadale garra	Buduna	Khatyad and Rara
4	Diptychus maculatus	Scaly osman	Budune asala	Khatyad
5	Naziritor chelynoides		Karange	Khatyad
6	Barilius barna	Barna baril	Faketo	Khatyad
7	Barilius bendelisis		Faketo	Khatyad
8	Puntius ticto	Ticto barb	Ratpakhe	Khatyad
9	Psilorhynchus pseudecheneis	Nepalese minnow Stone carp	Titaila	Khatyad
10	Nemacheilus corica		Gandi	Khatyad
11	Schistura rupicola	Stone loach	Gindula	Khatyad
12	Amblyceps mangois		Luthe	Khatyad
13	Glyptothorax gharwali		Chepte	Khatyad
14	Glyptothorax pectinopterus		Katuse cabre	Khatyad
15	Pseudecheneis serracula		Dhami	Khatyad
16	Pseudechenies sulcatus		Dhami , Kabre	Khatyad
17	Macroganthus ara	One-stripe spiny eel	Dhunge Bam	Khatyad
18	Schizothorax rarensis		Kalo Rara Asala	Rara
19	Schizothorax nepalensis		Nepali Aslaa	Rara
20	Schizothoraichthys marcophthalmus	Nepalese snowtrout	Tilke Asala	Rara
21	Naziritor chelynoides		Karange	Rara
22	Pseudecheneis serracula		Dhami	Rara

SN	Species	Common name	Nepali name	Rara or Khatyad Khola
23	Schistura rupicola		Gindula	Rara

ANNEX 8: FAUNAL BIODIVERSITY IN THE RARA KHATYAD WATERSHED

Table 29: Mammals commonly found in the Rara Khatyad watershed

Group	Species	Common Name	Nepali name
Mammals	Panthera pardus	Leopord	Chituew
	Ursus thibetanus	Asian black bear	Himali kaalo bhalu
	Unica unica	Snow Leopord	Hiu chituwa
	Canis lupus	Gray wolf or timber wolf	Khairo Syal
	Muntiacus muntjak	Barking deer	Ratuwa
	Moschus chrysogaster	Alpine musk deer	Kasturi mriga
	Nemorhaedus goral	Himalayan goral	Ghoral
	Ovis ammon	Mountain sheep	Nayan or naur
	Hytrix indica	Indian crested porcupine	Jharal or dumsi
	Macaca mullata	Rhesus monkey	Bandar
	Presbytis entellus	Northern plain gray langur	Guno
	Canis aureus	Golden jackal	Syal
	Vulpes Vulpes	Red fox	Phyauro
	Sus scrofa	Wild boar	Bandel
	Pteropsus	Bat	Chamero
	Martes flavigula	Yellow-throated marten	Malpasro
Aves	Milvus migrans	Black kite	Kalo chil
	Neophron percnopterus	Egyptian vulture	Seto gidda
	Lophophorus impejanus	Himalayan monal	Dafe
	Tragopan satyra	Crimson-horned pheasant	Munal
	Lophura leucogenys	Pheasant	Kalij
	Catreus wallichii	Cheer pheasant	Chir

Group	Species	Common Name	Nepali name
	Megalaima virens	Great barbet	Chykhura nyauli
	Francolinus fracolinus	Black francolin	Titra
	Orthotomus sutorius	Common tailorbird	Fisto
	Streptopelia chinensis	Spotted dove	Thople dhukur
	Pycnonotus leucogenys	Himalayan bulbul	Jureli
	Bubo bubo	Eurasian eagle-owl	Suga huchil
	Corvus macrohynchos	Large-billed crow	Koili or Himali kag
	Streptopelia senegalensis	Laughing dove	Dhukur
Reptiles	Gloydius himalayanus	Himalaya pit viper	Bhyagute Sarpa
	Laudakia tuberculata	Himalayan rock lizard	Patharchatuwa
Amphibians	Paa rarica	Rara Lake frog	Rara paha
	Geothelphusa dehaani	Fresh water crab	Gangato
Other	Apis dorsata	Giant honey bee	Bhir mauri
	Pieris brassicae	Large White Butterfly	Seto putali
	Julus	Millepede	Aringaal
	Thamnophis sirtalis	Garter snake	Tibetan snok

ANNEX 9: ROAD NETWORKS IN THE RARA KHATYAD WATERSHED

Table 30: List of roads in the Rara Khatyad watershed

SN	Name	GP or NP	Length	Population served
Earthen roads				
1	Putta Khola	Khatyad	2	225
2	Jama Gaikhola Jogilekh Agricultural	Khatyad	5	225
3	Seri Rola Rural	Khatyad	2	200
4	Ranakot Rola	Khatyad	3	900
5	Buga Ranakot	Khatyad	3	NA
6	Gothikhola Paikhu	Khatyad	14	21
7	Gothikhola Masana	Khatyad	12	29
8	Chintu Tallo Kawa Bhagoti	Khatyad	4	-
9	Kalakadi Chima	Khatyad	9	10,000
10	Panche Chaur Rumdakad road	Khatyad	30	16,000
Under construction				
11	Nakharji Ratapani	Khatyad	7	
12	Majhchaur Sukadhik	Khatyad	15	
Proposed				
13	Gothikola Jiuka	Khatyad	5	
14	Ramtadi Jaisele Lamru	Khatyad	4	
15	Bihani Koirala	Khatyad	16	
16	Panche Bihani Sainachaur	Khatyad	6	
17	Gamtha Sainachaur Panikhala	Khatyad	6	
18	Aama Sukadihik	Khatyad	9	
19	Nakharji Jhugala	Khatyad	8	
20	Sukadhik Dumuna	Khatyad	9	

ANNEX 10: IRRIGATION PROJECTS IN THE RARA KHATYAD WATERSHED

Table 31: List of irrigation projects in the watershed, including area irrigated and households benefited

SN	Name	Location (NP and ward #)	Agricultural land (ha)	Irrigated land (ha)	Benefited HH	Remarks
1	Kamausi	Khatyad 1	15	15	20	Seasonal
2	Aayarpata	Khatyad 1	1	1	45	Seasonal
3	Hansipale Sakhkhada	Khatyad 1	20	20	10	Seasonal
4	Raisedi	Khatyad 1	8	8	15	Seasonal
5	Jukamul	Khatyad 1	4	4	9	Seasonal
6	Melpati	Khatyad 1	5	5	5	Seasonal
7	Aayarpata Canal	Khatyad 1	1	1	45	Seasonal
8	Bhane Khola	Khatyad 2	12	12	47	Seasonal
9	Dhag	Khatyad 2	8	8	30	Year round
10	Garibi Nivarn	Khatyad 2	1	1	40	Seasonal
11	Jama Jiula	Khatyad 2	0	0	400	Year round
12	Danda Jiula	Khatyad 2	0	0	100	Year round
13	Srikot MHP	Khatyad 3	6	NA	66	Seasonal
14	Rakhe	Khatyad 3	Na	NA	220	Year round
15	Luyata Mujau	Khatyad 3	20	NA	85	Seasonal
16	Saguchaur Chyaupata	Khatyad 3	22	NA	30	Seasonal
17	Okhal Chhintya Chisapani	Khatyad 3	15	NA	34	Seasonal
18	Masaina	Khatyad 4	23	NA	20	Seasonal
19	Manamarya	Khatyad 4	19	NA	16	Seasonal
20	Bagad Kulo	Khatyad 4	25	NA	25	Seasonal
21	Khola Khet	Khatyad 4	30	NA	23	Seasonal
22	Paikhu	Khatyad 4	19	NA	21	Seasonal
23	Bhalagauda	Khatyad 4	12	NA	9	Seasonal
24	Kerai	Khatyad 4	NA	NA	111	Seasonal
25	Chimadungri	Khatyad 4	NA	NA	111	Seasonal
26	Simkana	Khatyad 4	NA	NA	111	Seasonal
27	Bagar	Khatyad 4	NA	NA	111	Seasonal
28	Nuwakhet	Khatyad 4	NA	NA	59	Seasonal
29	Dude	Khatyad 4	NA	NA	30	Seasonal
30	Dogadi Dimna	Khatyad 5	15	1	20	Seasonal
31	Nuwakoti Khola	Khatyad 6	40	40	200	Year round
32	Dhamkhet	Khatyad 6	2	2	21	Year round
33	Naulakhet	Khatyad 6	3	3	15	Year round
34	Dobkuna	Khatyad 6	30	30	75	Year round
35	Ligudekhola	Khatyad 6	120	100	60	Year round
36	Ukhada	Khatyad 6	2	2	15	Year round
37	Godkhet	Khatyad 6	10	9	58	Year round
38	Palatibagar	Khatyad 6	5	5	20	Year round
39	Dharakhola Pansari	Khatyad 6	5	4	50	Year round

SN	Name	Location (NP and ward #)	Agricultural land (ha)	Irrigated land (ha)	Benefited HH	Remarks
40	Bihani Hathang	Khatyad 7	50	50	400	Year round
41	Bihani Markatiya	Khatyad 7	51	51	150	Year round
42	Thara	Khatyad 7	125	125	250	Year round
43	Bihani Bali	Khatyad 7	15	5	132	Year round
44	Bihani Jaiseli	Khatyad 7	101	101	300	Year round
45	Kawakhola Sautadi	Khatyad 7	20	20	85	Year round
46	Panchi Garaju	Khatyad 7	52	52	120	Year round
47	Aam	Khatyad 8	70	70	700	Year round
48	Katiya Kapsadi	Khatyad 8	28	28	125	Year round
49	Okhaldhunga	Khatyad 8	9	9	63	Year round
50	Kuna	Khatyad 8	5	5	30	Year round
51	Riga	Khatyad 8	14	14	140	Year round
52	Sukadhik	Khatyad 8	100	75	250	Seasonal
53	Ghatjiula	Khatyad 8	25	20	250	Seasonal
54	Talibagar	Khatyad 8	20	20	68	Year round
55	Nawakhet	Khatyad 8	10	8	68	Year round
56	Biribaneghat	Khatyad 8	25	25	150	Year round
57	Okhaldhunga	Khatyad 8	15	15	225	Year round
58	Paribagar	Khatyad 8	120	100	305	Year round
59	Kaularukh	Khatyad 9	8	4	55	Year round
60	Dogadi	Khatyad 9	9	5	50	Year round
61	Kulomul	Khatyad 9	70	25	252	Year round
62	Ghatte Khola Chukarukh	Khatyad 10	20	20	120	Year round
63	Jaisipipal	Khatyad 10	12	10	83	Year round
64	Bin	Khatyad 10	11	8	45	Year round
65	Launigada	Khatyad 10	14	10	75	Year round
66	Siran	Khatyad 11	30	15	117	Year round
67	Syala siuto	Khatyad 11	50	20	200	Seasonal
68	Pasane Chaupta	Khatyad 11	20	10	200	Seasonal
		TOTALS	**1,597**	**1,191**	**7,390**	

Table 32: Forest user groups by type in the Rara Khatyad watershed

SN	Type of user group	No. of forests under management	Area (ha)	HH represented
1	Community forest	39	2,494.5	8,065
2	Leasehold	6	216.5	474
3	National	5	133.2	405
4	Private	6	8.91	113

5	Religious	2	50.5	60
6	Buffer zone community forest (BZCF)	2	76	80
	Total	**60**	**2,980**	**9,197**

ANNEX 11: WATER QUALITY

Table 33: Water quality test results in the Rara Khatyad watershed

FigureName	Latitude	Longitude	Dissolved oxygen (mg/L)	Ammonium (mg/L)	Phosphate (mg/L)
Dovan	29.52912812	81.78928647	*8.31	0	0
Rara Exit	29.52909015	82.06219265	6.05	0.0	3.0
Trilok	29.52229	82.04847	8.29	1.0	0.3
Kawa Khola	29.50770607	81.90421225	8.64	2.0	13.0*
Toli Khola	29.51301135	81.85389338	7.7	0.0	5.1
putta Khola	29.52879361	81.94737462	7.34	0.0	0.6
Dovan	29.52912812	81.78928647	*8.31	0	0
Rara Exit	29.52909015	82.06219265	6.05	0.0	3.0

*** Asterisk indicates a level exceeding standard healthy water parameters.**

ANNEX 12: MINING IN THE RARA KHATYAD WATERSHED

Table 34: Mining sites in the Rara Khatyad watershed by type and location

SN	Type	NP and ward #	Place name
1	Sand	Khatyad 1	Gauri Khola
2	Limestone	Khatyad 1	Rina
3	Sand	Khatyad 1	Radi Khola
4	Stone	Khatyad 1	Baljada
5	Limestone	Khatyad 1	Pipaldandi
6	Stone	Khatyad 1	Saina, Kharka
7	Sand	Khatyad 1	Saina, Kharka
8	Sand	Khatyad 3	Garali Khola
9	Stone	Khatyad 3	Adarigaad
10	Red Soil	Khatyad 4	Sera
11	Silicon	Khatyad 4	Rawa
12	Calcium carbonate	Khatyad 5	Naid Khola
13	Calcium carbonate	Khatyad 5	Chhote and Nair
14	Calcium carbonate	Khatyad 5	Danfe

ANNEX 13: COMMUNITY USER FOREST GROUPS IN WATERSHED

Table 35: List of CFUG by type of groups, location, and households served, and area covered

SN	Name	Type of forest	Location	Households served	Area covered (ha)
1	Thalalla	Community forest	Shahbada	75	6
2	Hariyali	Community forest	Kamausi	25	4
3	Majhdanda	Community forest	Jogilekh	120	-
4	Khanimela	Leasehold forest	Bamkanda	80	1.5
5	Puttakhola	Private	Bamkanda	45	1
6	Chamkholi Bhaisi	National	Bamkanda	200	1
7	Salleri	Community forest	Nigalibot	18	14.9
8	Kot Pineripakha	Community forest	Jampai	30	18
9	Bagdula	Community forest	Sreekot	125	-
10	Dudemata	Community forest	Dadupata	40	6
11	Chote	National	Jama	65	0.2
12	Siudikhola Ban	Private	Kharka	66	5
13	Raskot	Community forest	Rola	600	-
14	Dhauli Salleri	Community forest	Rola	400	-
15	Gadul Nuhaune	Community forest	Saina	63	-
16	Adarigad Pausalla	Community forest	Sreekot	200	-
17	Pariban	Community forest	Paikhu	63	4
18	Jalibada	Community forest	Paikhu	63	2
19	Thula gaira Lata	Community forest	Higoti	105	-
20	Panimela Baddichaur	Community forest	Kharka, Chimadungri	80	-
21	Balalna Chautara	Community forest	Chimadungri	60	-
22	Dhura	Community forest	Jiuka	70	61
23	Bamanikandh	National	Jiuka	70	50
24	Jayasun Khani	National	Jiuka	70	80
25	Pipleni	Leasehold Forest	Jiuka	70	62
26	Pademeli	Community forest	Kawa	141	200
27	Khetimai	Community forest	Khamale	177	500
28	Masta BZCF	Buffer zone community forest	Chakpande	41	76
29	Raulikhola	Leasehold forest	Chakpande	41	80
30	Khetimai	Religious	Lamera	60	50
31	Kakhibhid	Community forest	Panseri	50	25.4
32	Sunikhand	Community forest	Raskoti	117	2
33	Lufkot	Community forest	Bhanegaun	-	-
34	Chakhnemela	Community forest	Lamu	56	250
35	Gairapatal	Community forest	Gamtha	300	192

36	Mulodi Bhumchair	Community forest	Thara	130	100
37	Dimpata	Private	Khamale	1	0.1
38	Guyalakhada	Private	Thara	1	0.5
39	Rojikudu	Community forest		-	-
40	Beljar	Community forest		-	-
41	Thamlekh	Community forest	Riga, Thamlekh	800	8
42	Kabuliyati	Leasehold forest	Thamlekh	63	20
43	Pudaban	Leasehold Forest	Riga	130	50
44	Sukadhik	Community forest	Sukadhik	115	1.2
45	Tanachaur Rokayamela	Community forest	Jamir	96	600
46	Bukai Danda	Community forest	Bamdika	19	-
47	Moddanda	Community forest	Denbada	65	-
48	Khati	Community forest	Bina	42	20
49	Sallarukh	Leasehold forest	Sehi	90	3
50	Golya	Private	Dumana	-	1.5
51	Kadmul	Private	Dumana	-	0.8
52	Nauli Lamalekh	Religious	Dumana	-	0.5
53	Sunpati Palegairi	National	Dumana	-	2
54	Seilekh	Community forest	Hyanglu	120	-
55	Gahatadi Lisni	Community forest	Rikhiya	117	-
56	Syal Khola	Community forest	Lui, Rikhiya	3000	150
57	Ratu	Community forest	Bumnika	63	80
58	Bula Gaira	Community forest	Gothilekh	150	200
59	Gotha Khola	Community forest	Lui, Thamlekh	370	50
60	Syaulimela BZCF	Buffer zone community forest	Murma, Majhghatta	39	
	Total			9,197	2,979.61

ANNEX 14: FINANCIAL INSTITUTIONS

Table 36: List of financial cooperatives in the Rara Khatyad watershed, including transactions, investments and foci

SN	Name	Location	Annual transaction (in 000 in rupees)	Investment (in 000 in rupees)
1	Chhayanath Self-help	Khatyad-1		
2	Chhayanath Saving and Credit	Khatyad-2	60	30
3	Janamilan Medicinal and Arometic Plant	Khatyad-2	1,500	1,000
4	Red Panda Saving and Credit	Khatyad-2	1,000	700
5	Masta Multipurpose Cooperative	Khatyad-3	3,166	1,934
6	Cooperative Organization Ltd	Khatyad-4	2,000	100
7	Bhawani Agriculture and Livestock Cooperative Ltd	Khatyad-4	50	15
8	Darsan Cooperative Organization	Khatyad-5	66	66
9	Gamtha Agriculture Organization	Khatyad-6	1,300	50
10	New Vision Cooperative Organization	Khatyad-7	400	250
11	Srijanshil Cooperative Organization	Khatyad-8	1,000	600
12	Hanglu Cooperative Organization	Khatyad-10	377	-
13	Women Srijanshil Saving Cooperative Organization	Khatyad-10	120	50
14	Hatemalo Agriculture Cooperative Organization	Khatyad-10	360	50
15	Saving and Credit Cooperative	Khatyad-10	1,400	100
16	Saving and Credit Cooperatives Organization	Khatyad-11	1,200	150
17	Women Welfare Agricultural Cooperative Organization	Khatyad-11	105	61
18	Janasewa Multipurpose Cooperative Organization	Khatyad-11	344	20
		TOTAL	14,448	5,176

ANNEX 15: MEMBERSHIP IN SOCIAL GROUPS

Table 37: Group membership by sex and caste/ethnicity

Group type	Members			Caste/ethnicity			
	Female	Male	TOT	BCTS	Dalit	Janajati	TOT
Agricultural	177	41	218	53	0	165	218
Civic awareness	232	107	339	119	26	194	339
Mother group	610	0	610	107	22	481	610
Savings group	366	129	495	15	3	477	495
TOTAL	**1,385**	**277**	**1,662**	**294**	**51**	**1,317**	**1,662**

ANNEX 16: KEY STAKEHOLDERS – ORGANIZATIONS AND OFFICES

Table 38: Key organizations relevant to watershed health

SN	Organization	District	Key representative	Position	Phone
1	Chhayanath Rara NP	Mugu	Hari Jung Shahi	Mayor	9758900027
2	Chhayanath Rara NP	Mugu	Suntala Rokaya	Deputy Mayor	9748911743
3	Khatyad GP	Mugu	Ubjan Bahadur Shahi	Chairperson	9851192445
4	Khatyad GP	Mugu	Jayananda Rawal	Vice Chairperson	9848315244
5	Khatyad GP - Ward Number 1	Mugu	Mer Bahadur Budha	Chairperson	9868397120
6	Khatyad GP- Ward Number-2, Jama	Mugu	Lal Bdr Malla	Chairperson	9868397120
7	Khatyad GP - Ward Number-3, Ranakot	Mugu	Sukendra Baniya	Chairperson	9748118140
8	Khatyad GP - Ward Number-4, Chimadungri	Mugu	Kali Bdr Rokaya	Chairperson	9748926991
9	Khatyad GP - Ward Number-5, Khamale	Mugu	Mansingh Rokaya	Chairperson	9868343846
10	Khatyad GP - Ward Number-6, Lamru	Mugu	Bharat Bdr Shahi	Chairperson	9748905601
11	Khatyad GP - Ward Number-7, Gamtha	Mugu	Jayarishi Upadhyaya	Chairperson	
12	Khatyad GP - Ward Number-8, Aam	Mugu	Ram Bdr Rawat	Chairperson	9748905439
13	Khatyad GP - Ward Number-9, Nakharji	Mugu	Narendra Bdr Rokaya	Chairperson	9851003240
14	Khatyad GP - Ward Number-10, Hyanglu	Mugu	Tilak Bdr Rawal	Chairperson	9848322043
15	Khatyad GP - Ward Number-11, Ratapani	Mugu	NA	Chairperson	9758900068
16	FEDWASUN, Gamgadhi, Mugu	Mugu	Netra Prasad Chaulagai	Chairperson	9748903641

SN	Organization	District	Key representative	Position	Phone
17	DCC, Gamgadhi, Mugu	Mugu	Purna Bahadur Rokaya	Coordinator	9758900165
18	DCC, Gamgadhi, Mugu	Mugu	Karna Shila Malla	Deputy Chief	9748901537
19	FNCCI, Gamgadhi, Mugu	Mugu	Kamal Buddha	Chairperson	9748900721
21	SyauliMela Community Forest RARA Chhayanath - 9	Mugu	Belmati Rokaya	Chairperson	
21	Division Forest Office, Mugu	Mugu	DFO	DFO	087-460048
22	NIFWAN, Gamgadhi, Mugu	Mugu	Radhika Malla	Member	9748900762
23	FECOFUN, Gamgadhi, Mugu	Mugu	Bindu Rokaya	General Secretary	9868318857
24	Murma Community Development Center, Chhayanath Rara-9, Murma	Mugu	Birsha Bdr Rokaya	Chairperson	9858320182
25	Rara National Park	Mugu	Lal Bahadur Bhandari	Chief Warden	9858041685
26	Buffer Zone Management Committee (BZMC)	Mugu	Balaram Sahani	Chairperson	9848308467
27	Rara Tourism Development Center, Chhayanatha Rara-9, Murma	Mugu	Dev Chanda Rokaya	Chairperson	9851168993

ANNEX 17: VISION BUILDING FRAMEWORK EMPLOYED FOR COMPILING THE RARA KHATYAD WATERSHED PROFILE

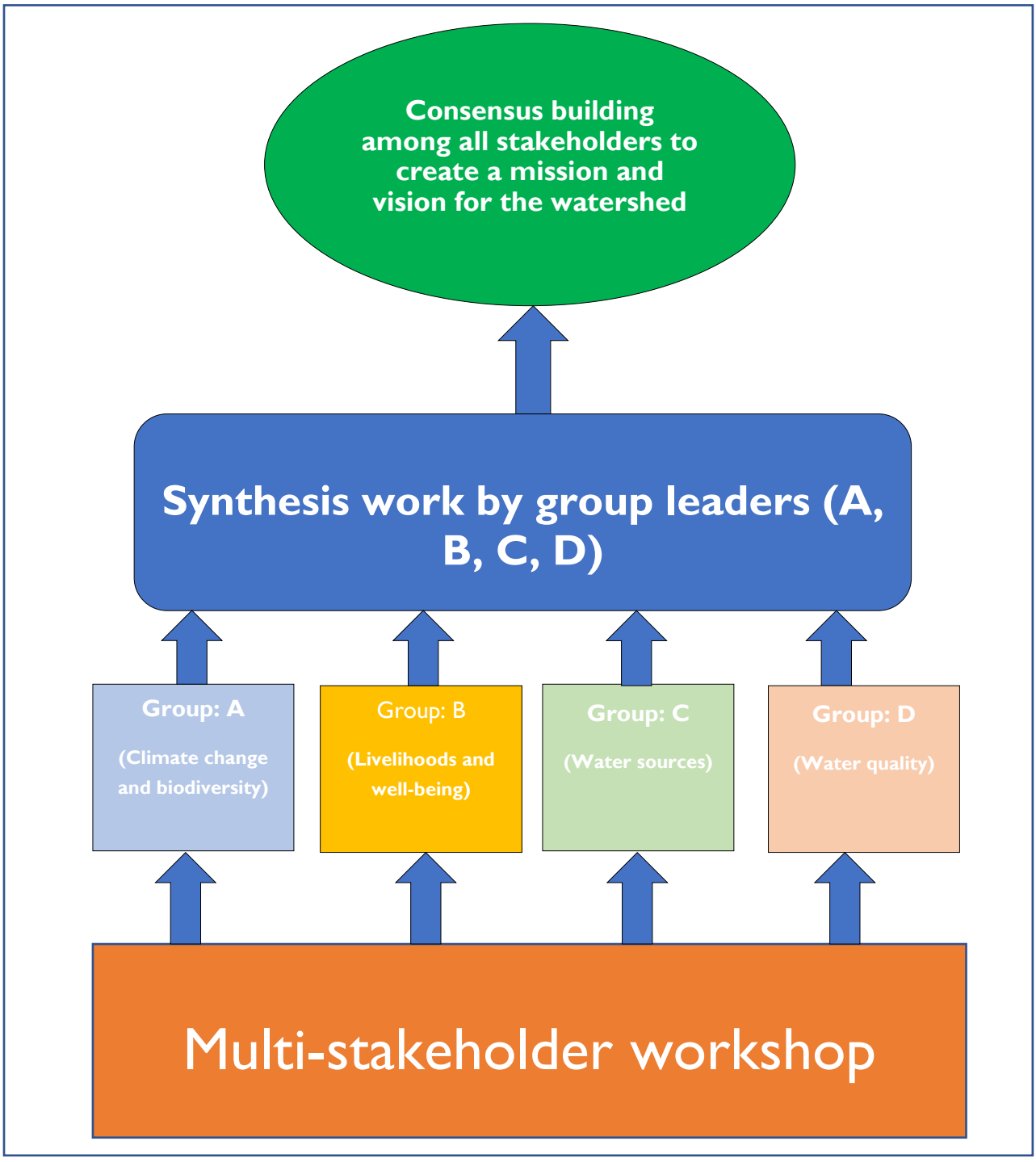

Figure 16: Vision Building Frameworkd adopted for Rara khatyad Watershed Profile