MIDDLE KARNALI WATERSHED PROFILE

STATUS, CHALLANGES AND OPPORTUNITIES FOR IMPROVED WATERSHED MANAGEMENT

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Cover photo: View of Karnali from Rakam Karnali, Dailekh in August 2019

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Program Title:	**USAID Paani Program**
DAI Project Number:	**1002810**
Sponsoring USAID Office:	**USAID/Nepal**
IDIQ Number:	**AID-OAA-I-14-00014**
Task Order Number:	**AID-367-TO-16-00001**
Contractor:	**DAI Global LLC**
Date of Publication:	**August 28, 2018**

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ABBREVIATIONS

BZFC	Buffer Zone Community Forest
BZMC	Buffer Zone Management Committee
CAPA	Community Adaptation Plan of Action
CBAPU	Community-based Anti-poaching 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
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
EIA	Environmental Impact Assessment
FEDWASUN	Federation of Drinking Water and Sanitation Users Nepal
FGD	Focus Group Discussion
GON	Government of Nepal
GP	*Gaun palika* or rural municipality (new federal administrative unit; formerly Village Development Committee)
IEE	Initial Environmental Examination

IRBM	Integrated River Basin Management
IUCN	International Union for Conservation of Nature
KII	Key Informant Interview
LAPA	Local Adaptation Plan of Action
LSGA	Local Self-Governance Act
MOE	Ministry of Education, Science and Technology
MOFSC	Ministry of Forest and Soil Conservation
MOAD	Ministry of Agriculture and Livestock Development
MOFE	Ministry of Population and Environment
MOFALD	Ministry of Federal Affairs and General Administration
MEWRI	Ministry of Energy, Water Resources and Irrigation
MOPIT	Ministry of Physical Infrastructure and Transport
MOFALD	Ministry of Federal Affairs and Local Development
MSC	Multi-stakeholder Consultation
NEFIN	Nepal Federation of Indigenous Nationalities
NFIWUAN	National Federation of Irrigation and Water Users' Association
NP	*Nagar palika* (new federal administrative unit; district level)
NPC	National Planning Commission
NRM	Natural resource management
PAANI	USAID Paani Program
USAID	United States Agency for International Development
VDC	Village Development Committee
WECS	Water and Energy Commission Secretariat
WWF	World Wildlife Fund

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 community forest user groups (CFUGs), cooperatives, water user groups, and, especially, the communities dependent on aquatic biodiversity and local water management. Leaders of Jorayal, Chure, Badikedar, and Mohanyal rural municipalities and the newly elected local government bodies 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, and NESS that works closely with Nepal's Water and Energy Commission Secretariat (WECS) and draws on the support of the WECS' member agencies. Paani enriched the watershed profile by compiling and reviewing secondary data and carrying 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. The Federation of Community Forestry Users of Nepal (FECOFUN) carried out household surveys of community perceptions. Other groups that have supported watershed profiling include NFIWUAN, FEDWASUN, NEFIN, MOE, MOFSC, MOAD, MOFALD, MEWRI, and MOPIT, 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 for the multiple users within the Middle Karnali watershed, which extends across Provinces 6 and 7 in Nepal.

The USAID Paani Program — also known as Paani, 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). Paani aims to increase the knowledge, engagement, and benefits of local water users in target river basins to build local water resource management capacity.

This watershed profile provides critical baseline information for local government, community, civil society, and private sector stakeholders within the Middle Karnali watershed to strengthen water resource management in a way that benefits human development and protects 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 Middle Karnali watershed (Figure 1) falls within the Karnali River Basin and includes parts of Dailekh, Achham and Kalikot districts of western Nepal. This watershed stretches over 903 km^2 with a population of 171,856 and population density of 182 people per km^2.

The highest population density is in Dailekh (215 people /km^2) followed by Achham (152 people/km^2) and Kalikot district (148.52 people/km^2) (CBS, 2011).

[1] It should be noted here 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, but Middle Karnali watershed extends across two provinces, 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 watershedprovides an integrated perspective of environmental and socio-economic change.

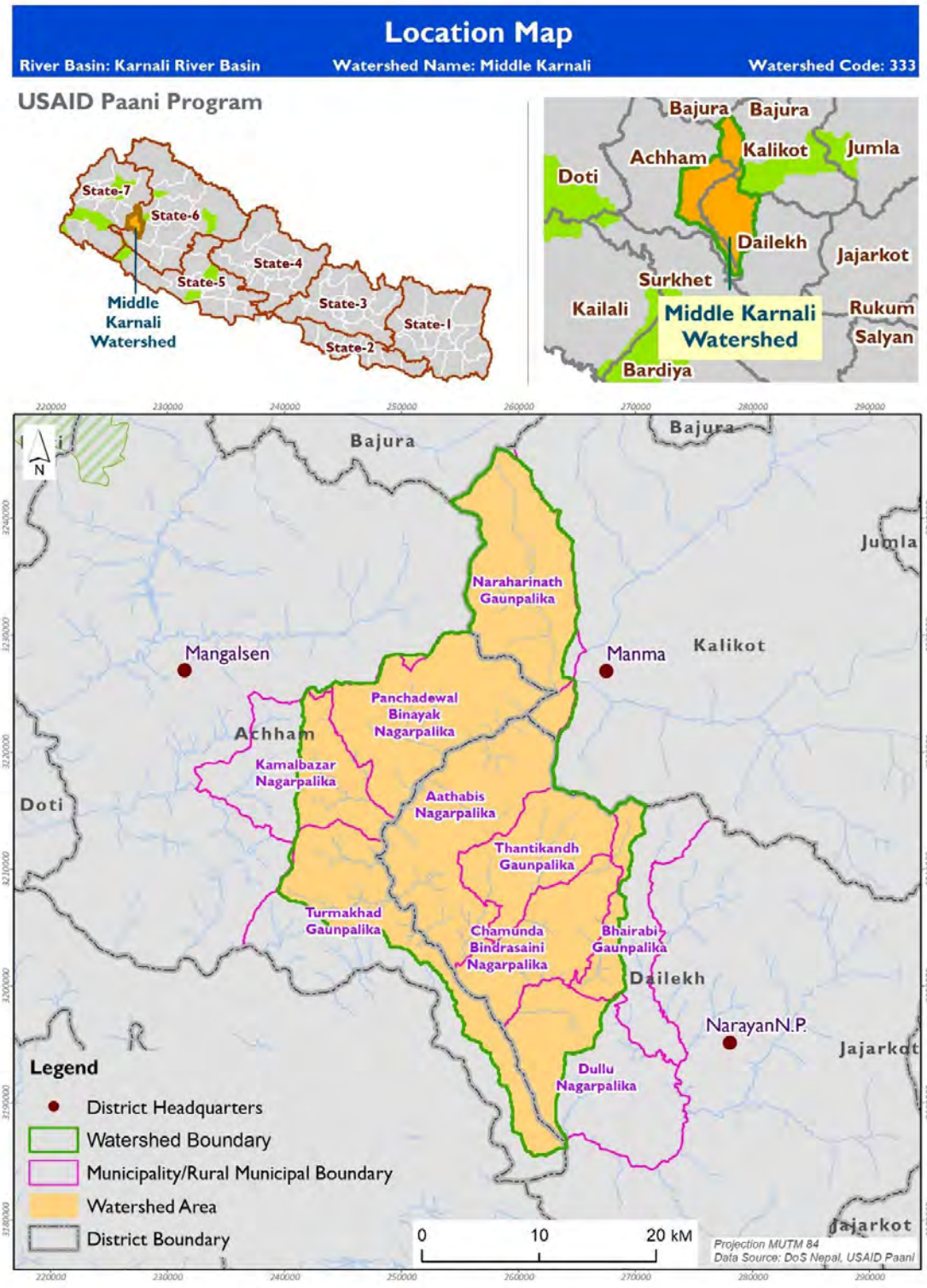

Figure 1: Map of Middle Karnali watershed

The major topography of the Middle Karnali watershed consists of middle hills (approximately 80% of the watershed area) and the rest is considered high mountain. Under the new federal structure this watershed covers parts of Province No. 6 (Kalikot and Dailekh districts) and Province No. 7 (Achham district).

The Karnali River is primarily a snow-fed river enriched by several tributaries that are both snow and rain fed. The major causal factors affecting hydrological flow from this watershed are deforestation, rural road construction, climate change, intensive agriculture, steep slope cultivation, landslides and sedimentation around river bank areas. The frequent landslides in the watershed are induced by intense and erratic rainfall as well as extended dry/hot periods that severely affect riverbeds, and consequently, degrade fish habitats in confluence areas that are important for fish breeding.

The aquatic systems are closely associated with the condition of the terrestrial landscape, which consists of local terrestrial biodiversity and agricultural land. With increased development activities, the relationship among land, water, and vegetation is becoming extremely complex and its effects on the watershed conditions require further study. These components are inter-connected in such a way that any disturbance in one of the components may change the watershed condition and quality of services it provides. One example of such a disturbance includes overextraction of timber and forest litter, which can create conditions for flash flooding and landslides. These hazards thereby lower river water quality and increase turbidity, affecting local residents and aquatic life.

Perhaps of greatest significance at this point in time is the Upper Karnali Hydroelectric Project, a proposed 900MW run-of-river dam to be built on the Karnali River between Dailekh and Surkhet. The project proposes to create a diversion channel that will lower water volume along a 52 km stretch of river. While the project promises impressive benefits for the region and the nation, managing the local impact on biodiversity and livelihoods will require vigilance on the part of local residents, government, and civil society organizations.

Priority issues for the Middle Karnali watershed

Based on a series of community consultations, stakeholder fora, and literature reviews in late 2016 and early 2017, the main challenges for the watershed are summarized in Table 1 and described below with recommendations for addressing each challenge.

Table 1: Priority issues for watershed health

SN	Priority issue	Impacts
I	Drying water sources	Drying water sources affect every aspect of household living: domestic, agricultural and livestock. For women and girls, who bear primary responsibility for obtaining water, drying water sources add considerably to their work burdens.
II	Declining fish populations and aquatic biodiversity	Destructive fishing practices are affecting fish stocks and diversity. When the Upper Karnali Hydropower Project (see next issue) is completed, it is projected to further affect local fish populations and aquatic biodiversity. Although an initial

		environmental impact assessment (EIA) was completed, further assessment related to fish and aquatic life is on-going.
III	Building sustainable hydropower with minimal environmental impact	The Upper Karnali Hydropower Project, when completed, will elevate flood risks for downstream communities and affect local fish populations and aquatic life. ERM is carrying out assessment beyond the initial EIA prepared by NESS. Continued monitoring will be necessary during construction and operation. The hydropower project, if constructed, has the potential to significantly impacts on aquatic biodiversity and increase risk to downstream users (especially irrigation) in the Middle Karnali watershed because of substantive disruptions in the patterns of hydrological flow. Significant anticipated impacts are blockage of fish movement and loss of fish habitat.
IV	Construction of improperly designed rural roads	Improper construction of rural roads exacerbates the conditions for floods and landslides during monsoon. Currently there is no authority to oversee proper construction techniques.
V	Forest degradation	Forest degradation contributes to the drying of water sources and increases the likelihood for soil erosion and landslides, which negatively impact aquatic health and biodiversity.
VI	Water pollution	Point source pollution from waste water disposal into rivers in the major market areas is deteriorating water quality. Sedimentation from road construction, agricultural run-off, and bathing and washing in rivers are three other significant factors.

1. Drying water sources

Drying water sources have become a great concern not only in Middle Karnali, but many parts of western Nepal. There are four major drivers behind this challenge: 1) poorly sited and/or poorly designed rural roads that increase erosion; 2) increasing dry periods and number of hot days; 3) forest degradation, and 4) landslides. Increased demand may also affect water availability.

The loss of water sources affects every aspect of household living: domestic, agricultural and livestock. As just one example among many, in Dullu NP, residents said 50% of the springs have either dried up or emit far less water than in previous years.

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; and
- Create water source maps so the community can share in the monitoring of water levels and availability.

1. Declining fish populations and aquatic biodiversity

Fish populations in Middle Karnali have declined in recent years, primarily to climate- and human-induced pressures. The climatic pressures include rising water temperatures, increasingly intense rainfall, and natural hazards (i.e., landslides) precipitated by rising temperatures and rainfall events. Human-induced pressures on fish populations range from direct interventions such as destructive fishing techniques (e.g., poison and electric current) to indirect factors such as improperly constructed roads and increasing agricultural run-off into rivers and tributaries.

These declines in fish population are acutely felt by traditional fishing community, which rely on this livelihood source for survival. As these communities are typically comprised of marginalized groups in Nepali society, the lack of fish has forced many people to seek other livelihood opportunities, which are difficult to find and for which they are insufficiently skilled to fulfill.

Furthermore, fish populations are negatively affected by lax enforcement of policies that could protect these habitats.

Recommendations:

- Form fishing community groups to advocate collectively for better representation in local communities and government;
- Build capacity among traditional fishing groups to understand and address potential threats to aquatic biodiversity and habitat destruction;
- Initiate dialogue with government agencies to promote stronger fishing guidelines enforcement;
- Promote ecotourism in the watershed as another livelihood option for traditional fishing communities; and
- Support local governments to develop necessary laws for river system co-management and improved conservation of fish and aquatic life by handing over stretches of river (2-4 kms) to local communities.

2. Building sustainable hydropower with minimal environmental impact

When completed, the Upper Karnali Hydropower Project, a 900 MW dam, will have the potential to impact aquatic biodiversity in the area, and increase flood risks to downstream communities. The hydropower project, if constructed, has the potential to significantly impact aquatic biodiversity and increase risks to downstream users (especially irrigation users) in the Middle Karnali watershed through substantive disruptions in the patterns of hydrological flow. In addition to community displacement and forest loss due to reservoir construction in Aathabish Municipality, major anticipated impacts are

blockage of fish movement and loss of fish habitat. In the Aathabish area, where the Karnali flows very silently, there are important breeding sites for cold-water fish in the low velocity, deep-water pockets that exist along the edge of the river. These will be disrupted by dam construction.

Recommendations:

- Ensure review of any revisions to the impact assessment and proposed mitigation plans.
- Encourage participation of downstream stakeholders in public participation hearings to ensure their opinions are heard; and
- Continue assessing the environmental impacts of the Upper Karnali Hydropower Project to determine the short- and long-term effects on the watershed, and to develop appropriate benefit sharing and compensation mechanisms.

3. Construction of improperly designed rural roads

For the last three decades, the government of Nepal has increased development budgets substantially for building roads in rural parts of the country. However, much of this road network has been developed without consulting local communities and without undertaking appropriate environmental impact assessments of the areas in which the roads are built.

There is one exception to this trend. In Narharinath GP, the roads have been constructed with proper side walls and slope gradients to allow for water drainage. These roads were also built primarily with human labor and not heavy machines, which tend to shake loose fragile soils from the hillsides, thus increasing deposition in rivers and tributaries below.

Residents in Aathabish, Turmakhad, Badmlamji, Kamalbazar, and Panchadeval Binayak all reported cases where improper road construction incited landslides and contributed to the loss of spring water sources and increased landslides (Figure 2).

Recommendations:

- Raise awareness and build capacity in local government and contractors about the Environmentally 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.

Figure 2: Map of major landslide risk areas in the Middle Karnali watershed

4. Forest degradation

Forest degradation occurs through the overuse of forest resources (e.g., forest litter), open grazing, forest fires and overharvesting of timber. Forest degradation contributes to the drying of water sources and increases the likelihood for soil erosion and landslides, which negatively impact aquatic health and biodiversity.

Recommendations:

- Raise awareness about forest health and management and the effects of open grazing on forest health;
- Plant community forest on available bare lands;
- Create incentives for communities to limit over extraction of forest resources;
- Adopt technologies that enhance forest health: hedge row planting, agro-forestry, strip inter-cropping with legumes and others species; and
- Adopt scientifically-proven interventions to minimize forest fire potential and impact (e.g., fire line construction).

5. Water pollution

Point source pollution has become a serious concern in the Middle Karnali watershed. Appropriate household waste disposal is the primary challenge, along with open defecation, soil erosion, and agricultural run-off from local farms. Our findings indicate that no local initiatives were currently active in Middle Karnali to address this challenge.

Recommendations

- Raise awareness about water pollution, pollutions sources, and the need for locally devised pollution control measures;
- Raise awareness for managing degradable, non-degradable, and toxic wastes in urban areas; and
- Improve solid waste management near water sources.

1. MIDDLE KARNALI WATERSHED: NATURE, WEALTH AND POWER

This Middle 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 USAID Paani Program conducted a series of literature reviews, household surveys, focus group discussions, and key informant interviews to characterize eight priority watersheds, including the identification of priority threats and opportunities. Through the exit workshop in the Middle Karnali the USAID Paani Program 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 resources in support of activities in all aspects of watershed conservation.

Related annexes

Annex 1: Methodology

[2] Anderson, Ion, Mike Colby, Mike McGahuey, and Shreya Mehta. "Nature, wealth and power: leveraging natural and social capital for resilient development." *Washington, DC: USAID* (2013). https://rmportal.net/library/content/nwp-2.0

2. NATURE

In this section, we review the status of the environment and natural resources in the Middle Karnali watershed, paying special note to trends and changes that may threaten the health and sustainability of these assets. The Karnali River, the longest river in Nepal, flows through the center of the watershed and drains water from an area of more than 900 km^2. The numerous tributaries and wetlands support a rich aquatic biodiversity, including a number of commercially important native fish species.

The water resources from the tributaries of the Middle Karnali watershed also play an essential function in providing water for agriculture, drinking and sanitation that contributes to support livelihoods of 171,856 people within the watershed.

2.1 MIDDLE KARNALI WATERSHED

The Karnali River originates from Mansarovar and Rakshas lakes in Tibet before entering Nepal. The Karnali links to numerous snow-fed tributaries, including the Mugu Karnali, Humla Karnali, Thuli Bheri, and West Seti rivers. The Middle Karnali watershed includes a 67.7-kilometer long section of the Karnali River, from the confluence of the Humla Karnali and Tila Rivers at Jitegada downstream to the Karnali's confluence with the Lahore Khola at Tallo Dugeshwar. The river bed is primarily boulders in the north and sandy in the south, contributing to a high sediment load. Toward its southern end, near the Indian border, the Karnali forms a spectacular gorge at Chisapani, which hosts several trans-Himalayan and sub-Himalayan fish species. In all, 74 fish species have been counted in the Karnali (Shrestha, 1990). White water rafting and sport fishing are popular recreational activities.

Three-fourths of the Middle Karnali watershed sits in the midhills of Nepal, its topography comprised of steep and fragile slopes vulnerable to erosion and landslides. The remaining area is categorized as middle mountain (Figure 3).

Middle Karnali has long been the focus of hydropower development in Nepal. At the intersection of Accham, Dailekh and Surkhet districts, the GMR Consortium of India is presently building a 900 MW run-of-river dam. As the Karnali is rich in aquatic biodiversity, many residents fear the dam will negatively impact fish and other aquatic life. For example, cold water fish prefer warmer waters in which to spawn, and which are available in many Karnali tributaries. The Upper Karnali Hydropower Project may impede fish movement up the river and diminish the potential for maintaining fish numbers.

Middle Karnali is also rich in forest resources: 53% of the land area is forest. In addition to timber, the forests offer many valuable non-timber forest products such as cinnamon, turmeric, soap nut, and Himalayan nettle. Thirty percent of the land is dedicated to agriculture, while 13% is used as grazing land.

Demographically, 59% of the population in Middle Karnali identifies as Brahmin/Chhetri/Thakuri, 30% as Dalit, and 3% as Janajati. Of the Janajatis, 70% are Tharu, living in the southern reaches of the watershed. Agriculture is the primary source of income (70%) followed by livestock rearing (12%). Service-based occupations (4%), remittance (3.5%) and wage employment (3%) are also significant sources of livelihood in the watershed. The remaining 8% of income sources are scattered among fishing, poultry farming, and

dairy farming. Seasonal migration and migration abroad for work are increasing rapidly in the watershed, primarily for men. As climate change has made productivity more unpredictable, many farmers have turned to alternate crops (e.g., seasonal vegetables, citrus fruits) to buffer against vacillations in annual production.

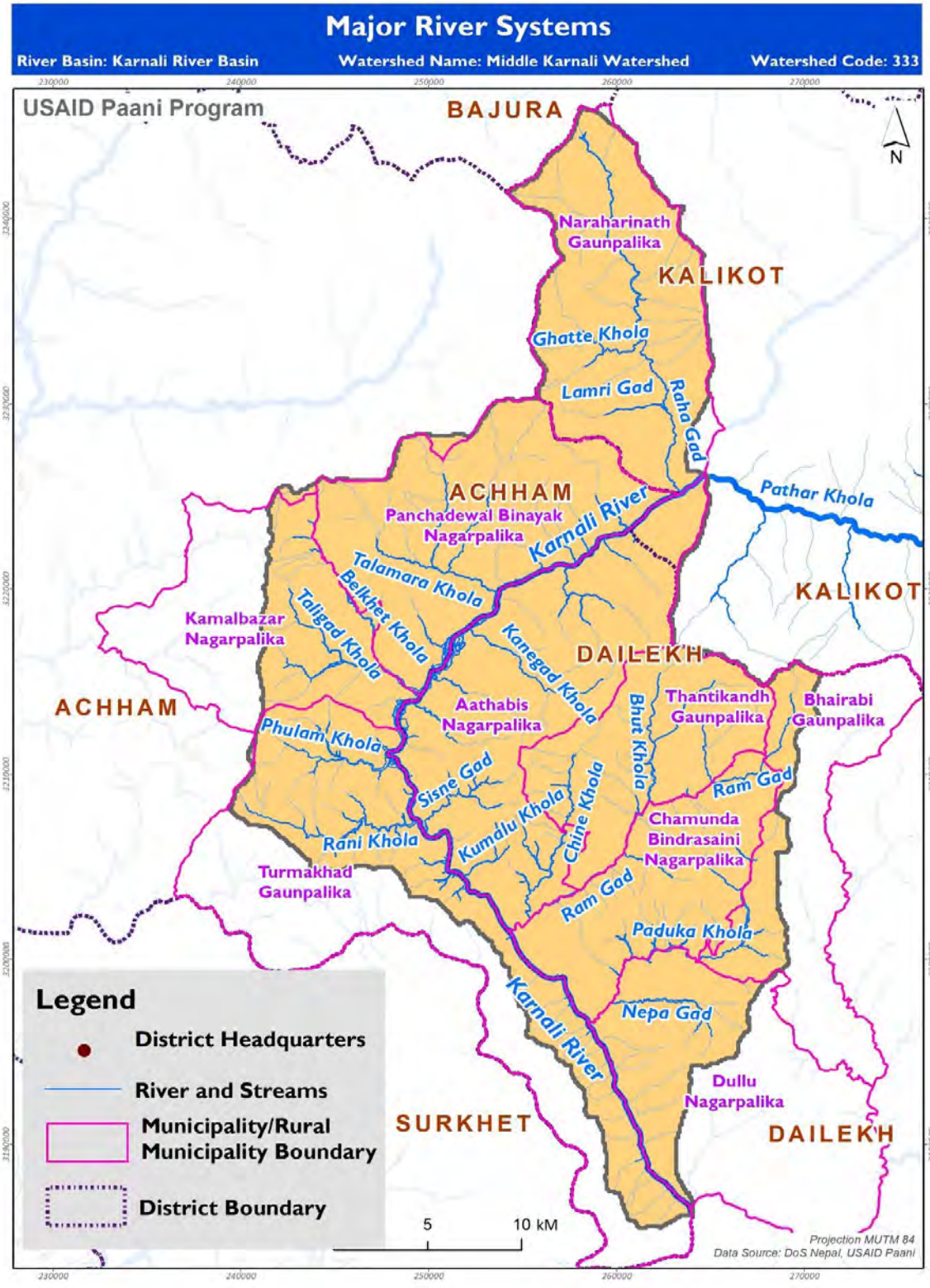

Figure 3: Map of the Middle Karnali watershed and its river network

2.2 WATER AVAILABILITY AND QUALITY

The Middle Karnali has numerous small rivers and tributaries scattered throughout the watershed totaling 659 km in waterways (Figure 3). The major tributaries in this area include the Lodegaad, Chiltagaad, Bhanakotgaad, Khulagaad, Talagaad, Pulum Khola, Thote Khola, Amina Khola, and Mahana Khola. These tributaries provide fish with breeding grounds during the summer months. Within Middle Karnali there are 33 sub-watersheds: 17 in Accham, 15 in Dailekh, and one in Kalikot (Annex 5).

Water discharge in fourteen tributaries in the Middle Karnali watershed was estimated using the float method during Paani's water quality survey in 2017 (Table 2). Water discharge in the main stem at the outlet of the watershed has been modeled by IWMI and estimated at 891,253 liters/second at the height of the monsoon (August) and as low as 81,515 liters/second in January.

Table 2: River and stream discharge rates in the Middle Karnali watershed

SN	Place	Elevation	Dry season avg. discharge (L/S)	Monsoon avg. discharge (L/S)	Winter season avg. discharge (L/S)
1	Kuinka Khola	609	630	348	333
2	Ramagaad	636	162	30,612	2,395
3	Chiltadagaad	663	50.7	2,252	104
4	Pulletala Khola	739	54	6,573	406
5	Lodegaad	593	33	1,561	45
6	Chine Khola	564	38	1,710	143
7	Dogade	716	214	21,600	685
8	Kanegad (Rakam) Khola	623	51	4,884	85
9	Barle Khola	730	214	13,363	899
10	Paduka Khola	720	106	3,289	39
11	Khidkijyula Sinhasen	637	33	7,399	212
12	Chamunda Bindrasain	575	100	5,462	545
13	Rahagaad	653	NA	NA	4,769
14	Gungaad	596	2	219	20

Fifty-two percent of households obtain water for daily needs through pipes, while 40% rely on surface water and 4% use stone spouts for daily domestic needs. Ninety-three percent of the drinking water sources in Middle Karnali are public and the rest are privately-owned.

Despite this array of water sources, 97% of households reported difficulty in obtaining enough water for their daily needs. Forty-nine percent of households reported needing more than 30 minutes per day to collect daily water, while 30% said they needed between 15 and 30 minutes per day. Community perceptions of water availability reflect these statistics. Ninety-five percent of respondents said that water quantity had decreased in recent years, while 94% said local water sources had been drying up.

Looking at access, 11% of residents reported unequal access to public water sources. Thirteen percent of respondents cited caste discrimination as the basis for this unequal access, 82% cited diminished water availability, and 24% said long distances to available water[3].

Water availability and access issues disproportionately affect women and girls in Middle Karnali as they most commonly bear responsibility for obtaining daily water. In Nepa GP in Dailekh, respondents said drying water sources were forcing them to walk 2-3 kms one way to collect water. For girls, this has meant less time studying for school, and, in some cases, missing school altogether. As climate change and rural road construction continue to impact water availability, it is expected that this situation may not soon change in Middle Karnali.

Water quality in the watershed was determined by testing a range of parameters, including pH, nitrate nitrogen and nitrate nitrogen, ammonium, phosphate. All were found to be in the normal range for drinking, domestic use and irrigation. Ammonium (max 8 mg/l) and phosphate (max 22 mg/l) levels were found to be slightly elevated in a few sites. The water was sampled at several locations in the watershed using an Akvo Caddisfly kit.

Related annexes
Annex 5: Lakes, streams, rivers, and sub-watersheds
Annex 12: Micro hydropower projects in the Middle Karnali watershed
Annex 13: Irrigation projects
Annex 14: Water quality

2.3 LAND USE AND LAND COVER

Forest covers 52% of the total area in Middle Karnali, followed by 30% for agriculture, 13% for pasture and grazing land, and the remaining 5% by various water bodies. The forest is a major natural resource in the watershed composed primarily of Chir pine and hilly broadleaved trees in the northern part, and a Chir pine and Sal forest mix in the south (Figure 4). Other important forest species include Alder, Rhododendron, Quercus, and Kharsyu. Forests in Middle Karnali also offer numerous non-timber forest products such as timur (Szechuan pepper), rittha (soapnut), aamala (gooseberries), khoto (resin), lokta, and somalata, among others.

[3] Percentages here add up to more than 100 because respondents were allowed to give more than one factor.

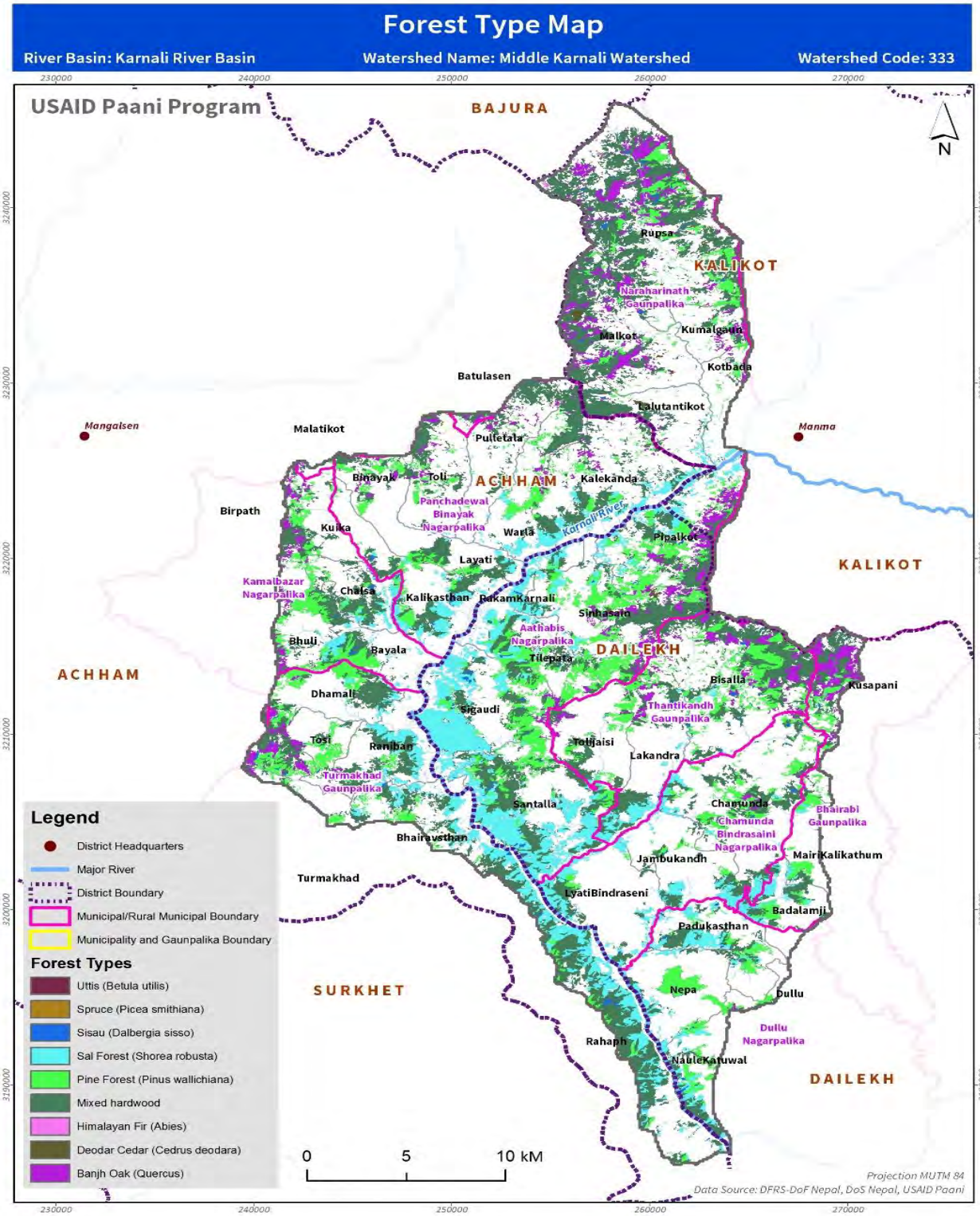

Figure 4: Forest cover and type in the Middle Karnali watershed

Slope influences the retention and availability of soil moisture. Remote sensing was used to determine the general slope of the watershed, as this characteristic plays a strong role in anticipating the likelihood and intensity of floods and landslides. Seventy-three percent of the watershed is categorized as moderately steep, 15% as gently sloping, and 11% as steep.

The significant forestation in the watershed provides control over soil erosion; however, land satellite data from Global Forest Watch between 2000-2016 show the watershed has lost 353 hectares of forest over that time, while gaining 110 hectares in other parts (Figure 5). Concerns about infrastructure development are often concerns about soil retention and fertility as respondents say both have declined in the past decade.

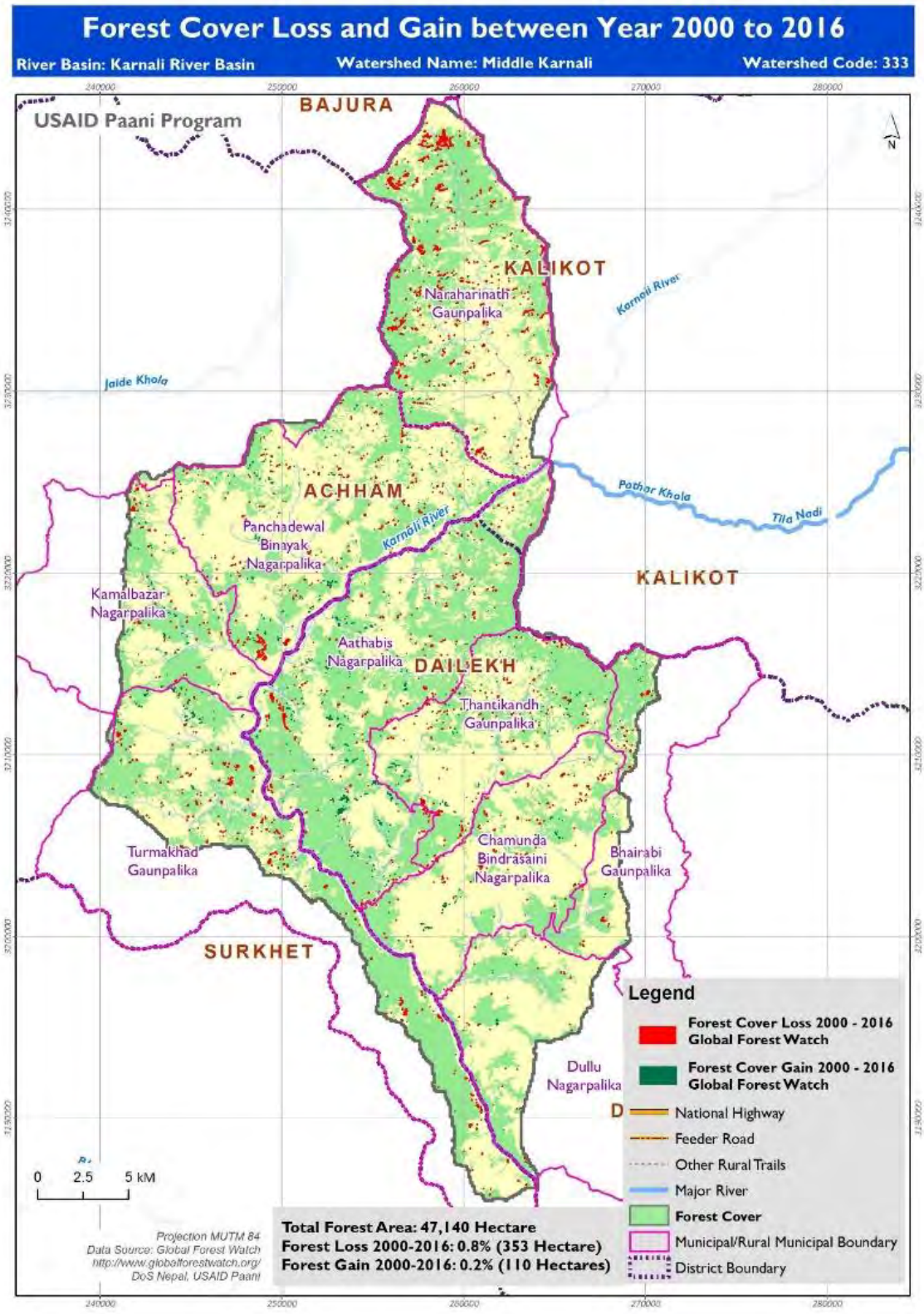

Figure 5: Forest loss and gain in the Middle Karnali watershed

2.4 BIODIVERSITY AND INVASIVE SPECIES

The Middle Karnali watershed contains numerous and diverse habitats for aquatic and terrestrial species among its numerous forests and rangelands. The forests are dominated by Chir pine (*Pinus roxburgii*) and hilly broad-leaved trees at higher elevations and Sal forest and Chir pine at lower altitudes. Riparian types of forest can be found at lower elevations populated by simal (*Bombax ceiba*) and palash trees (*Butea monosperma*). Forests are jointly managed by the District Forest Office (DFO) and numerous community user forest groups (CFUGs) in Middle Karnali.

The Karnali River is especially important – nationally and globally – for its aquatic biodiversity and many species can be found in the Middle Karnali, though their numbers are currently under threat from climate change and anthropogenic pressures on the environment. Respondents noted 46 different species of fish in the watershed (Annex 8) that use the Karnali and its tributaries as breeding grounds. Of these fish species, a few are considered endangered such as the snow trout (*Schizothorax*) and mahseer (*Tor* sp). Rare migratory fish like the Indian motted eel (*Anguilla* spp), and Dwarf gonch (*Bagarius* spp.) were formerly plentiful in Middle Karnali.

The Upper Karnali Hydropower Project conducted fisheries surveys in 1998 and 2012. The survey results show 78 fish species belonging to 14 classes. It also reported migratory fish species that use river stretches for breeding, rearing, rest and feeding purposes. Upstream migration generally starts in the Karnali River when discharge increases in May and June after pre-monsoon rains. Downstream migration starts when discharge decreases in September and October after the monsoon (EIA 2013). Mitigating the impacts of a dam will require developing means of fish passage and identifying and meeting specific requirements of seasonal water flows that prevent disruption of critical ecological functions.

The Nepal Fish Biodiversity Project (NFBP), implemented by the Centre for Molecular Dynamics - Nepal (CMDN), used environmental DNA (eDNA) to identify different fish species in the Karnali River. With the help of local fishermen, researchers collected fish samples for morphological and genetic analysis. The project used three different methods to identify fish. The project conducted three field samplings at nine sites, including three sites in the Middle Karnali Watershed, at two seasons between May 2016 and October 2017. Of the 629 fish captured during all three phases, experts identified 51 species through genetic analysis. They identified 13 new species not detected during earlier collection and genetic analysis. They identified 33 unique species in the first phase and 35 in the second phase of the studies through genetic analysis[4].

Invasive species are of significant concern in Middle Karnali, both aquatic and terrestrial. These species pose a threat to biodiversity as they can often dominate an ecosystem and its resources through aggressive growth. To date, several invasive plant species have been noted in the Middle Karnali watershed, such as West Indian Lantana (*Lantana camera*), Santa Maria feverfew (also known as Madhesi pati; *Parthenium hysterophorus*), and Siam weed (*Chromolaena odorata*). Farmers control these species primarily with fire, which is unsafe. No aquatic invasive species have been noted in the watershed.

Related annexes

Annex 7: Fish and aquatic life species

[4] http://kathmandupost.ekantipur.com/news/2018-04-22/experts-identify-36-fish-species-in-karnali-river.html

Annex 8: Mammals and population trend
Annex 9: Reptiles and population trend
Annex 10: Birds and population trend

2.5 CLIMATE AND PHYSIOGRAPHY

There are four prominent climatic seasons in Nepal: winter (Dec-Feb), spring/pre-monsoon (Mar-May), summer/monsoon (Jun-Sept) and autumn/post-monsoon (Oct-Nov). Temperature and rainfall variations persist not only by season but also by altitudinal gradients.

2.5.1 RAINFALL

There are two long-term rainfall data stations in the lower elevations of the Middle Karnali watershed at Asaraghat and Balebudha. In the mountains, regional topographic variations have a profound effect on the spatial variation of rainfall. For this reason, data from additional stations slightly outside the watershed (Dailekh, Serighat, Raskot, and Managalsen) were also used to create rainfall estimates and projections. Figure 6 shows the estimated monthly rainfall – the solid blue line – using these sources.

The average annual dry season (Nov – Apr) rainfall is 34 mm. The average wet season rainfall is 237 mm. The average annual rainfall for the Middle Karnali watershed is 1,293 mm.

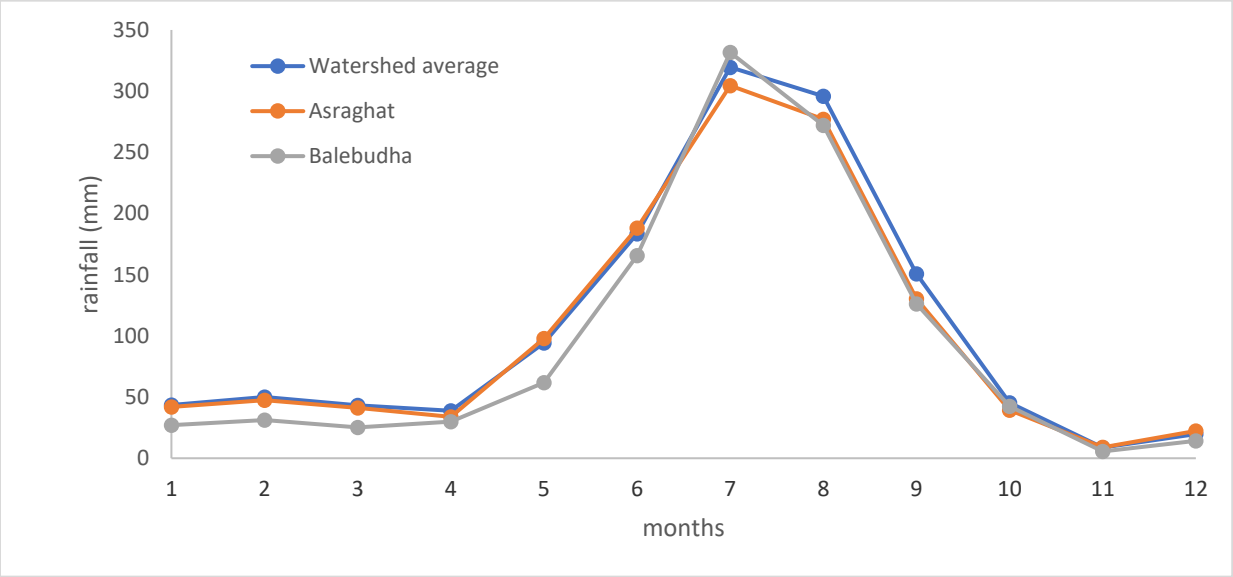

Figure 6: Long-term average monthly rainfall (in mm) estimated in the Middle Karnali watershed

However, these rainfall numbers are not so straight-forward as there is significant topographic variation in rainfall amounts across the watershed. Thus, effective water management will require strategies that meet irrigation needs in the dry season while also maintaining minimum environmental flows necessary to support aquatic life in the river system.

Extremely diverse rain fall patterns over seasons can have manifold implications in the management of aquatic biodiversity in situ. It also shows that water availability greatly varies by seasons. This situation demands to devise strategies for different seasons. Such strategies should consider how to meet irrigation demands in the dry season but without impeding sufficient environmental flows to maintain aquatic life in the river system.

2.5.2 TEMPERATURE

Air temperature in Middle Karnali varies by altitudinal gradients. Using a combination of meteorological stations within and just outside the Middle Karnali watershed, we triangulated data to determine annual temperature averages. The highest monthly average maximum temperature was 26°C, while the low average annual temperature was 9.05° C. Figure 7 shows the average annual mean temperature distribution across the watershed.

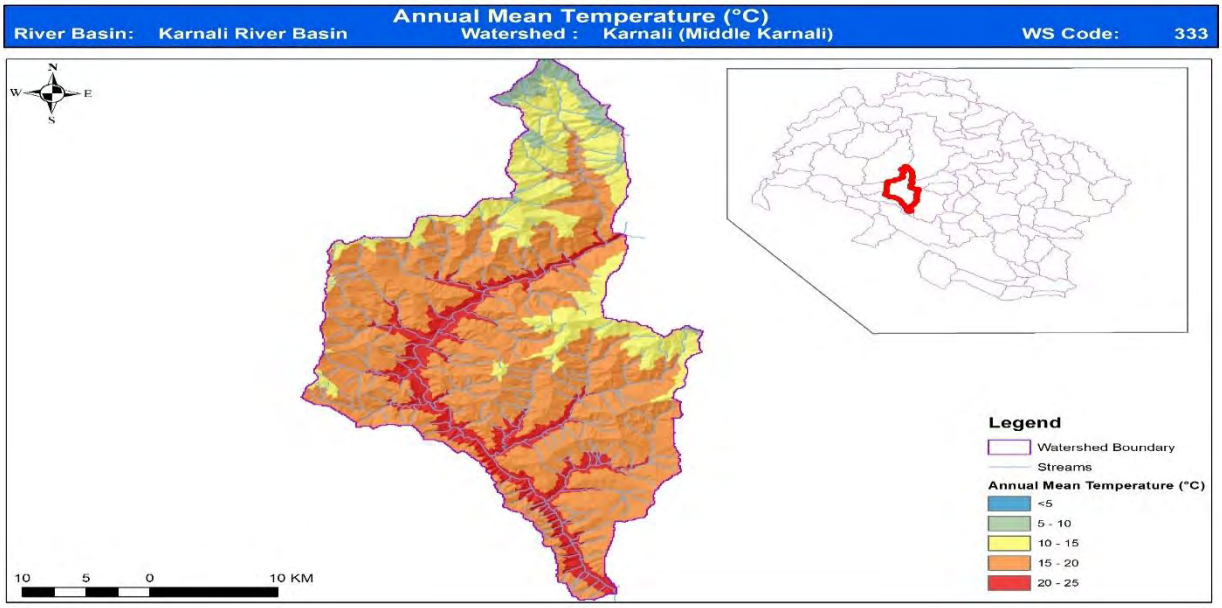

Figure 7: Maximum, minimum and average long-term monthly temperatures (ºC) in the Middle Karnali watershed

To understand climate change trends, we solicited community perceptions on changing rainfall and temperatures and combined these observations with 35-year records (1980-2015) from a meteorological station just outside Dailekh.

In the Middle Karnali watershed, winter and spring temperatures have been observed to be increasing at a rate of 0.03°C/year while summer (monsoon) and mean annual temperatures have risen at the rate of 0.02°C/year (Figure 8). The average post-monsoon temperature of the watershed does not show any change. The temperature increase rate appears higher than in the northern part of the watershed for all seasons.

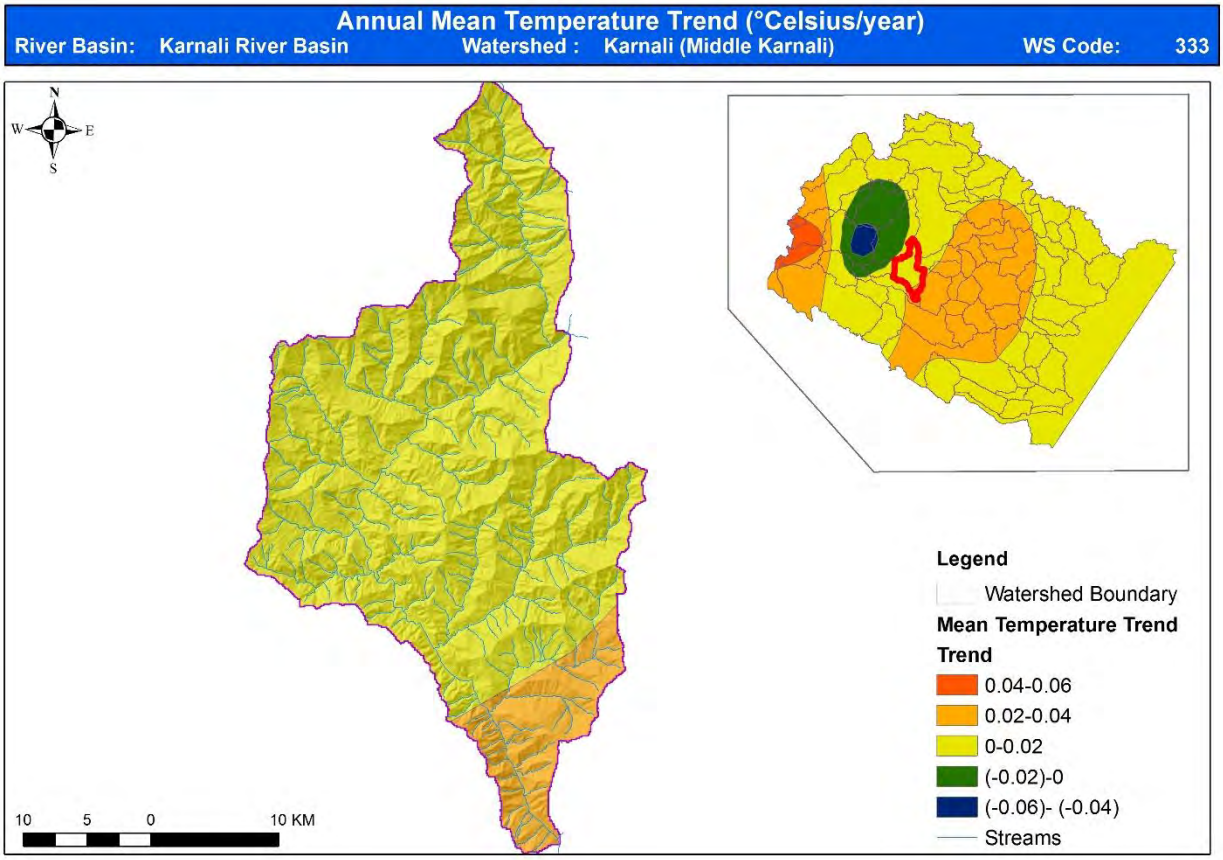

Figure 8: Annual mean temperature change trend in the Middle Karnali watershed

Observed spatial and seasonal variations in rainfall over Middle Karnali were found to be inconsistent. Average annual rainfall appears to be increasing in the western part of the watershed (+10mm/year) and decreasing in the eastern half (-10mm/year). Figure 9 illustrates these changes in rainfall.

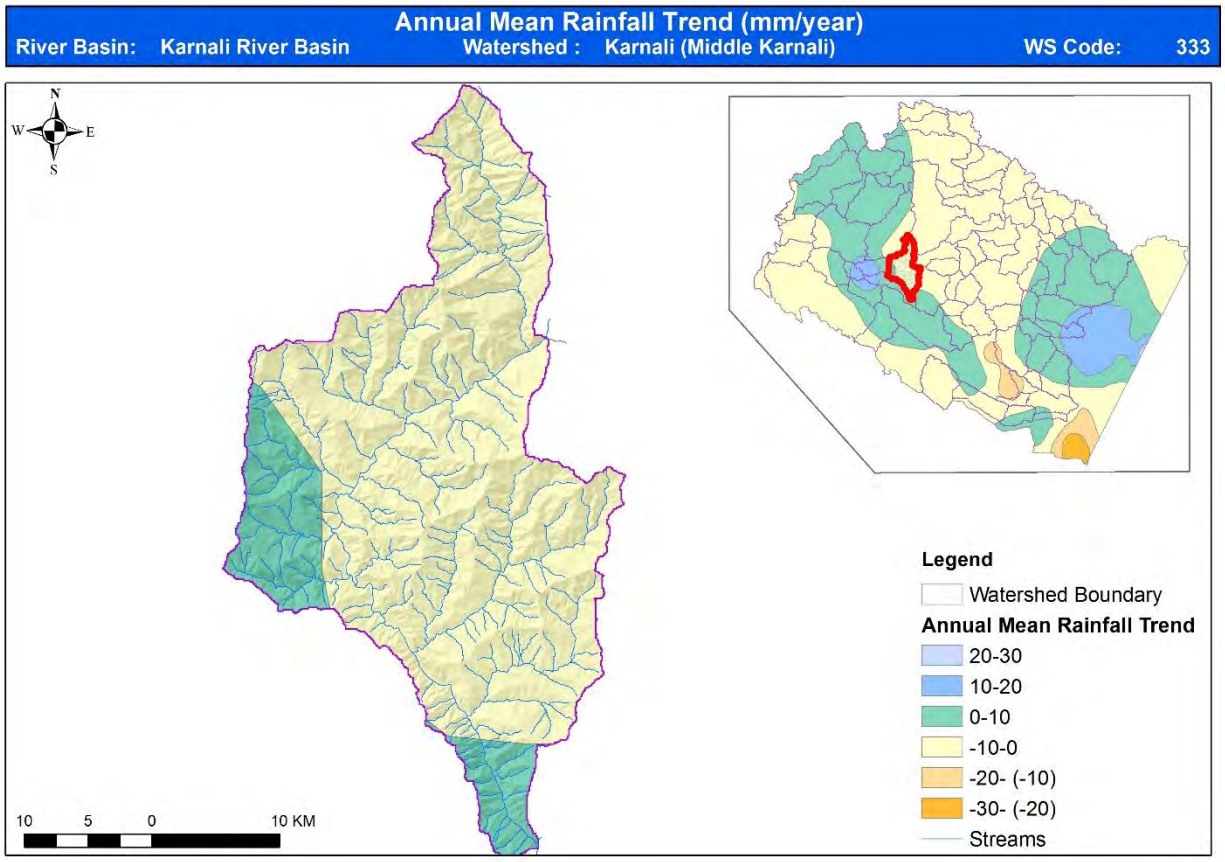

Figure 9: Long-term annual mean rainfall trend (mm/year) observed in Middle Karnali watershed

2.6 CLIMATE RESILIENCE AND DISASTER RISK REDUCTION

Increased human activity combined with climate change impacts are escalating environmental degradation in many parts of the Middle Karnali watershed, in some cases, increasing the likelihood and intensifying the effects of natural hazards such as floods and landslides. Figure 10 presents the percentage of VDCs vulnerable to various natural hazards based on field observations and information gathered through KIIs and FGDs with various stakeholder groups in Middle Karnali. The VDCs were assessed for risks to fire, flood, landslides, and drought/food security. Considering the risks together, 20 VDCs (49%) were cited as highly vulnerable, 16 (39%) as medium vulnerable, and 5 (12%) as low.

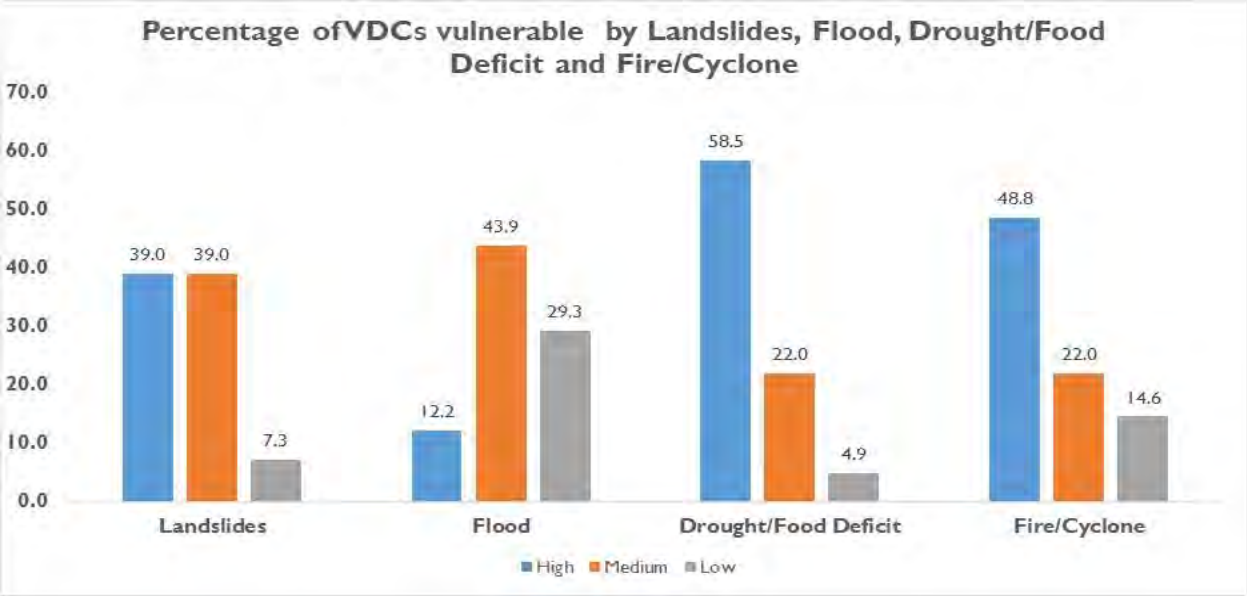

Figure 10: Vulnerability assessment of VDCs by risk to various natural hazards

Communities in Middle Karnali have responded to these risks with climate-resilient activities to strengthen livelihoods and minimize the impacts of natural disasters when they occur. Our field observations noted the installation of recharge ponds, rainwater harvesters, and drip irrigation to maximize water use. Napier grass and hedge row planting were implemented to promote improved soil conservation.

Although there are no early warning systems currently installed in the watershed, each of the three former district governments developed a disaster preparedness plan to share with communities in the event of a natural hazard.

3. WEALTH

The population of the Middle Karnali watershed is 171,856 a figure that has increased in the past decade as people from the high hills have migrated to the Tarai (esp. from Achham and Dailekh) in search of work. This has created a mosaic of more than 30 different ethnic groups in the region. Currently 66% of residents identify as Brahmin/Chhetri/Thakuri, 30% are Dalit, and 3% identify as Janajati.

Agriculture is the main source of livelihood (84% of households). Only four households (out of 369 surveyed) cited fishing as their primary occupation. Many households necessarily diversify their income sources to protect against shocks and setbacks by raising livestock, poultry and migrating for labor (seasonally and abroad). Despite these measures, securing sufficient income beyond present needs remains a challenge.

To buffer against shocks and climate change impacts, households are adopting climate-smart technologies to ensure their crops and well-being. Field observations found households using check dams, hedge row planting, and rainwater harvesting tanks.

Banking with formal institutions is uncommon in the Middle Karnali watershed. Only 19% of households reported having a bank account. However, several government and private financial institutions are available in the watershed. A branch of the Nepal Investment Bank recently opened in Dab, Dailekh, near the future site of the Upper Karnali Hydropower Project.

GESI issues: Changing rainfall and temperature patterns have made farming a less reliable occupation. For this reason, many men in Middle Karnali now migrate to India for work. In their absence, women take on the agricultural burdens for the family, placing added weight on an already formidable set of responsibilities.

To help women meet these demands, agriculture extension services are offering trainings to women to acquire newly-needed skills. Women-focused civil society organizations provide livelihood diversification programs such as tailoring, cooking, and hotel management. While these trainings are well-intended, local residents say few women have time and opportunity to take advantage.

3.1 FISHING PRACTICES

Seven traditional fishing communities live within the Middle Karnali watershed, though they are few in number in terms of population (1,587 people). These groups include Majhi (36%), Badi (27%), Kumal (26%), Tharu (9%), Rajbhar (1%), Nuniya (1%), and Sonar (1%).

Capture fisheries are becoming an increasingly important source of income as the commercial fishing industry continues to develop. Major fish markets have appeared in many sites along the Karnali highway, including Tallo Dungeshwor, Rakam Karnali, Khidkijyula, and Humla Bazaar. Many smaller markets supply fish to local hotels and restaurants.

Capture fisheries have provided another attractive livelihood option for households that are struggling with agriculture and/or other occupations. Fish farming ponds are becoming increasingly common in the watershed. In Rakam, 32 fish ponds now operate, cultivating Mangur fish primarily.

Snow trout, mahseer, and bajelo are important fish species in the watershed, for consumption and sale in the marketplace. Discussions with local residents found that these species are declining in numbers, which they presumed to be due to the rise in destructive fishing practices, such as poison and electric current. Increased sewage disposal in rivers was also cited as a possible cause. These threats were reported as particularly high in Ramagaad, Paduka Khola, Kapri Khola, Talagaad, Lodegaad, and Tunibagar.

3.2 AGRICULTURE PRODUCTIVITY

Agriculture is the primary livelihood in the Middle Karnali: 84% of households cite this as their primary occupation and 30% of the land cover in the watershed is dedicated to farming. The major crops include rice, millet, wheat, maize, and potato. Livestock plays an integral role in local farming systems, in which goats, cattle, and buffalo are most common. Farmers can sell produce at markets in Tunibagar, Paduka, Khidkijyula, and Rakam Karnali.

Most landholdings for famers are small and largely depend on rainfall. Only 21% of farmed land (15,588 ha of 73,214) is irrigated by a variety of sources: lakes, pumps, ponds, and reservoirs.

Nonetheless, food security due to drought and underproduction remains a concern. Almost half of households in the watershed have less than three months of food to support their families (Table 3). Of the 45% with less than three months food security, 65% of those households are Dalit and 30% are Janajati.

Table 3: Food security levels by household

Food sufficiency level	Households	Percentage
Less than 3 months	169	45.83
3 to less than 6 months	152	41.35
6 to less than 9 months	39	10.26
9 to less than 12 months	8	2.24
12 months or more	1	0.32
Total	**369**	**100**

3.2.1 SOIL MANAGEMENT AND FERTILITY

Nearly all households in our survey (99% of 727) said that soil fertility had declined and 95% reported that productivity had declined as a result of this change.

Deforestation, habitat degradation, over grazing, non-point source pollution, and agricultural runoff were listed as additional threats to soil fertility. Many households said improved access to agricultural

inputs and modern farming technologies could help restore soil fertility as it is more difficult to secure reliable farm labor due to migration.

Local agriculture service centers can provide technical support to farmers regarding biofertilizers and environmentally-sound pest management technologies.

3.3 INFRASTRUCTURE

The design and construction of infrastructure, such as roads and hydropower plants, have an impact on the health of the watershed. For example, poorly designed rural roads on steep slopes can increase soil erosion and landslides. 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. Irrigation canals, while bringing benefits to one group of farmers, can also reduce the amount of water available to other farmers. 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 impacts within the watershed. Sustainable infrastructure should provide equitable distribution of benefits with minimal long-term, environmental impacts.

3.3.1 HYDROPOWER

The Karnali River has long been the focus of hydropower intentions as its steep decline from north to south creates a strong, steady flow that can be harnessed for electricity. The 900 MW Upper Karnali Hydropower Project is projected to be a 64 meter tall and 207 meter wide dam whose construction and operation will require displacing 56 households and affect another 426 downstream.

The project is licensed to the GMR Consortium of India, which has been a large source of controversy in Nepal, as 88% of the power generated will be exported to India. Nepal, however, stands to gain considerable revenue from the electricity sold and local residents will be able to buy shares in the project, although those details are still under negotiation.

Environmentally, the Upper Karnali project will destroy 273 ha of forest area and 48 ha of privately-owned land. Downstream of the dam, riverine communities and aquatic life will be impacted by the diminished water flow and seasonal "dewatering" of a 54-kilometer stretch of river. Fishing communities in Dailekh are especially vulnerable as these groups are socially-marginalized and without other options for livelihood.

FGDs and KIIs with residents revealed that communities have abiding concerns about proper remediation of environmental impacts that construction will have on the local ecology and livelihoods.

In additional to the Upper Karnali Hydropower Project, there are numerous microhydro projects operating in the watershed, and all of these were constructed without conducting an environmental impact assessment (EIA). Therefore, residents are unaware of the impact these projects will have on the water and aquatic life in the future.

3.3.2 GRAVEL MINING

Gravel mining relates to the management of aquatic biodiversity and local peoples' livelihoods. On one hand, gravel mining creates incomes opportunities for local people who are also dependent on the aquatic biodiversity. On the other hand, gravel mining may pose threats to river system and aquatic lives if overextracted without proper monitoring.

As the Karnali River is lined with boulders for most of its course, gravel mining has become a popular commercial venture in the Middle Karnali watershed. During monsoon, large quantities of aggregate is deposited near Dungeshwor and Rakam Karnali in Dailekh and near Kalikasthan in Achham. However, unlike many areas where gravel is overextracted, some extraction is occasionally necessary in these areas to lower the riverbed.

Gravel mining provides another livelihood option for households, particularly for those in the Badi community who rely on fishing as their primary means. However, the use of heavy machinery for mining gravel has become more common and this limits the potential for employment.

Despite the relative low impact of gravel mining at present, many households did express concerns that continued mining could affect fish habitats, especially where road construction is concerned and heavy machinery is used crush boulders into aggregate.

One potential site of concern is near Tallo Dhungeshwor where a large quantity of material has been taken to build roads. Some households noted that the velocity of the river had quickened due to the extraction of gravel. If river flow becomes too strong, it can uproot some aquatic plants and impede fish swimming up river to spawn.

3.3.3 ROADS

Roads play a central role in economic development and, accordingly, road-building is a high priority in all parts of rural Nepal, including the Middle Karnali. Road building, however, brings significant environmental pressures (e.g., soil erosion, landslides) and can be harmful if roads are not built without a prior environmental assessment to guide construction.

Middle Karnali contains 332 kms of road and 77 of those kilometers are black-topped as part of the Karnali highway, a government-built "strategic road," which runs north to south through the watershed. The Karnali highway runs along the Karnali river and provides a major corridor for commerce and transportation.

Another 256 kms of earthen roads spread throughout the watershed, constructed through support from local governments. Many households report that earthen roads have not been built with proper drainage systems, leading to road washouts and increased soil erosion. FGD participants recommended stronger enforcement of environment-friendly construction guidelines.

Related annexes

Annex 11: Road networks in the Middle Karnali watershed

3.3.4 IRRIGATION

While irrigation is necessary to improve livelihoods and economic development in the watershed, the amount of water diverted directly affects aquatic life. Keeping minimum flows intact is crucial to maintain watershed health. Environmental assessments are required for medium and large projects (>300 ha), but not for smaller projects.

Households in the Middle Karnali watershed have benefited from various supported irrigation schemes. In 1999, the European Union developed irrigation models in Kalbhairab and Rakam Karnali in Dailekh. USAID helped to install eight small irrigation schemes through the KISAN I project. The Government of Nepal has partnered with the World Bank to provide expansion of temporary dams, irrigation skills, and

increased usage of drip irrigation, sprinklers, and water harvesting tanks. In this latter program, farmers must provide 15% of the cost either through labor or cash payment.

Rain is the primary source of irrigation in Middle Karnali, providing water to 75% of the existing water irrigation schemes. Seventeen percent of schemes use river canals, while 13% use nearby ponds.

The KISAN 1 project sponsored by USAID has been responsible for numerous water supply strategies through the watershed, including irrigation ponds (cement and plastic) and several pipeline schemes to extend irrigation coverage.

Related annexes
Annex 13: Irrigation projects

3.4 SOLID WASTE AND MANAGEMENT

Solid waste (e.g., garbage, plastics) in the watershed emanates from a number of sources and the lack of sanitation systems, personal and village-wide, threatens water quality and aquatic life.

In Middle Karnali, FECOFUN interviewed 365 households regarding waste management. Fifty-six percent said they disposed household waste in their kitchen gardens, while 22% used a local sewer system, and 21% reported they dumped waste into nearby rivers and tributaries. Only 2% of households had a personal septic tank system. Regarding solid waste, 26% of households incinerate, 24% dispose in nearby waterways, and 22% said they used it for composting.

Point source pollution was observed primarily near the markets that operate along the Karnali highway. Small settlements with restaurants and hotels directly dispose waste into the nearby Karnali River. These markets are located in Tunibagar, Rakam Karnali, Ramagaad, Paduka, and Khidkijyula.

Related annexes
Annex 15: Major pollution points

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 Middle Karnali watershed. Analysis indicates there is a need to better understand how current institutional arrangements related to, for example, fisheries and gravel mining are positioned (or not) to 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 Middle Karnali watershed.

4.1.1 ACCESS TO WATER FOR DOMESTIC AND AGRICULTURAL USE

Drying water sources are a major cause for concern in the Middle Karnali watershed. While the issue of drying springs is still not perfectly understood, many water sources have been swept away by soil erosion, landslides, forest fires, and improperly constructed roads.

Water accessibility in Middle Karnali is a serious issue. Obstacles to water accessibility can be physical (e.g., distance to water points) or cultural (e.g., water sources available only to certain castes), or both. Twenty-two percent of respondents said they did not have equal access to water. Of that 22%, 82% cited water scarcity as a primary obstacle, while 24% reported long distances to water, and 16% noted cultural barriers (e.g., certain water sources reserved for particular castes).

The 2015 Constitution of Nepal (section 57) declared the newly-devised federal system would delegate significant authority to local municipalities, including many related to water resource management and relevant environmental issues.

These new governance responsibilities suggest time is appropriate to work closely with local authorities to develop plans to promote improved watershed health. Figures 1 and 3 show the three new *nagar palikas* and two new *gaun pali*kas that are entirely in the Middle Karnali watershed and the four other *palikas* that lie partially in the watershed—a total of nine local jurisdictions. The following 12 agencies are the main technical agencies responsible for water resource management in Middle Karnali:

1. District Coordination Committee (Achham, Dailekh, Kalikot)
2. Division Forest Office (Achham, Dailekh, Kalikot)
3. Agricultural Knowledge Center (Achham, Dailekh, Kalikot)
4. Soil and Watershed Management Office (Surkhet and Jumla)
5. Upper Karnali Hydropower Project (Dailekh)

4.1.2 ACCESS AND INCLUSION IN LOCAL NRM PLANNING

In the Middle Karnali watershed, water availability is a pressing concern, but so are forests and the many NTFPs and ecosystem services they provide. As the need for economic development continues to be

addressed, many people living in the watershed have concerns for balancing livelihoods with sustainable livelihoods and biodiversity conservation.

In the watershed, several forms of user groups (i.e., forest, water, irrigation) form a bridge between government and community to balance household needs with natural resource availability. The Federation of Community Users, Nepal (FECOFUN) is the leading forestry organization that advocates for community forest user groups (CFUG) and others in the watershed. They are also an important partner to USAID on the Paani project.

There are currently 186 CFUGs active in Middle Karnali comprised of 28,707 households. Collectively, these groups manage 19,427 ha of forest in the region. CFUGs take the lead in monitoring and regulating forestry use for their group.

The Federation of Drinking Water and Sanitation Users Nepal (FEDWASUN) represents water users in Middle Karnali while the National Federation of Irrigation Water Users Nepal (NFIWUAN) provides leadership on irrigation issues.

While user groups of all forms aspire to equitable access to natural resources, proper representation of caste and gender among its members and in leadership positions is a key concern. Looking at CFUGs in Middle Karnali, we find that women comprise 43% of membership, while Dalits comprise 52% of membership, and Janajatis 5%.

GESI issues: Women's participation in community-based organizations and user groups has been increasing in recent years, but men still dominate the conversations and decision-making. While the Dalit participation rate of 52% in CFUGs is impressively high compared to other parts of Nepal, stakeholders have noted that their input and participation seems less valued by the group.

Participation in DRR activities and committees is also of particular importance as development and climate change continue to impact the watershed. Of 73 households surveyed, 82% said they belonged to a DRR committee. Membership in these committees was 90% male and only 10% female. Looking at caste, BCT members were 72%, while Dalits were only 27% and Janajatis just 1%.

Related annexes
Annex 17: Community user forest groups

4.1.3 ACCESS TO BENEFIT SHARING IN THE WATERSHED

The land, water, flora and gravel of the Middle Karnali watershed comprise the major natural resources of the area. And, each of these faces numerous threats from, among others, deforestation, habitat degradation, unsustainable agricultural practices, and non-point source pollution. These challenges are exacerbated by the watershed steep topography and a general lack of suitable land for crops.

In the Middle Karnali watershed, stakeholders have identified these agencies (Table 4) as critical to addressing natural resource issues:

Table 4: Key offices in Middle Karnali for addressing natural resource issues

Office	Location	Remarks
Governmental		
Agriculture Knowledge Center (AKC)	Dailekh, Achham and Kalikot	Starting work with capture fishery groups to discuss sustainable harvest practices
District Coordination Committee (DCC)	Dailekh, Achham and Kalikot	Works with local mayors and village heads to coordinate natural resource sharing in Middle Karnali
Division Forest Office	Dailekh, Achham and Kalikot	Liaising with CFUGs to insure clear understanding and proper enforcement of use and conservation guidelines
Soil and Watershed Management Office	Jumla and Surkhet	Turning focus to the effects of development activities on soil erosion, soil fertility and watershed management
Nongovernmental		
Community forest user groups (CFUG)	183 formed; numerous locations	Share responsibility for sustainable use and management of community forests
Alliance for Agriculture		Sponsoring coordination meetings between farmers and agriculture-related government offices
Rural Access Program	Numerous locations	Endorsing environment-friendly road construction practices in the watershed

While there are many environment- and agriculture-focused groups active in the Middle Karnali watershed, participation in them is low. Only 22% of households claim membership in an NRM planning group. Of that 22%, 17% are affiliated with a community forest user group. The remaining households are distributed among various water (5%), irrigation (5%), and drinking water (11%) groups. Looking at caste and ethnicity, 13%% of Janajati, 25% of Brahmin/Chhetri/Thakuri, and 17% of Dalit claimed affiliation with a local representative NRM body.

National guidelines states that women should comprise 33% of the seats in a CFUG. While nearly all groups meet those standards in Middle Karnali Watershed, focus groups discussions revealed that women's participation appear to be limited, particularly in decision-making and leadership responsibilities. Surveying all NRM groups in Middle Karnali Watershed, only 23% of leadership positions were held by women and/or persons from a marginalized group.

Local governments are tasked with using a participatory approach to local NRM planning; however, in our survey, only 20% of residents said they were aware of such planning such as Local Adaptation Plans of Action (LAPA) and Community Adaptation Plans of Action (CAPA).

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 a majority of the population in Middle Karnali is dependent on climate-sensitive agriculture, variations in temperature and precipitation are causing serious livelihood distress to communities. To adapt to these changes, many farmers have adopted climate-smart technologies to strengthen their crops and livestock and to promote resilient food systems. Some of these technologies include alternative crops (e.g., citrus fruit trees), rainwater harvesting tanks, and drip irrigation.

At the policy level, the government of Nepal has developed a National Adaptation Plan of Action (NAPA), while delegating authority to the NPs and rural municipalities to develop Local Adaptation Plans of Action (LAPA) and Community Adaptation Plans of Actions (CAPA). Nepal's current NAPA promotes climate-smart technologies as described above and advocates for building capacity in rural districts to diversify livelihoods and income sources as another source of buffer against future shocks.

Preparation and implementation of LAPAs and CAPAs in Middle Karnali has been slow. There is currently only one LAPA operational in Dailekh. Two Water Use Master Plans (WUMPs) have been implemented in Dailekh and Achham. Achham, Dailekh, and Kalikot all have developed and implemented Local Disaster Risk Management Plans (LDRMPs).

4.2.2 COMPLIANCE WITH LAWS AND POLICY PROVISIONS

Surveys and focus groups revealed a generally low knowledge of existing environmental policies and provisions, and similarly low compliance with these regulations where they were known. A primary reason for this is the remote location of many communities in the Middle Karnali watershed where they have limited interaction with government officials and representatives. Creating a culture of environmental stewardship and a shared interest in promoting watershed health will require significant outreach to equip citizens with relevant information.

For example, despite the existence of the Aquatic Animals Protection Act 1961, the use of harmful, non-traditional methods of fishing (e.g., gill nets, poison, electric currents) continues to rise and decimate local fish populations. Weak enforcement of this legislation allows these practices to continue unchecked. Similarly, local governments in Middle Karnali Watershed (Chamunda Bindrasaini Municipality, Dullu Municipality, Aathabis Municipality and Thatikandh Rural Municipality of Dailekh; and Pancah Dewal Binayak Municipality, Kamal Bazar Municipality and Turmakhand Rural Municipality of Achham District) each enacted an Aquatic Animal and Biodiversity Conservation Act 2018. The laws specifically mentioned setting up river stretch management through community river groups. They also include strict provisions for combating destructive fishing and maintaining e-flows in cases of infrastructure construction.

The Solid Waste Management Act 2011 contains strict language forbidding the unregulated disposal of household and industrial waste. Twenty-six percent of households are burning their solid waste, while 22% use some of this waste for compost, and 24% dump solid waste into the nearby river.

4.3 GOVERNANCE

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

Through FGDs and KIIs, respondents expressed their growing awareness of the need to develop stronger relations between upstream and downstream communities. In spite of the many regulations providing vision on issues related to watershed health, there was a general consensus that their lack of implementation would lead to conflict between communities on issues of fish, forests, and water. Moreover, increasing infrastructure development, in the form roads and hydropower, has raised general concerns about e-flows and maintaining sustainable agricultural production.

Survey responses indicate that coordination among VDCs, municipalities, districts, and provinces is quite low. Women and marginalized persons are not well represented in the formal and informal institutions and organizations in Middle Karnali watershed. Similarly, village and municipality level government planning and budgeting processes (e.g., LAPA, CAPA, WUMP) are neither very transparent nor very participatory. Building consensus and ownership between government and citizens will improve the potential to create conditions favorable to conserving aquatic biodiversity and promoting community resilience.

Related annexes

Annex 19: Existing policy provisions and status of enforcement

Annex 20: Key stakeholders – organizations and offices

5. VISION AND MISSION FOR THE MIDDLE KARNALI WATERSHED

This Middle Karnali 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 (e.g., universities).)

5.1 VISION STATEMENT FOR THE MIDDLE KARNALI WATERSHED

A two-day vision-building session was organized in Dailekh in July 2017. The participants were divided into five groups to draft their own watershed vision statement. The groups were asked to draft the statements based on what they hoped to see in the watershed 20 years from now. The five drafts were shared with the entire group and they synthesized the following vision statement:

"Residents of the Middle Karnali watershed aspire to social, economic, and environmental prosperity defined by biodiversity conservation and equitable and sustainable use of water based on scientifically-integrated principles of watershed management."

5.2 COMMITMENT TO CONSERVE THE MIDDLE KARNALI WATERSHED

Reviewing the threats, challenges, and opportunities identified with regard to watershed health, participants of different consultation workshops described what they intended to do within their capacity to act (e.g., as residents, government representatives, NGO/CBO representatives, fishing communities, etc.) and the outcomes expected from each set of activities. These ideas have been organized by watershed health theme in Table 5.

Table 5: Action commitments and expected outcomes by theme

SN	Theme	Major Activities	Expected outcomes
1	Climate change and aquatic biodiversity conservation	• Build capacities of local governments and communities to improve capture fisheries management • Initiate fisheries co-management practices • Initiate regulatory framework at local level	• Climate smart best watershed management practices implemented and scaled up • Practices established to maintain fish stocks and aquatic biodiversity at

SN	Theme	Major Activities	Expected outcomes
		• Form and mobilize community river groups • Conserve aquatic habitats and fish species	community level, supported by local governments • Public private partnerships established that promote eco-tourism linked with biodiversity values of the watershed • Enhanced natural resource based livelihood opportunities in the watershed
2	Physical infrastructure and disaster management	• Build capacities of concerned groups affected by the Upper Karnali Hydropower Project to ensure e-flow and fish passage mitigation during hydropower plant construction and operation • Prepare guidelines for rural road construction • Prepare/enhance LAPAs, LDRMPs, and WUMPs at municipal level	• Enhanced advocacy skills of local communities in regard to aquatic biodiversity conservation • Values of free flowing river for the promotion of ecotourism and aquatic biodiversity conservation recognized at local level • Enhanced resilience capacity of marginalized communities
3	Water availability and water quality	• Map spring sources and initiate protection and improvement of water sources • Scale up rainwater harvesting practices • Set up more solar pumps • Manage waste and sludge disposal	• Enhanced water resources management practices at local level • Practices of multi-use water system implemented • Improved waste management practices
4	Livelihoods	• Initiate mimic in-situ fisheries conservation to promote fisheries based livelihoods • Support branding and marketing of fish products • Promote alternative livelihoods of fishing communities, linking with subsidies programs from local and provincial governments	• Enhanced fisheries based livelihoods • Diversification of livelihoods options of fishing communities • Local communities of watershed aware of rafting and other river based livelihoods

SN	Theme	Major Activities	Expected outcomes
5	Governance, policy, and gender and social inclusion (GESI)	• Promote sustainable fishing practices through community river stretch co-management involving fishing communities • Form policy, laws and guidelines at local level for biodiversity conservation and climate change adaptation • Ensure participation of women, Dalit and marginalized people in decision making through legal and policy provisions of local governments in the watersheds	• Community based river stretch management practices begun • Aquatic biodiversity conservation recognized and prioritized by local governments in the watershed • Adoption of equitable benefit sharing practices

6. RECOMMENDATIONS

The Middle Karnali watershed profile presents the status, major challenges and opportunities facing water resources management for the multiple users located within the region. Based on discussion at the workshops, stakeholders proposed the following recommendations to improve climate change adaptation and freshwater biodiversity conservation in the watershed:

1. **Enhance water availability and efficient water use**

- Create water source maps so the community can share in planning and monitoring of water availability and water levels.
- Introduce water source protection and conservation methods to develop more comprehensive multiple water use systems. Raise awareness about multiple-use water technologies (MUS) that maximize water use efficiency, such as sprinkler and drip irrigation. Plant trees and shrubs in springsheds and on barren land in communities to reduce run-off, retain rainwater, and recharge natural springs.

2. **Establish/strengthen mechanisms for restoring healthy populations of fish and other aquatic life of high economic and/or biodiversity value**

- Initiate dialogue with government agencies to establish and enforce regulatory frameworks (aquatic biodiversity laws, regulations, and guidelines) for fisheries co-management. Support local governments to develop necessary laws for river system co-management and improved conservation of fish and aquatic life by handing over stretches of river to local communities.

- Form fishing community groups to advocate collectively for better representation in local communities and government.

- Build capacity among traditional fishing groups and Upper Karnali Hydropower Project affected communities in the watershed area to understand and address potential threats to aquatic biodiversity and habitat destruction. Develop stronger monitoring of destructive fishing practices in the watershed and educate local fishers about the importance of aquatic biodiversity and conservation.

- Promote ecotourism in the watershed as another livelihood option for traditional fishing communities.

3. Develop sustainable hydropower while ensuring river system health and community well-being

- Continue assessing environmental impacts of the Upper Karnali Hydropower Project to determine the short- and long-term effects on the watershed, and to develop appropriate mitigation and benefit-sharing and compensation measures and mechanisms. Raise awareness and ensure review of any revisions to impact assessments and/or proposed mitigation plans.

- Initiate dialogue with relevant stakeholders through traditional fishing groups and groups in affected communities to discuss potential impacts of proposed hydropower projects on aquatic biodiversity and riverine system of Karnali River. Encourage participation of downstream stakeholders in public hearings to ensure their views are heard.

4. Strengthen planning and design of environmentally friendly local infrastructure

- Raise awareness among community members about the environmental impacts of infrastructure development (e.g., roads, irrigation, and hydropower).

- Raise awareness and build capacity in local government and contractors about the Environmentally Friendly Local Governance (EFLG) framework. Form committees of concerned citizens to advocate for environmentally-friendly road construction.

- Provide training and support for low-cost stabilization techniques for slopes and river banks using bioengineering methods and river bank planting.

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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 Middle Karnali 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 Middle Karnali 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 Middle Karnali area where the USAID Paani Program and other projects can provide support; and
- Providing a platform for consultation and advocacy for Middle Karnali 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-stakeholders consultation [MSC] 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, cross cutting areas, were used while conducting surveys including governance, gender and social inclusion and policy.

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

The HH survey data (Table 6) were organized into four broad categories: a) climate change and biodiversity; b) livelihoods and well-being; c) water sources; and d) water quality. The surveys were conducted in locations that were selected during the entry MSC as participants indicated specific issues and challenges appropriate to their respective areas.

Table 6: Household (HH) surveys by topic and number conducted

Subject of HH survey	Number conducted
Biodiversity and climate change	727
Livelihoods and well-being	369
Water sources	578
Water quality	204
Total	**1,878**

To complement the surveys, we conducted 39 FGDs and12 KIIs to investigate the key issues identified by households. Water quality and discharge were measured by Paani staff using the Akvo Flow Mobile App.[5]

Figure 11: Methodological approach illustrated

Annex 2: Land use and land cover

Table 7: Land use and land cover

Land use	Percentage
Forest and shrub land	53
Agriculture	30
Grazing land	14
Water bodies	2
Barren land	1
Total	100

[5] Akvo Foundation: https://akvo.org/products/akvoflow/#overview

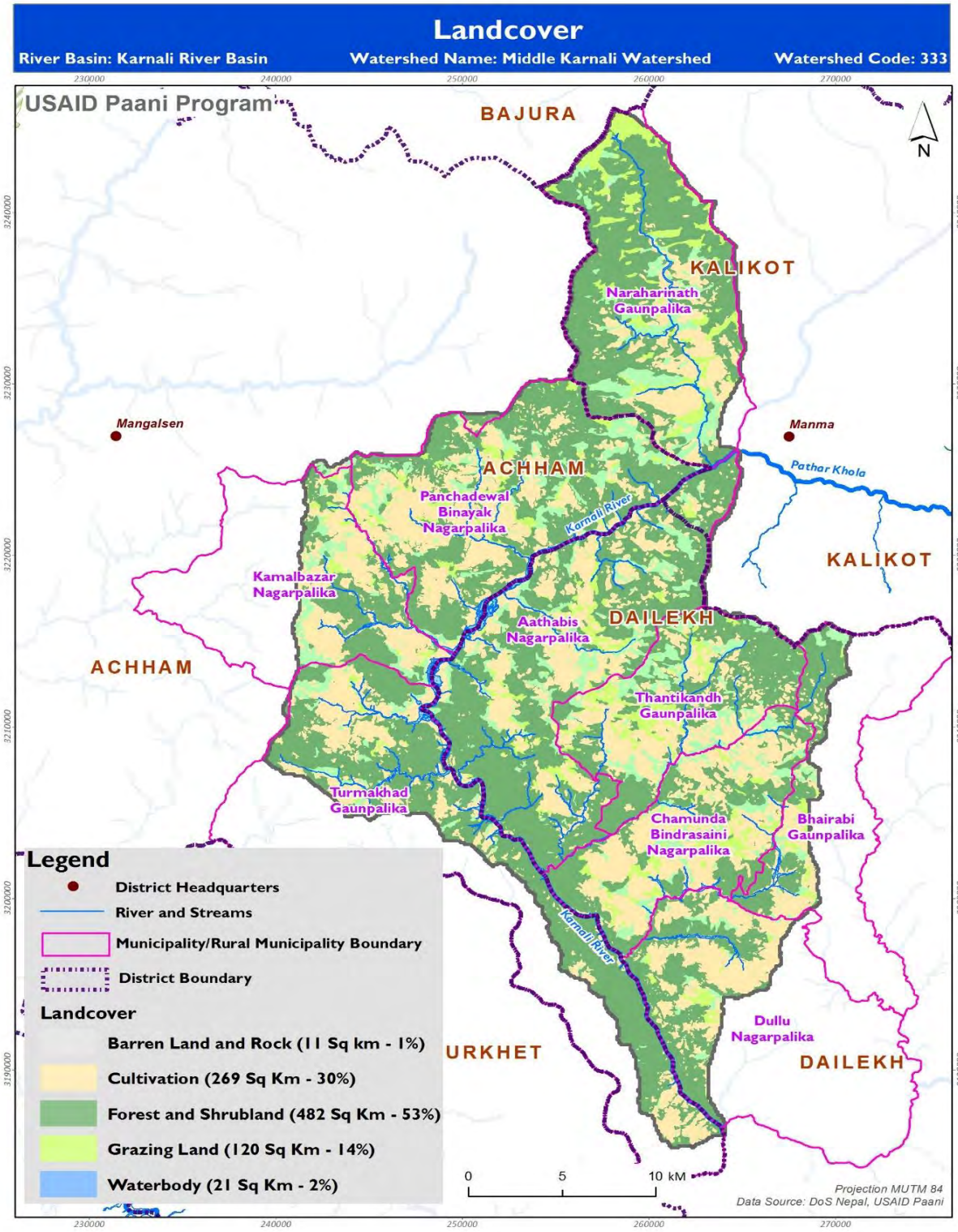

Figure 12: Map of land use and land cover in the Middle Karnali watershed

Annex 3: Population

Table 8: Population by municipality, sex, and caste/ethnicity

	BCTS			Dalit			Janajati			Total			
NP/GP	**M**	**F**	**Tot**	**M**	**F**	**Tot**	**M**	**F**	**Tot**	**M**	**F**	**Tot**	**%**
Aathbis	9,275	9,166	18,441	4,733	4,668	9,401	679	666	1,345	14,687	14,500	29,187	**14**
Chamunda Bindrasain	8559	8,596	17,155	3,586	3,833	7,419	742	771	1,513	12,887	13,200	26,086	**12**
Dullu	13,168	14,958	28,126	5,665	6,378	12,043	543	728	1,271	19,376	22,064	41,441	**19**
Kamalbazar	7,609	8,970	16,580	3,147	3,847	6,994	58	65	124	10,814	12,883	23,697	**11**
Naraharinath	7,580	7,445	15,024	3,201	3,052	6,253	57	39	96	10,838	10,535	21,373	**10**
Panchadewal Binayak	8,591	9,685	18,276	3,731	4,473	8,204	550	381	930	12,872	14,539	27,410	**13**
Thantikandh	6,367	6,689	13,056	2,464	2,683	5,147	282	366	648	9,113	9,738	18,851	**9**
Turmakhand	8,100	8,762	16,861	3,652	3,777	7,430	262	143	406	1,2014	12,683	24,697	**12**
Total	69,248	74,271	143,519	30,179	32,711	62,890	3,173	3,160	6,333	10,2600	110,142	21,2742	**100**
Total %	**33%**	**35%**	**67%**	**14%**	**15%**	**30%**	**1%**	**1%**	**3%**	**48%**	**52%**	**100**	

Annex 4: Temperature and precipitation

Table 9: Detailed temperature and precipitation figures

Month	Avg. max. temperature	Avg. min. temperature	Monthly average	Difference	Rainfall (mm)
May	33	16.2	24.6	16.8	4.2
Jun	34.9	17.1	26	17.8	56.6

July	32.1	18.3	25.2	13.8	518
Aug	31	17.1	24.05	13.9	456
Sept	28.7	14.5	21.6	14.2	331
Oct	26.9	10	18.45	16.9	21.6
Nov	24.3	8.8	16.55	15.5	0

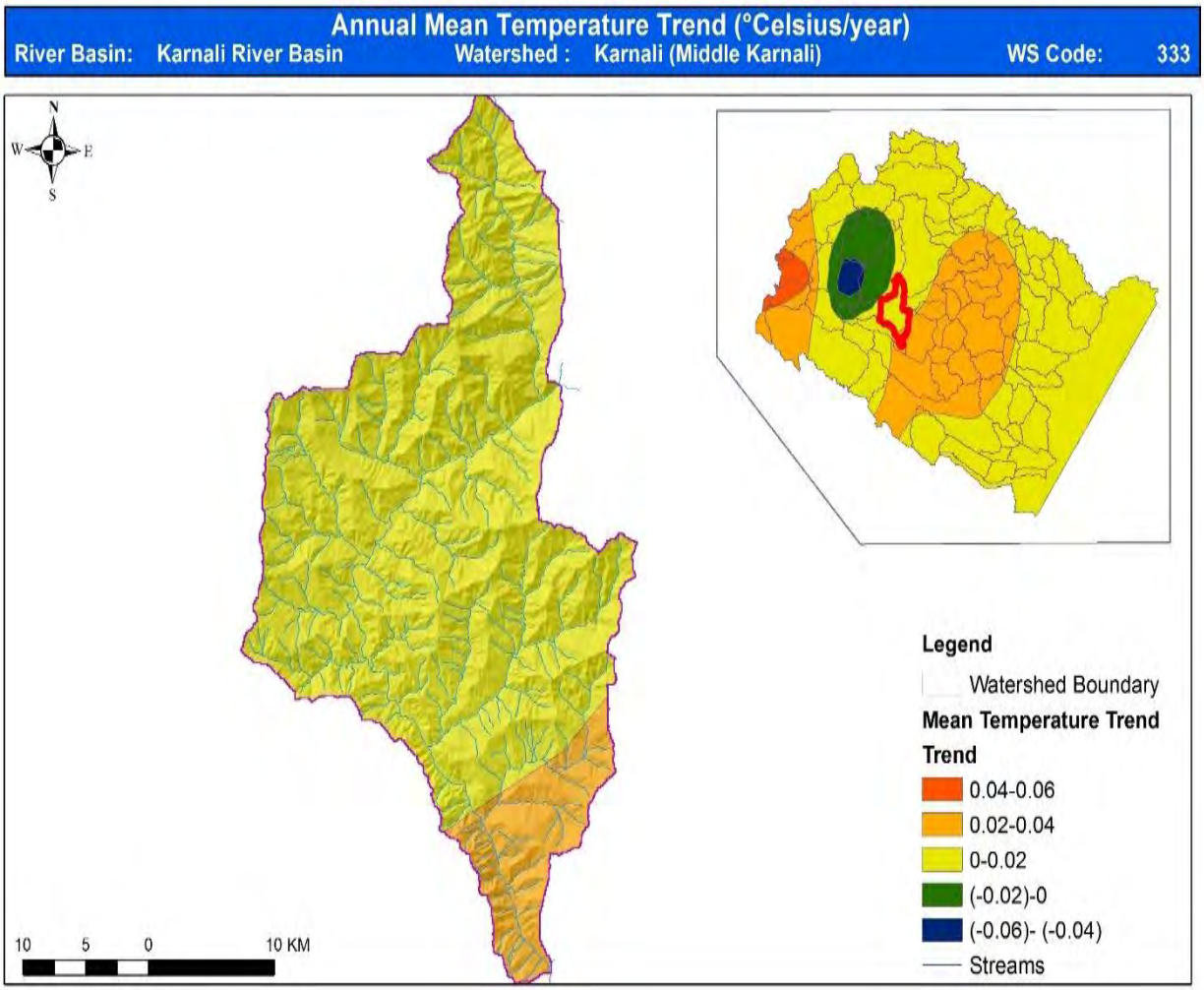

Figure 13: Annual mean temperature change trend in the Middle Karnali watershed

Annex 5: Lakes, streams, rivers, and sub-watersheds

Table 10: Types of water bodies in the Middle Karnali watershed

SN	Name of river	Location (VDC)	Type
1	Karnali	Middle of watershed	Large
2	Lodeghat	Bhairabsthan and Raniban	Karnali tributary
3	Kuikagad	Bayala, Kuika, Chalsa and Kalikasthan	Karnali tributary
4	Chiltadagaad	Kalekanda	Karnali tributary
5	Bhanakotgaad	Kalekanda	Karnali tributary
6	Khulalugaad	Kalekanda	Karnali tributary
7	Talagaad	Bayala and Layati	Karnali tributary
8	Baralegaad	Barala and Pulletala	Karnali tributary
9	Chisi Khola	Toshi and Turmakhand	Karnali tributary
10	Pulam Khola	Raniban and Dhamali	Karnali tributary
11	Thote Khola	Barala	Karnali tributary
12	Amina Khola	Baral	Karnali tributary
13	Malana Khola	Kalekanda and Barala	Karnali tributary

Table 11: List of identified sub-watersheds in the Middle Karnali watershed

District	Name	Area [km2]	VDCs
Achham	Dhaulebagar-Jambugaad	41.86	Rahaph
Achham	Tallobalade Khola	17.13	Rahaph, Bhairabsthan
Achham	Gode-khata-Keu Khola	17.59	Bhairabsthan, Turmakhad
Achham	Telechour Khola	25.93	Nada, Turmakhad
Achham	Rani-Raya Khola	27.45	Raniban, Bhairabsthan, Turmakhad
Achham	Ghatte-Lode Khola	24.32	Dhamali, Tosi, Raniban
Achham	Seti Khola	33.92	Kalekhanda
Achham	Talamera Khola	20.62	Warla, Layati
Achham	Siutare Khola	17.19	Kalikasthan
Achham	Phulam-Gadi Khola	17.57	Bayala, Dhamali
Achham	Kaphilbagar Khola	24.73	Chelsa, Bayala, Bhuli
Achham	Chene -Kuika-Bhandar Khola	33.45	Kuika, Chalsa

Achham	Pulletoli Khola	20.82	Pullentala, Toli
Achham	Binayak Khola	20.34	Binayak, Toil
Achham	Gamri-Ghatte Khola	21.22	Pulentala, Warala
Achham	Budabaliwa-Kunta Khola	23.88	Rahaph
Achham	Amai-Bhalakor-Lobda Khola	24.37	Bhairabsthan
Dailekh	Karnali Nadi I	56.5	Pipalkot, Rakam Karnali and Singasain
Dailekh	Kanegaad	32.7	RakamKarnali, Sigaudi, Singasain, and Tilepata
Dailekh	Karnali II	61.99	RakamKarnali, Sattala, Sigaudi, Tilepata, and Tolijaisi
Dailekh	Bire Khola	37.05	Sattala, Tolijaisi
Dailekh	Budgaad	38.11	Bisalla, Lakandra
Dailekh	Upper Ramgaad	46.5	Bisalla, Chamunda, Kusapani
Dailekh	Lower Ramgaad	44.35	Chamunda, Jambukandh, Lakandra, Layanti, Bindrasaini, and Sattala
Dailekh	Karnali III	9.45	Layanti, Bindrasaini
Dailekh	Paduka Khola	66.5	Badalamji, Bhairakalikathum, Chamunda, Jambukandh, Kusapani, Layanti, Bindrasaini, Padukasthan
Dailekh	Nepagaad	24.27	Dullu, Nepa, Padukasthan
Dailekh	Karnali IV	23.85	Nauli Katuwal, Nepa
Dailekh	Sote Khola	28.15	Chhiudi Pusakot, Dullu, Malika, Naule Katuwal
Dailekh	Sano Khola	48.58	Kasikandh, Kushapani, Raniban
Dailekh	Chham Godi	56.35	Badakhola, Badalamji, Bansi, Bhairikalikathum, Kharigaira, Raniban, and Rawatkot
Dailekh	Nabhisthan Khola	30.5	Badalamji, Dullu, Gamaudi, Padukasthan, and Rawtkot
Kalikot	Rupsagaad	143.86	Rupsa, Malkot, Lalu, Kotbada, and Kumalgaun

Annex 6: Forest types and composition

Table 12: Forest types by area and percentage

Forest Type	Area (sq km)
Mixed Hardwood	200
Pine	106
Sal	91
Quercus	55
Sisau	15
Deodar Cedar	3
Himalayan Fir	1
Total Area:	**471**

Annex 7: Fish and aquatic life

Table 13: Types of fish and aquatic life and population status

S.N.	Local name	Status	Location and district
1	Thumri	Decreasing	Rakam Karnali, Dailekh
2	Tikhine	Decreasing	Rakam Karnali, Dailekh
3	Bajelo	Decreasing	Rakam Karnali, Dailekh
5	Kabhri	Decreasing	Rakam Karnali, Dailekh
6	Jamaki	Decreasing	Rakam Karnali, Dailekh
7	Guduno	Decreasing	Rakam Karnali, Dailekh
8	Tote	Decreasing	Rakam Karnali, Dailekh
9	Sap	Decreasing	Rakam Karnali, Dailekh
10	Thed	Decreasing	Rakam Karnali, Dailekh
11	Kaindi	Decreasing	Rakam Karnali, Dailekh
12	Jagri (Ladya)	Decreasing	Rakam Karnali, Dailekh
13	Kathel	Decreasing	Rakam Karnali, Dailekh
14	Singha	Decreasing	Rakam Karnali, Dailekh
15	Gatya	Decreasing	Rakam Karnali, Dailekh
16	Chadel	Decreasing	Rakam Karnali, Dailekh
17	Pate	Decreasing	Kalikot
18	Kala	Decreasing	Kalikot
19	Lohori	Decreasing	Dungeswor, Dailekh
20	Bam	Decreasing	Dungeswor, Dailekh
21	Budhuna	Decreasing	Dungeswor, Dailekh
22	Khatti	Decreasing	Dungeswor, Dailekh
23	Sahar	Decreasing	Dungeswor, Dailekh
24	Phageta	Decreasing	Dungeswor, Dailekh
25	Barga	Decreasing	Dungeswor, Dailekh
26	Asala	Decreasing	Dungeswor, Dailekh

27	Jhadnga	Decreasing	Dungeswor, Dailekh
28	Shed	Decreasing	Dungeswor, Dailekh
29	Kalauch	Decreasing	Dungeswor, Dailekh
30	Bhoti	Decreasing	Dungeswor, Dailekh
31	Charkane	Decreasing	Dungeswor, Dailekh
32	Kholi	Decreasing	Dungeswor, Dailekh
33	Masina	Decreasing	Dungeswor, Dailekh
34	Thumre	Decreasing	Kalekanda, Achham
35	Panpi	Decreasing	Kalekanda, Achham
36	Sui	Decreasing	Tulta, Achham
37	Kuida	Decreasing	Tulta, Achham
38	Chilti	Decreasing	Tulta, Achham
39	Thed	Decreasing	Tulta, Achham

PAANI Program, Focus Group Discussion, 2017

Annex 8: Mammals and population trend

Table 14: Types of mammals, location, and population trend

Name	Scientific Name
Jackal	Canis aureus
Monkey	Macaca mullata
Leopard	Panthera pardus
Fox	Vulpes bengalensis
Langoor	Semnopithecus entellus
Wild Boar	Sus scrofa
Bat	Pteropsus sp.
Squirrel	Funambulus pennant
Porcupine	Hytrix indica

Annex 9: Reptiles and population trend

Table 15: Reptile species, location and population trend

Name	Scientific Name
Rat Snake	Ptyas mucosus
Katle	Acrossocheilus hexagonolepsis
Harep	Trimeresurus sp.
Lizard	Calotes sp.
Frog	Rana tigrana

Annex 10: Birds and population trend

Table 16: Bird species, location and population trend

Name (Nepali)	Scientific Name
Crow	Corvus macrohynchos
Julphejureli	Pycnonotus leucogenys
Phisto	Orthotomus sutorius
Ranichari	Pericrocotus flammeus
Dhukur	Streptopelia spp
Eagle	Milvus migans
Kalotitra	Francolinus franodinus
Nyauli	Megalaima virens
Thopledhukur	Streptopelia chinensis
Chichilkote	Parus major
Kuthurke	Megalaima asiatica

Annex 11: Road networks

Table 17: Road networks in the Middle Karnali watershed

	Strategic road	District Road Core Network (DRCN)	Village Road Core Network (VRCN)	Total length (Km)
Black-topped	77			77
Achham				
Dailekh				
Kalikot				
Earthen		167.9	88.7	256.54
Achham		79.14	33	
Dailekh		81.5	54	
Kalikot		7.25	1.7	
Total				333.54

Annex 12: Micro hydropower projects in Middle Karnali

Table 18: List of micro hydropower plants in Middle Karnali

SN	Name	Capacity (kw)	HH Benefited	VDCs	River/stream name	Remarks
1	Baralagad (I)	16	156	Lyati	Barala Khola	Fully operational
2	Moriyali Khola	17	287	Pulletola	Moriya Khola	Fully operational
3	Kuika Khola (III)	10	110	Kalikasthan	Kuika Khola	Under construction
4	Baralagad	15	150	Barla	Barla Khola	Fully operational
5	Malkot	30	600	Malkot	Rupsa Khola	Fully operational

Annex 13: Irrigation projects

Table 19: List of irrigation projects by name, location, and area

SN	Name	District	Irrigated land (Ha)	VDC
1	Chiplekhola	Achham	4	Birpath
2	Kukudekhola	Achham	3	Toshi
3	Titaudo Kulo	Achham	7	Toshi

4	Simkholi Jaksi Pipe Pokahari	Dailekh	3	Rakam
5	Chadekhola Thulagha	Dailekh	2	Dullu
6	Parimela	Dailekh	4.5	Naule
7	Tahara Pokharu	Dailekh	1	Belpata
8	Thulakhet Kholsi Pipeline	Dailekh	1.5	Belpata
9	Khajuri	Dailekh	1.5	Toli
10	Chipchipe Plastic Pond	Accham	0.25	Raniban

Annex 14: Water quality

Table 20: Water quality by river/stream and tested aspect

	Name of the river/stream					Water quality standards		
	Ṣunat Khola	Barle Khola	Belkhet Khola	Sadani Khola	Chinne Khola	* Drinking	** Irrigation	** Aquaculture
Date of test	15-May--2017	14-May-2017	12-May-2017	11-Apr-2017	14-Apr-2017			
Conductivity (µS/cm)	177.9	176.1	118.9	321.6	NA	1,500		
Temp °C	27.8	25.9	27.4	29.1	NA			4 to 30
Iron (mg/L)	0	0.0	0.39	0.0	0	0.3 (3)	5	0.01
pH	7.2	7.3	5.9	7.5	6.8	6.5-8.5	6.5-8.5	6.5-9.0
Nitrate Nitrogen (mg/L)	0	0.0	0.3	0.0	0.0	50		<300
Nitrite Nitrogen (mg/L)	0	0.0	0.03	0.0	0.0		<5	
Ammonium (mg/L)	0	3	7	NA	NA	1.5		0.025
Phosphate (mg/L)	4.4	14.5	11.5	1.5	NA			

	Name of the river/stream					Water quality standards		
	Kali Khola	**Ramghat Khola**	**Majuna Khola**	**Khidkijyula Khola**	**Rakam Khola**	* **Drinking**	** **Irrigation**	** **Aquaculture**
Date of test	11-May-2017	17-Apr-2017	20-Apr-2017	17-Apr-2017	14-May-2017			
Conductivity (µS/cm)	108.6	158.4	NA	73.7	123.1	1,500		
Temp °C	27.3	30.5	NA	30	27.6			4 to 30
Iron (mg/L)	0	0.0	0.0	0.0	0.0	0.3 (3)	5	0.01
pH	6.9	6.6	7.5	6.8	7.1	6.5-8.5	6.5-8.5	6.5-9.0
Nitrate Nitrogen (mg/L)	0.8	0.0	0.0	0.0	0.0	50		<300
Nitrite Nitrogen (mg/L)	0.11	0.0	0.0	0.0	0.0		<5	
Ammonium (mg/L)	0	3	NA	2	1.0	1.5		0.025
Phosphate (mg/L)	23.5	13	NA	13	19	0.4 EEC		

	Name of the river/stream					Water quality standards		
	Dogade Khola	**Chitlang Khola**	**Paduka Khola**	**Ghatte Khola**	**Pulletola Khola**	* **Drinking**	** **Irrigation**	** **Aquaculture**
Date of test	14-May-2017	14-May-2017	16-Apr-2017	20-Apr-2017	13-May-17			
Conductivity (µS/cm)	205.1	181.4	NA	NA	223.6	1,500		
Temp °C	27.8	28.8	NA	NA	28.1			4 to 30
Iron (mg/L)	0.08	0.0	0.0	0.0	0.0	0.3 (3)	5	0.01
pH	7.1	7.5	7.2	NA	7.1	6.5-8.5	6.5-8.5	6.5-9.0
Nitrate Nitrogen (mg/L)	0.0	0.0	0.0	0.0	0.0	50		<300
Nitrite Nitrogen (mg/L)	0.0	0.0	0.0	0.0	0.0		<5	

Ammonium (mg/L)	5	1	NA	NA	2	1.5		0.025
Phosphate (mg/L)	0	22	NA	NA	1.5	0.4 EEC		

	Name of the river/stream					Water quality standards		
	Lode Khola	Max	Min			* Drinking	** Irrigation	** Aquaculture
Date of test	8-May-2017							
Conductivity (µS/cm)	139.7	223.6	73.7			1,500		
Temp °C	31.6	31.6	25.9					4 to 30
Iron (mg/L)	0.03	0.39	0			0.3 (3)	5	0.01
pH	6.2	7.5	5.9			6.5-8.5	6.5-8.5	6.5-9.0
Nitrate Nitrogen (mg/L)	0.0	1.3	0			50		<300
Nitrite Nitrogen (mg/L)	0.0	0.11	0				<5	
Ammonium (mg/L)	0.0	7	0			1.5		0.025
Phosphate (mg/L)	7.9	23.5	0			0.4 EEC		

Annex 15: Major pollution points in the Middle Karnali watershed

Table 21: Major pollution points in the watershed

SN	VDC	Place Name	Description
1	Sigaudi	Hulma	Settlement/small market
2	Tun	Toono Bagar	Settlement/small market
3	Sattalla	Upper Karnali office site	Settlement/small market
4	Rakam Karnali	Rakam Karnali	Settlement/small market
5	Paduka	Paduka Khola	Settlement/small market

6	Naule Katuwal	Tallo Dhungeshow	Settlement/small market
7	Padhuka	Padhuka Jamukadh	Cremation site
8	Rakam Karnali	Khidkijyula	Settlement/small market

Annex 17: Community user forest groups

Table 22: Community user forest groups by location, area and representation

Name	Location	Area (Ha)	HH served
Andheri Patal	Pancha Dewal Binayak NP	8.75	32
Kalikhal	Pancha Dewal Binayak NP	7.5	52
Karchate	Pancha Dewal Binayak NP	21	52
Belani	Pancha Dewal Binayak NP	260.5	154
Ratlamosalghari	Pancha Dewal Binayak NP	10	143
Baudada	Pancha Dewal Binayak NP	53	175
Lampate Buksada	Pancha Dewal Binayak NP	50.5	107
Kotbarsako Baato	Pancha Dewal Binayak NP	14.75	52
Mati Khnnya	Pancha Dewal Binayak NP	7	65
Latiphale	Pancha Dewal Binayak NP	2	88
Panchuli Chaitepatal	Pancha Dewal Binayak NP	250	402
Bharichada Nausen	Pancha Dewal Binayak NP	70	266
Saldada	Pancha Dewal Binayak NP	11	103
Bairikuti	Pancha Dewal Binayak NP	14	105
Khurke Salla	Pancha Dewal Binayak NP	15.25	125
Manike Melo	Pancha Dewal Binayak NP	14.5	146
Liti Salleri	Pancha Dewal Binayak NP	9	90
Delikada Thalikot	Pancha Dewal Binayak NP	49.52	140
Jam Dugri	Pancha Dewal Binayak NP	22	83
Simla Chaurpani Paleban	Pancha Dewal Binayak NP	203	124
Samaude	Pancha Dewal Binayak NP	11.25	61
Kalyan	Pancha Dewal Binayak NP	23.4	95
Hadikhola Bandepani	Pancha Dewal Binayak NP	12	119
Bangelado	Pancha Dewal Binayak NP	9.5	175
Jamun	Pancha Dewal Binayak NP	3.7	22

Dubasen	Pancha Dewal Binayak NP	23	81
Kalayan	Pancha Dewal Binayak NP	35.25	109
Yakata	Pancha Dewal Binayak NP	26.75	266
Kauchakapada Paani	Pancha Dewal Binayak NP	20	106
Ratuwapani	Pancha Dewal Binayak NP	5	42
Bandra pani	Pancha Dewal Binayak NP	25.5	59
Kolgade	Pancha Dewal Binayak NP	3.88	40
Ratimate	Pancha Dewal Binayak NP	19.6	56
Maurelo	Pancha Dewal Binayak NP	12.63	56
Kalepani	Pancha Dewal Binayak NP	235.5	739
Lampate Palchaur	Pancha Dewal Binayak NP	194	378
Puranaghata Paani	Pancha Dewal Binayak NP	41.5	361
Kalika	Pancha Dewal Binayak NP	160.25	240
Jhyaldada	Pancha Dewal Binayak NP	47.5	91
Jalabeshwori	Pancha Dewal Binayak NP	194.75	279
Malika	Pancha Dewal Binayak NP	323.25	64
kalika	Pancha Dewal Binayak NP	480.78	189
Raniban	Pancha Dewal Binayak NP	64	55
Ramailo	Pancha Dewal Binayak NP	75	182
Namuna	Pancha Dewal Binayak NP	26.96	173
Jankalyan	Turmakhand GP	260	322
BP	Turmakhand GP	252.73	433
Chalne	Turmakhand GP	59.2	129
Goganpani	Turmakhand GP	263.23	254
Melai	Turmakhand GP	587.75	203
Jansewa	Turmakhand GP	405.56	NA
Jankalyan	Turmakhand GP	69.3	NA
Nimade	Turmakhand GP	775.82	137

Thulo	Turmakhand GP	714.94	131
Kalsainik	Turmakhand GP	230	230
Chaurimela	Turmakhand GP	121	82
Shibjadi	Turmakhand GP	121.3	140
Luda	Turmakhand GP	29.14	180
Naulipatal	Turmakhand GP	563	77
Talupatre	Turmakhand GP	401.25	400
Thalpata	Turmakhand GP	255	254
Aasaraghat	Turmakhand GP	180	204
Rahbalde Salleri	Turmakhand GP	110	115
Kalikeshwori	Turmakhand GP	105.47	254
Jansewa	Turmakhand GP	72.03	169
Bhairab	Turmakhand GP	88.92	201
Chaurepani	Turmakhand GP	512.26	107
Septekolgae Mainnagade	Turmakhand GP	208	113
Badera Baiseni	Turmakhand GP	383.36	202
Khirapani	Turmakhand GP	81.2	92
Laxmi Pragatisil	Turmakhand GP	576	182
Malika	Turmakhand GP	195.23	166
Gharkhet Aaarukhet	Dullu NP	31.42	57
Aeselu Katiya	Dullu NP	75.26	93
Tuni Gaira	Dullu NP	18	85
Tuni Pata	Dullu NP	43.36	45
Lekhroti	Dullu NP	19.2	56
Gogan Pani	Dullu NP	13.43	24
Batase Dada	Dullu NP	35.03	87
Latali	Dullu NP	280	103
Dharekhola	Dullu NP	65	153

Majhimela Lirimela	Dullu NP	91	58
Jhaurelebhandar Khola	Dullu NP	107	114
Nigal Pani	Dullu NP	25.6	54
Satisalli	Dullu NP	183.28	195
Sharada	Dullu NP	10.42	90
Amara	Dullu NP	106	229
Lamakhali	Dullu NP	141.73	97
Kerenipakha	Dullu NP	166	27
Siddha Malika	Dullu NP	194.58	49
Saraswoti	Dullu NP	150	98
Thulogaira	Dullu NP	185.79	112
Trikule Dada	Dullu NP	168.42	67
Ratamata	Dullu NP	19.91	56
Pati Kanla	Dullu NP	64.74	57
Paripakha	Dullu NP	90.43	182
Lekhali Laligurans	Dullu NP	178.27	84
Dhaukhani	Dullu NP	185.83	102
Paripakha Salghari	Dullu NP	144.16	36
Budhekot	Dullu NP	78.71	111
Darshani Badipati	Dullu NP	92.18	89
Syaulekandh	Dullu NP	72	222
Banskoti Dharampani	Dullu NP	103.75	194
Gallapani	Dullu NP	50	173
Umara Chhahare Khola	Dullu NP	88	192
Pachila	Dullu NP	92.61	327
Pokhara Gallapani	Dullu NP	26	47
Lamawata Ratamata	Dullu NP	116	310
Thadolekh	Dullu NP	136	310

Kanda Gaun Thadolekh	Dullu NP	47.5	190
Chame Takura	Dullu NP	13.5	197
Ludaharime Bhairab	Dullu NP	169.5	465
Krishnakot Machhakarange	Dullu NP	23	100
Mikachaur	Dullu NP	91.87	198
Rani Ban	Dullu NP	32.81	120
Dhudhe Malika	Dullu NP	40.84	193
Ringnesoti Ranikuntha	Dullu NP	74	389
Bhaulu Ranidhunga	Dullu NP	148.31	195
Bhaulu Gitthekhola	Dullu NP	177.77	142
Satkhamba	Dullu NP	79	97
Bindabasani	Dullu NP	12	55
Madasain	Dullu NP	29.13	111
Maibhagabati	Dullu NP	33	34
Hudunge	Dullu NP	10.72	89
Raniban	Dullu NP	58.6	313
Sisne Adherikhola	Dullu NP	50	158
Langhali	Dullu NP	12.75	44
Kala Bajen	Dullu NP	13	109
Khalparne	Dullu NP	34.36	114
Ram Chahan	Dullu NP	13.68	95
Sidharth	Dullu NP	59	106
Baisalakula Khola	Dullu NP	44.5	208
Banga	Dullu NP	40.42	110
Irupani Koshi Daha	Chamunda Bindasaini NP	163.18	261
Chiletra	Chamunda Bindasaini NP	34	124
Batkayachour	Chamunda Bindasaini NP	73	186
Kalika	Chamunda Bindasaini NP	89	102

Chautara Siyala	Chamunda Bindasaini NP	96.43	202
Bhartale	Chamunda Bindasaini NP	115.84	136
Kalika	Chamunda Bindasaini NP	180	199
Salleri Chour	Chamunda Bindasaini NP	180	271
Basanta Hariyali	Chamunda Bindasaini NP	150	170
Najur	Chamunda Bindasaini NP	182.34	126
Siddhapaila	Chamunda Bindasaini NP	112	161
Sankhetgoganpani	Atthabisa NP	131.6	167
Thatasetijar	Atthabisa NP	35	152
Bayal Dhunga	Atthabisa NP	140	377
Nainaldev Malle Budhapahada	Atthabisa NP	96	85
Adhikari Hariyali	Atthabisa NP	195.12	392
Kalila	Atthabisa NP	198	136
Adhikari	Atthabisa NP	186	184
Jalapa Devi	Atthabisa NP	115	188
Narasinge	Atthabisa NP	117	110
Sitalpatal	Atthabisa NP	85.8	130
Tarkutimile	Atthabisa NP	88.96	87
Satokhal Naulothalo	Atthabisa NP	149	120
Satokhal Ikhreni	Atthabisa NP	106	96
Shirubari	Atthabisa NP	22.42	36
Tarapani	Atthabisa NP	70	70
Ratimata Bajathalo	Atthabisa NP	43.57	157
Belanisalkot	Atthabisa NP	119	64
Lali Guras	Narharinath GP	39.88	105
Kala Silla	Narharinath GP	75.71	161
Koiralo Patal	Narharinath GP	75	95
Badapatal	Narharinath GP	82.72	102

Janjagriti	Narharinath GP	46.4	90
Bandalni	Narharinath GP	24.64	66
Mahadev	Narharinath GP	25	95
Nanda Devi	Narharinath GP	57.3	171
Gadul Bishnu	Narharinath GP	42.08	50
Pituli	Narharinath GP	44	77
Ambika Devi	Narharinath GP	97.2	84
Navjyoti	Narharinath GP	56.4	155
Siwanath	Narharinath GP	83.36	174
Kalika Salleri Mahila	Narharinath GP	48.25	80
Gourikot	Narharinath GP	76.52	50
Nainal Mandu	Narharinath GP	61.6	146
Amrel Dev	Narharinath GP	20.9	54
Saleri	Narharinath GP	44.85	193
Sotargaun	Narharinath GP	13.5	128
Bhairi Mahila	Narharinath GP	76.73	215
Taula	Narharinath GP	6	21
Chotikot	Narharinath GP	59	98

Annex 18: Existing policy provisions and status of enforcement

Table 23: Current policy provisions and relevant observations

Policy Provision (for aquatic natural resources)	Local reality
Municipality (Local Body): Local bodies are empowered to prepare and implement programs with regard to forests, vegetation, biodiversity, soil conservation, and environmental conservation in the village development area (Local Self Governance Act, 1999, section 28(h)). Municipalities are required to assist in environment conservation by controlling air, land aand water pollution in the municipality area; conservation of environment, forest, plants and other natural heritage; collection, transportation and disposal of solid waste of the municipality area (LSGA, section 96 (1) (c)).	Although the LSGA has been in force for the past 18 years, local bodies have not given priority to developing a separate programme for conservation of biological diversity. The municipalities in the watershed area focus only on collection and disposal of solid waste.
CFUG: Forest Act 2049 and Forest Regulation 2051 prohibits a number of activities in CF, unless specific permission has been granted by the DFO (rules….and ….). Such activities include harvesting trees, carrying out cultivation and any other destructive practices inside forests; mining, quarrying stone, soil or sand, or removing any substances in a way that is likely to have significant adverse impact on the environment; using hazardous pesticides or explosives in a river, stream or source of water flowing inside a CF.	Community forest user groups have been formed and mobilized by FECOFUN to carry out conservation-related activities.

Annex 19: Areas with prepared LAPAs and CAPAs

Table 24: Areas with prepared Local Adaptation Plans of Action (LAPAs)

Location	Organization/Project	Implementation Activity
Nepa, Bisalla, Naule, Tilepata (Dailekh)	Nepal Climate Change Support Program	Rainwater harvesting, irrigation ponds, and vegetable farming
Lalu (Kalikot)	Nepal Climate Change Support Program	Water conservation ponds
Bhairabstahan and Turmakhand (Achham)	Nepal Climate Change Support Program	Rainwater harvesting and irrigation ponds

Annex 20: Vision building framework employed for compiling the Middle Karnali watershed profile