LOWER KARNALI WATERSHED PROFILE

STATUS, CHALLANGES AND OPPORTUNITIES FOR IMPROVED WATERSHED MANAGEMENT

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Cover photo: Workers collect stones to build a retention wall on the banks of the Karnali River to prevent flooding. Every year, flooding harms lives and damages property in villages of the Lower Karnali watershed.

Photo credit: USAID Paani Program/Manoj Chaudhary

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STATUS, CHALLENGES AND OPPORTUNITIES FOR IMPROVED WATER RESOURCE MANAGEMENT

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:	**February 8, 2019**

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ABBREVIATIONS

BZFC	:	Buffer Zone Community Forest
BZMC	:	Buffer Zone Management Committee
CAPA	:	Community Adaptation Plan of Action
CBAPU	:	Community-based Antipoaching Unit
CBS	:	Central Bureau of Statistics
CBOs	:	Community-based Organizations
CFUGs	:	Community Forest User Groups
CIP	:	Community Irrigation Project
CSOs	:	Community Service Organizations
DADO	:	District Agriculture Development Office
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	:	Gaunpalika or rural municipality (new federal administrative unit; formerly Village Development Committee)
HA	:	Hectare
IEE	:	Initial Environmental Examination
IRBM	:	Integrated River Basin Management

IUCN	:	International Union for Conservation of Nature
KII	:	Key Informant Interview
KM	:	Kilometer
KW	:	Kilowatt
LAPA	:	Local Adaptation Plan of Action
LSGA	:	Local Self-Governance Act
MOE	:	Ministry of Energy
MOFSC	:	Ministry of Forest and Soil Conservation
MOAD	:	Ministry of Agriculture Development
MOE	:	Ministry of Environment
MOFE	:	Ministry of Forest and Environment
MOFALD	:	Ministry of Federal Affairs and Local Development,
MOI	:	Ministry of Irrigation
MOPPT	:	Ministry of Physical Planning and Transportation
MOEWRI	:	Ministry of Energy, Water Resources and Irrigation
MM	:	Millimeter
MSC	:	Multi-stakeholder Consultation
NEFIN	:	Nepal Federation of Indigenous Nationalities
NFIWUAN	:	National Federation of Irrigation and Water Users' Association
NP	:	Nagarpalika (new federal administrative unit; district level)
NPC	:	National Planning Commission
NRM	:	Natural resource management
PAANI	:	Program for Aquatic Natural Resource Improvement
Sec.	:	Second
USAID	:	United State Agency for International Development
VDC	:	Village Development Committee
WECS	:	Water and Energy Commission Secretariat
WWF	:	World Wildlife Fund
°C	:	Degree Celsius

ACKNOWLEDGEMENTS

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

This discussion draft watershed profile is the result of many people working together. Most significant were the generous contributions of time, thoughtful attention, and ideas of members of many community forest user groups (CFUGs), cooperatives, water user groups, and especially, the communities dependent on aquatic biodiversity and local water management. Leaders of Lamkichuha, Tikapur, Rajapur, Madhuban, Thakurbaba and Panchapuri Municipalities (nagarpalika) and Mohanyal, Janaki, Geruwa and Barahatal Rural Municipalities (gaunpalika), and the newly elected local government representatives 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 WECS' member agencies. Paani enriched the watershed profile by compiling and reviewing secondary data and by collaborating with the Federation of Drinking Waters Supply and Sanitations Users Nepal (FEDWASUN), who carried out surveys to assess community perceptions and biophysical conditions. Thanks are also due to several other collaborating government agencies, civil society organizations, and federations for their consistent cooperation and contributions to prepare this watershed profile. These groups include civil society groups

National Federation of Irrigation Water User's Association (NFIWUAN), Federation of Drinking Water and Sanitation Users Nepal (FEDWASUN), and Nepal Federation of Indigenous Nationalities (NEFIN), and several government agencies including Ministry of Energy, Water Resources and Irrigation (MOEWRI), Ministry of Forest and Environment (MOFE), Ministry of Agriculture Development (MOAD), Ministry of Federal Affairs and Local Development (MOFALD), and Development Ministry of Physical Planning and Transportation (MOPPT), who gave their full cooperation and support at the national, district and local levels. Any errors in this discussion document are those of the Paani team.

EXECUTIVE SUMMARY

This profile assesses the status, major challenges and opportunities for water resource management and aquatic biodiveresity for the multiple users within the Lower Karnali watershed, which extends across parts of provinces 5, 6 and 7 under the new federal system of governance, and include parts of Bardiya, Kailali, and Surkhet districts (Figure 1).

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

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

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

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

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

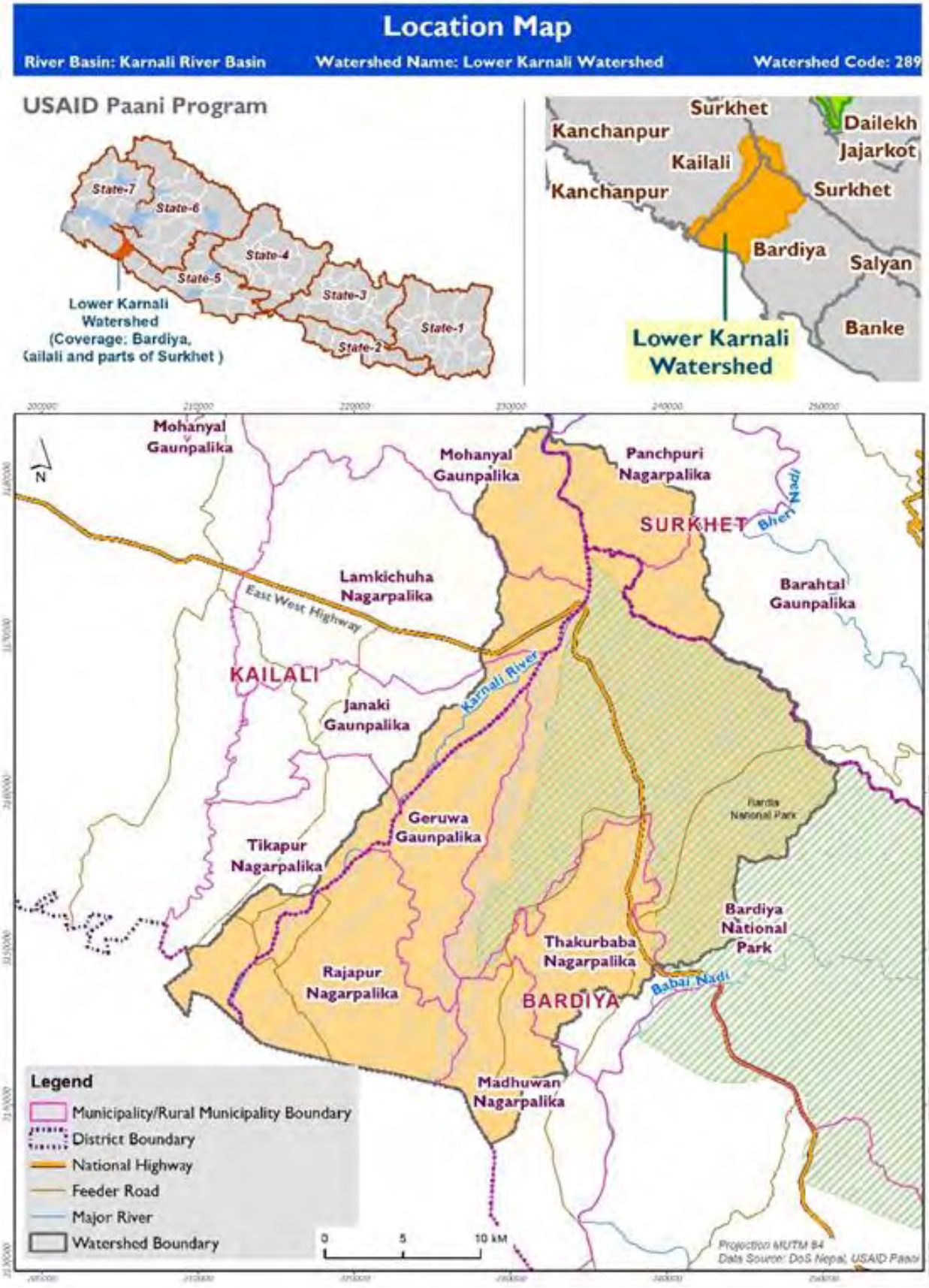

Figure 1: Map of the Lower Karnali watershed

Lower Karnali is one of 60 watersheds in the Karnali River Basin. The Karnali River is the longest river in Nepal, extending from the southern slopes of the Himalaya in China and flowing down through Nepal and into India, where it merges with Ganges River in Bihar. Six miles north of Chisapani, in the southern part of Nepal, the Karnali bifurcates into the Geruwa (eastern) and Karnali (western) rivers, and the land between these rivers form the watershed. Water levels in the Karnali below this point are abnormally high in recent years due to heavy sedimentation in the Geruwa. Local residents say the Karnali changes its course approximately every 20 years.

The river systems in the watershed allow aquatic species to move up and down in response to temperature and habitat change as needed. The north-south linkages are especially important for environmental flows and as potential corridors for climate change-related migrations[2]. For example, the endangered Gangetic Dolphin appears in Karnali during the monsoon season and other endangered species, such as gharial, crocodiles and the Golden Mahseer, take refuge in this area. Bardiya National Park (BNP) sits in the northeast corner of the watershed, a "biodiversity hotspot"[3] that covers more than 100 km^2.

Rainfall patterns in the watershed have changed dramatically in a short span of time, according to local residents, exacerbating floods and river cutting, and intensifying sedimentation in downstream areas. The steep topography of the watershed and fragile geology influence to the quality of these natural hazards. Infrastructure development, such as roads, irrigation canals, and diversion headworks, also contribute to downstream flooding in this watershed.

The Sonaha, a traditional fishing community, bear a disproportionate burden in relation to these natural hazards. This group lives primarily in lowland areas that are most vulnerable to climate-induced floods and landslides. Furthermore, changes in aquatic habitats directly impact their livelihood.

The Lower Karnali watershed features a successful and long-standing Farmer Managed Irrigation System (FMIS) for parts of the Kailali and Bardiya districts. FMIS relies on local water governance driven by traditional institutions found in the Tharu community. Additional support for FMIS in this area from the World Bank and Asian Development Bank have ensured proper canal maintenance for improved year-round operation.

Agriculture is the primary livelihood throughout most of the watershed, except in the urban centers (e.g., Tikapur, Chisapani). Urban residents work in a variety of businesses, most of them catering to travelers and transit through the watershed, such as hotels, tea shops, and restaurants. Surveys revealed that 54% of the households refer to agriculture as their main occupation, while 25% engage in wage labor, and 4% raise livestock.

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[2] Conservation Landscapes of Nepal, GoN, Ministry of Forest and Soil Conservation (2016)

[3] Bardiya National Park Buffer Zone Management Plan (2007-2011)

Agriculture productivity per unit has risen over the past decade in Lower Karnali, according to the District Agricultural Development Office (DADO), through the use of newly-available seed varieties and improved crop management practices. However, the use of chemical pesticides has also increased, sparking concerns about harmful run-off into nearby water sources.

Through a triangulated method of focus groups, interviews and ground truthing with Google Earth, the study found little change in land use in the watershed except for agricultural land converted into residential land, which raises environmental concerns related to urbanization and rising population density in vulnerable areas.

Priority Issues for the Lower Karnali watershed

As part of a broader river system, the Lower Karnali watershed facilitates ecological and hydrological processes, which support the maintenance of ecological communities. The watershed range of ecological zones – from the Terai Arc Landscape in the south to the Siwaliks in the north – help maintain the rich biological and cultural diversity of the area. Over time, the diverse ecosystems within the watershed have been experiencing acute pressures from the growing population. Based on a series of community consultations, stakeholder and literature reviews, we identified five priority issues (Table 1) and offer recommendations, which are described in detail below.

Table 1: Priority issues and impacts on aquatic biodiversity in the Lower Karnali watershed

SN	Issue attached with	Impacts
I	**Declining fish numbers and aquatic biodiversity**	For spawning, fish prefer protected areas around boulders and bridge pillars, and in gently flowing water. If these habitats are disturbed, reproduction is impacted. Activity on the rivers in the Lower Karnali is disrupting these spawning grounds, especially in the Geruwa River and around the construction of the Girijapuri Barrage, where fish mobility is limited. Furthermore, the growth of commercial fishing in these waters poses a threat on two fronts. For one, destructive fishing techniques used by commercial outfits are drawing unsustainable amounts of fish from the water, and two, traditional fishing communities are being affected as they have to compete against these larger competitive entities.
II	**The Sonaha community**	The Sonaha are an indigenous community almost wholly dependent on rivers, in which they fish and pan for gold. Increasing natural hazards such as flooding and river cutting are destroying their livelihood assets. Politically, the Sonaha are not recognized as a formal indigenous community by the Nepali government; therefore, they are not entitled to certain formal protections afforded to other indigenous groups in the country, such as an exemption that would allow them to fish and pan for gold within national park areas. Under these conditions, the

		Sonaha's existence is threatened and they are vulnerable to exploitation by more powerful groups.
III	**Shrinking lakes, ponds and wetlands**	Increasing sedimentation has diminished the size of lakes, ponds and wetlands in the watershed. Local residents say that aquatic biodiversity has correspondingly declined in these waterbodies, including several species of migratory birds. Shrinking lakes, ponds and wetlands also reduce the amount of usable water for irrigation and other domestic uses. Rising riverbeds (due to sediment) alter existing water flow regimes, which can affect aquatic and riparian vegetation, aquatic connectivity, and erosion control processes.
IV	**Increasing climate-induced natural hazards (e.g., floods, river cutting and inundation)**	Increasing floods, river cutting, and inundation in the Lower Karnali watershed impose disastrous impacts on human and aquatic life alike. For farmers, cultivated land is lost and overall production is negatively affected. For fish and other aquatic life, changes in flow regimes complicate reproduction, and, in other cases, destroy safe habitats. Many residents cited the Kailashpur Dam in India as responsible for the increased inundation. Built to protect farmers in Uttar Pradesh, the dam restricts the migration of the Gangetic dolphin and other species, and contributes to increasing sedimentation upriver in the Geruwa and Karnali rivers. Additionally, increasingly intense rainfall events are aggravating these river conditions, delivering more water than can be absorbed and distributed throughout the watershed. Inundation and flash flooding are the result.
V	**Transboundary water governance challenges**	India maintains a barrage on the Karnali River at Girijapuri that prevents the movement of several aquatic species, including the rare Gangetic dolphin. This restriction impedes their upstream movement, which is especially important during spawning season. As a result, the lack of movement induces inbreeding depression of species, in some cases, and contributes to species decline in others. The barrage does open its doors for 15 days between March and April, but during the rainy season the barrage opens for only 2-3 hours per day, which locals say is not enough time for species to make their way upstream to spawning grounds.

I. Declining fish numbers and aquatic biodiversity

Fish prefer to live and spawn in areas filled with boulders, tree roots and bridge pillars, around which they can protect themselves. When these areas are disturbed by changes in water flow or water quality, fish

stocks will decrease. In Lower Karnali, barrages built on the river (e.g., Girijapuri) and low winter seasonal flows in the Geruwa River impact the health of aquatic life.

Overfishing threats have declined since the government ceased issuing commercial fishing licenses in 1995. Since then, traditional fishing communities have been largely successful in maintaining their livelihoods. However, the increasing presence of destructive fishing practices are as seen as a potential threat.

Tortoises have declined in number along the Geruwa River and tributaries, as they have been overharvested by local communities. Concerns have also been expressed regarding the health of Bhagaraiya Lake, an important wetland in the watershed.

Recommendations:

- Discourage destructive fishing practices (e.g., poison, electric current) and overfishing through the introduction of regulatory fishing practices and awareness building programs;
- Introduce mitigation measures (e.g., green coverage) for reducing agricultural runoff and soil erosion in upstream areas of the watershed;
- Support development of inclusive and progressive capture fishery policies and guidelines by providing relevant information for local decision-makers;
- Regulate gravel mining and strengthen cross-border coordination with Indian counterparts on issues related to gravel mining as they impact aquatic biodiversity;
- Develop restoration initiatives for Bhagariya Lake, including invasive species removal (e.g., water hyacinth); and
- Strengthen the capacity of local lake and wetland committees to manage water resources, and increase the capacity of local communities to seek government and non-government funds for this work.

II. The Sonaha community

The indigenous Sonaha community is highly dependent on the river system to support their livelihoods through fishing and gold panning. Most Sonaha are landless and have little to no representation in local governance. They live primarily in river lowlands that are especially susceptible to natural hazards. Reduced fish stocks in the Geruwa River and prohibitions against gold panning within Bardiya National Park (where many Sonaha live) has complicated their quest for cultural survival. Moreover, though the Sonaha are an indigenous community, they have not been formally recognized by the Nepal government, which limits the protections and opportunities that might improve their daily lives.

Recommendations

- Study and foster dialogue to explore the reasons why Sonaha communities are not recognized as indigenous people by the Nepali government;
- Identify biodiversity hotspots in local rivers and hand over management to local fishery groups to manage and sustain fish stocks. It is recommended that these units cover 2-4 km stretches of river per group. Local fisher communities (e.g., Sonaha) will collaborate with government agencies in this work;
- Build capacity for local residents to improve capture fishing while eliminating the use of destructive fishing practices, such as poison and electric current;
- Tailor the Aquatic Biodiversity Conservation Act to harmonize more closely with local norms, values, and standards adopted by river dependent communities; and
- Support the establishment of eco-tourism as a means to improve livelihood options for Sonaha and other traditional communities.

III. Shrinking lakes, ponds and wetlands

Increasing sedimentation in the Lower Karnali river system has affected the level and quality of water available for domestic and agricultural purposes. Sand and mud deposition have caused river beds to rise to unprecedented heights, altering the natural habitats for aquatic species while also decreasing water flow rates. As one example, local residents explained that Bhagaraiya Lake had decreaed one-third in size due to excessive sedimentation delivered in the rainy season. Farmers around the lake depend on this source for irrigation, and fish numbers in the lake have declined dramatically.

Recommendations

- Form and strengthen wetland conservation committees to ensure that future interventions will have minimal impacts on water bodies while promoting aquatic biodiversity protection and conservation;
- Strengthen the local capacity of lake management committees to manage water resources, and increase the capacity of local communities to seek government and non-government funds for this work.
- Develop restoration initiatives for Bhagariya Lake, including invasive species removal (e.g., water hyacinth);
- Conduct research on aquatic biodiversity including wetland bird species;
- Increase collaboration with local stakeholders to minimize the effects of floods through improved soil conservation measures; and
- Promote coordination between watershed residents and government agencies to ensure effective knowledge sharing and investment.

IV. Increasing climate-induced natural hazards (e.g., floods, river cutting, and inundation)

The Lower Karnali watershed is highly vulnerable to floods, sedimentation, and river cutting, all of which have been intensified in recent years as a result of anthropogenic pressures and climate change. The topography and geologic composition of this watershed is another factor that can exacerbate the occurrence of natural disasters (Figure 2). For example, the Kailashpur Dam in Uttar Pradesh, India, impounds water during the monsoon months, which slows the flow rates that are needed to provide adequate drainage to the Lower Karnali watershed.

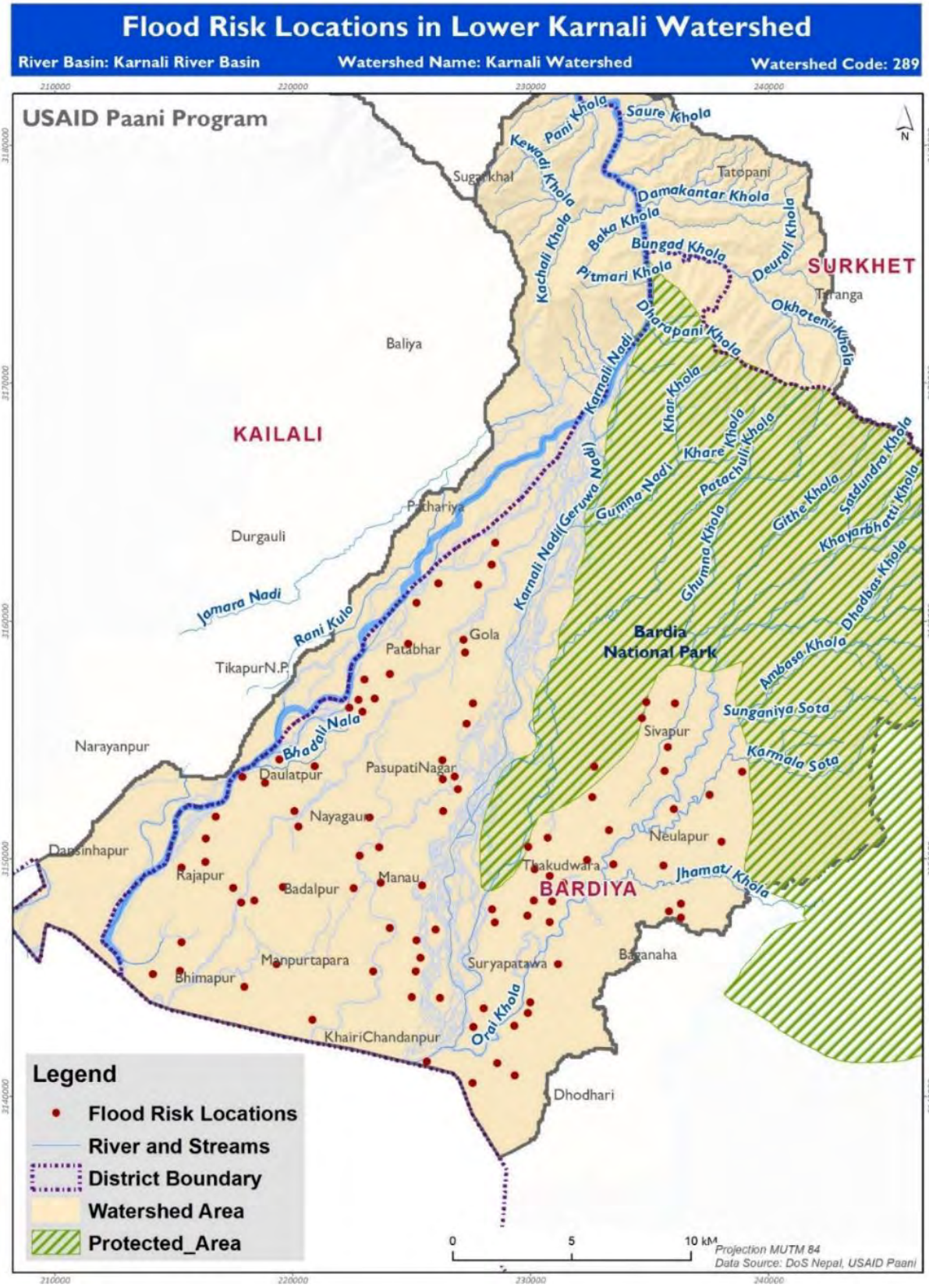

Figure 2: Map of flood risk locations in the Lower Karnali watershed

Historical weather data shows that high intensity rainfall events are increasing, particularly during the monsoon season, but with an overall reduced average rainfall of 10 mm per year (Marahattha, 2009). In other words, less rain falls overall in the watershed, but more rain falls in singular events, which delivers greater impacts on the environment. Flooding not only devastates physical assets, such as homes, livestock and soil but also takes many human lives. As floods in Lower Karnali have grown more intense in recent years, concerns about water levels, temperature variations and sedimentation have become more common among local residents and governments.

Recommendations

- Improve river bank stabilization by using available bio-engineering technologies;
- Install early warning systems throughout the watershed to disseminate information on impending floods when climate conditions are favorable;
- Promote watershed management practices that are affordable, climate-smart, and eco-friendly;
- Strengthen the adaptive capacity of marginalized communities who are dependent on water and other natural resources for maintaining their livelihoods;
- Form and strengthen local networks for promoting conservation initiatives between upstream and downstream communities; and
- Support local institutions (governmental and non-governmental) to develop inclusive planning documents such as LAPAs, CAPAs, and WUMPs.

IV. Transboundary water governance challenges and multi-use

India maintains a barrage on the Karnali River at Girijapuri that prevents the movement of several aquatic species, such as the Gangetic dolphin. This restriction impedes their upstream movement, which is especially important during spawning season. As a result, the lack of movement induces an inbreeding depression of species, in some cases, and contributes to species decline in others. The barrage does open its doors for 15 days between March and April, but they are closed during the rainy season except for 2-3 hours per day, which locals say is not enough time for enough species to make their way upstream to spawning grounds.

In the watershed, the Rajapur Irrigation Project and the Rani Jamara Kulariya Irrigation Project divert large amounts of water from the Geruwa and Karnali rivers, respectively. These two systems have been held up in Nepal as models of good irrigation governance; however, further analysis is required to understand how these systems relate to mulitiple water uses and users, and the conservation of aquatic biodiversity *in situ*.

Recommendations

- Negotiate with Girijapuri barrage management for longer door-open hours to allow greater up and downstream migration of fish;
- Conduct freshwater biodiversity studies around the Girijapuri barrage to document evidence to support local observations; and
- Develop georeferenced data on aquatic biodiversity and biodiversity hotspots to inform future decision-making about the river and fishery management. Figure 3 offers one example: the USAID Paani Program team has mapped major areas of dolphin movement through GIS data and corroborated these findings with local stakeholder input. The data will be helpful in developing effective strategies to protect dolphin numbers in the watershed.

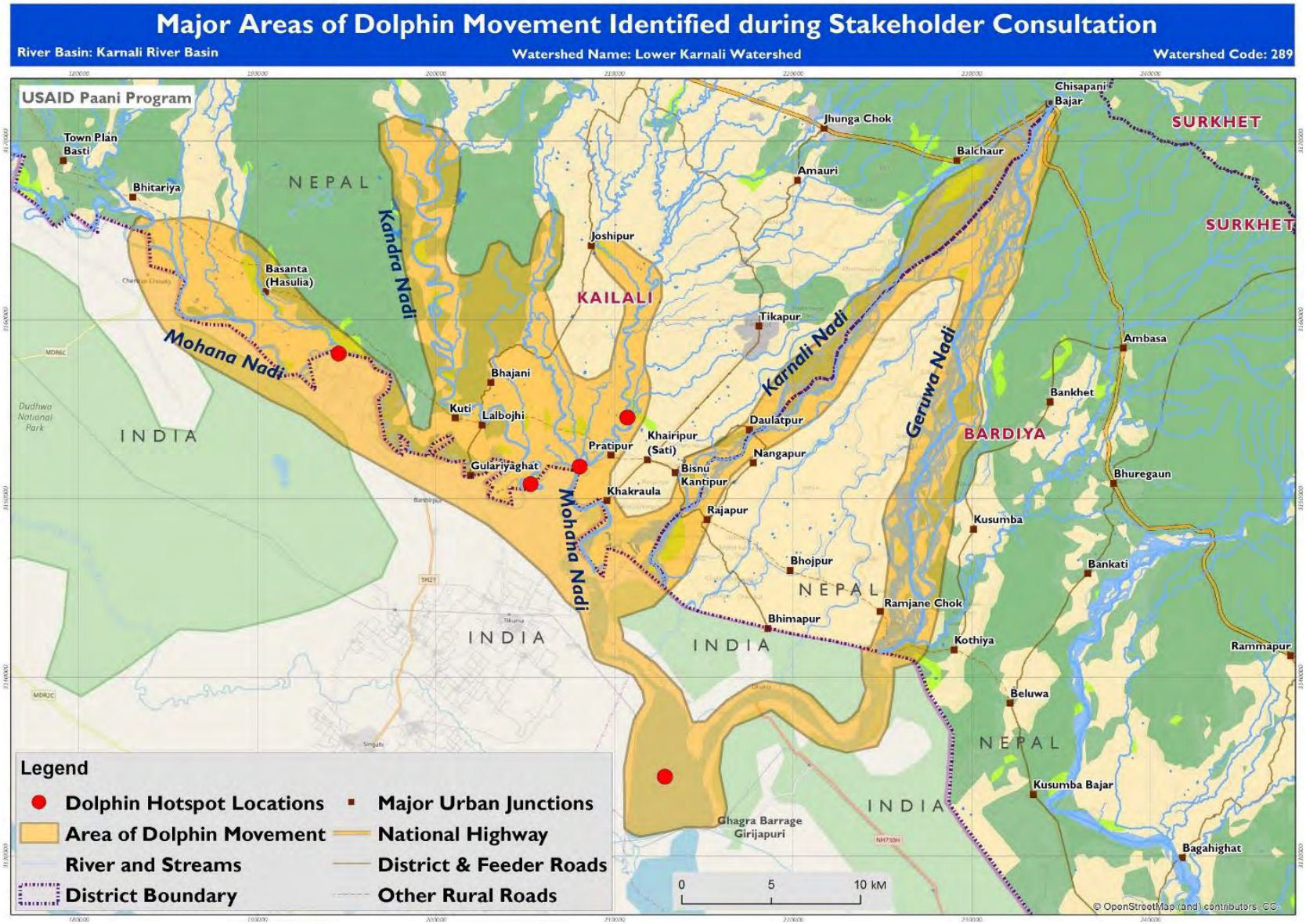

Figure 3: Primary areas of Gangetic dolphin movement in the Lower Karnali watershed.

1. THE LOWER KARNALI WATERSHED: NATURE, WEALTH AND POWER

The Lower Karnali watershed Profile is organized around three interrelated themes that influence the management and overall health of the watershed: **nature** (environment and natural resources), **wealth** (socioeconomics and infrastructure—the many ways that people use nature), and **power** (governance and institutions—the ways that the different people and groups make decisions together about the watershed and its uses) [4]. The analysis draws on multiple data sets associated with these themes to identify critical issues and opportunities for this watershed. We introduce this watershed in terms of its local natural and social dimensions. Then we examine how climate change and other drivers threaten and impact local livelihoods and biodiversity.

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

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

Related annexes

Annex 1: Methodology

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

2. NATURE

This section examines the environmental and natural resource dimensions of the watershed, including climate and weather, hydrology, biodiversity, fisheries, and land use within the Lower Karnali watershed. The Karnali River flows to the watershed and bifurcates into the Geruwa and Karnali near Chisapani. The area between these rivers supports a rich aquatic biodiversity, but with many potential vulnerabilities that we will examine.

2.1 LOWER KARNALI WATERSHED

The Lower Karnali watershed covers parts of three districts: Surkhet, Kailali and Bardiya with the majority of its area in the latter. This watershed includes parts of 11 different administrative units (Table 2).

Table 2: Administrative units in the Lower Karnali watershed

Gaunpalika (rural municipalities/GP)	% contained within watershed	Nagarpalika (municipality/NP)	% contained within watershed
Rajapur	100	Thakurbaba	77
Geruwa	100	Madhuban	39
Janaki	25	Tikapur	34
Mohanyal	8	Panchapur	13
Barahatal	6	Lamkichuha	11
Protected areas			
Bardiya National Park	37		

Of the 875 km^2 in the Lower Karnali watershed, 65% is considered Tarai (plains) and 35% is Siwalik hills. The total drainage density is 613 km^3 and ranges in elevation from 1,457 m in the north to 118 m in the south near the Indian border.

The Lower Karnali watershed forms the southern outlet for the Karnali River. In this area, the Karnali River takes a braided form with diverging and converging channels separated by bars. At Chisapani, the watershed exits the mountains and enters the Tarai. Here the Karnali bifurcates into the Geruwa River (eastern branch), which forms the western boundary of Bardiya National Park, and the Karnali (western), which flows between the Kailali and Bardiya districts. A large alluvial delta forms between these branches. The branches rejoin 10 km south of the Indian border at Bharthapur.

Braided rivers are morphologically active and, thus, intrinsically unstable (Redolfi et al., 2016). In the Lower Karnali watershed, this means that the Geruwa and Karnali rivers take on silt and increase discharge rates at different times. Evidence from other studies find that the Geruwa River maintained higher flow rates than the Karnali until 2009. Rising sediment loads and other factors in the Geruwa eventually slowed these rates, and now the Karnali is the more freely flowing channel (Donchyts et al., 2016). Much of these river dynamics are natural, but this instability is further influenced by anthropogenic interventions such as water withdrawal (e.g., irrigation), artificial channel narrowing, and sediment extraction. Notably, irrigation is widespread in the watershed: along with many existing projects, the Rani-Jamara-Kularia irrigation scheme (currently under construction) will draw 100 m^3/s from the Karnali River when operational.

Land cover in the Lower Karnali watershed is primarily forest (55%), followed by cultivated land (35%), water (9%), and grazing land (2%). In addition to the Geruwa and Karnali rivers, 57 tributaries of various sizes channel water throughout the area (Figure 4).

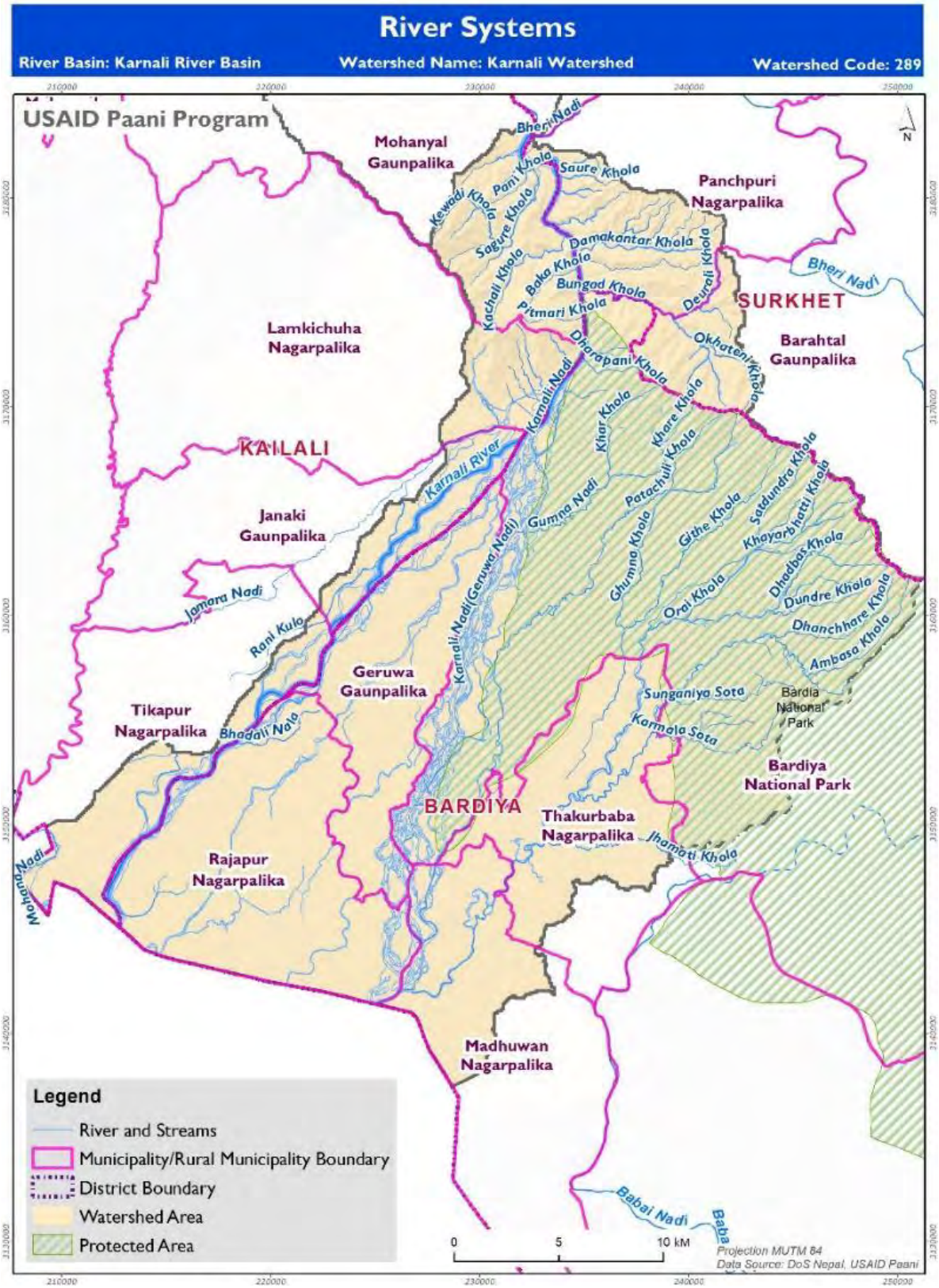

Figure 4: River network within the Lower Karnali

In terms of population, the watershed is 57% occupied by Janajati groups, followed by 31% Brahmin-Chhetri-Thakuri (BCT), and 8% Dalit. Four percent are identified as traditional communities, but not formally recognized as Janajati (e.g., Sonaha). The large Janajati population is primarily Tharu, an indigenous group that lived centuries in relative isolation owed to their natural resistance to malaria. However, in the 1960s, aid efforts to eradicate malaria opened up the region to settlement by other social groups, who migrated from the hills in search of cultivable land. As a result, Tharus were quickly displaced and marginalized in the traditional Hindu social hierarchy.

Like the Sonaha, the Tharu rely heavily on fishing for their livelihoods. Other traditional fishing communities in the watershed include the Kumal, Musahar, and Majhi. These groups can be found in all parts of the watershed but are concentrated in Geruwa NP, Rajapur GP, Tikapur GP, and Madhuban GP. Taken together, fishing communities form 51% of the population, or approximately 85,000 people.

Between these two branches, a large alluvial delta has formed where communities have engaged in agriculture and other livelihood practices for generations. While agriculture is the most common occupation in the Lower Karnali watershed (Table 3), most households necessarily diversify their income sources. The average annual income in the Lower Karnali watershed is 1050 USD, with annual farming income around 400 USD and wage labor 340 USD.

Table 3: Sources of livelihood in the Lower Karnali watershed

Livelihood	Number	Percentage
Agriculture	1,336	54.4
Daily wage labor (tradework and construction)	615	25.0
Livestock rearing and dairy productiony	103	4.1
Off-farm income generation activity (entrepreneurial activities)	82	3.3
Capture fishery	75	3.1
Service jobs in Nepal	65	2.7
Service jobs outside Nepal	101	3.8
Traditional occupations	39	1.6
Social welfare	17	0.7
Hospitality	8	0.3
Others	3	0.1
	2,456	100

Source: Paani HH Survey 2017

2.2 WATER AVAILABILITY AND QUALITY

The Lower Karnali watershed contains 57 rivers and streams, and forms the downstream plain of the Karnali River Basin. Water is abundant in the area between the Geruwa and Karnali rivers south of Chisapani. The total drainage density of the watershed is 613 $m^{3,}$ and the average annual rainfall is 1,793 mm.

Long-term daily discharge information from Chisapani was analyzed and compared against Paani measurements at various locations in the winter and monsoon season (Table 4). Discharge during pre-monsoon and post-monsoon have been observed to be increasing over that time, but the discharge rate in monsoon is decreasing over the same time period at a rate of 0.76m^3/s. Because the Lower Karnali watershed is located at the outlet of the Karnali River Basin, the trends observed in the river discharge

are likely the result of changes in climatic variables at the river basin scale rather than changes at the watershed scale.

Table 4: River and stream discharge rates in the Lower Karnali watershed

Location	Latitude	Longitude	Elevation	River Discharge	
				Winter	Dry
Ambasa-Thakurdwara	28.51126	81.31745	125	30.5	-
Bungaad Khola	28.67338	81.28669	182	168.3	20.3
Jamati	28.43703	81.31809	114	13.8	87.7
Kachali Bridge	28.69776	81.27725	160	50	23.3
Karuwa	28.7315	81.24741	173	8.3	5.3
Orahhi - down confluence	28.37339	81.21363	89	-	411.4
Orahhi	28.47675	81.30566	108	493.4	329.1
Orahhi Bridge	28.39678	81.2404	77	0	568.2
Raanipur	28.47254	81.31593	107	111.3	28.1
Sanghure Khola	28.72138	81.26325	164	45.4	12.8
Sujanpir	28.45563	81.28366	106	1287.5	306.1

Source: Paani biophysical survey, 2017

Table 5: Important water bodies in the Lower Karnali watershed

SN	Name	Type	Area (ha)
1	Tara	Wetland	3
2	Bhgaraiya	Wetland	12
3	Karnali	Flood plain	15,625
4	Orahi	Flood plan	2,188
5	Kaurahi	Flood plain	375
6	Bathuwa	Lake	25

Lakes, ponds, wetlands, and flood plains (Table 5) are key water bodies in the watershed, providing not only water and ecosystem services to the local households, but also important habitat to amphibians and migrating birds. In addition, 25 artificial ponds have been constructed within Bardiya National Park (BNP) to meet water demands for wildlife. Five of these ponds are equipped with solar pumps.

Water quality in the watershed was determined by testing a range of parameters, including pH, nitrate nitrogen, ammonium and phosphate (Annex 14). All were found to be in the normal range for drinking, domestic use and irrigation, save for ammonium and phosphate, which were elevated in some locations, potentially indicating excessive chemical fertilizer use and/or eutrophication. The water was sampled at several locations in the watershed using an Akvo Caddisfly kit (Figure 5).

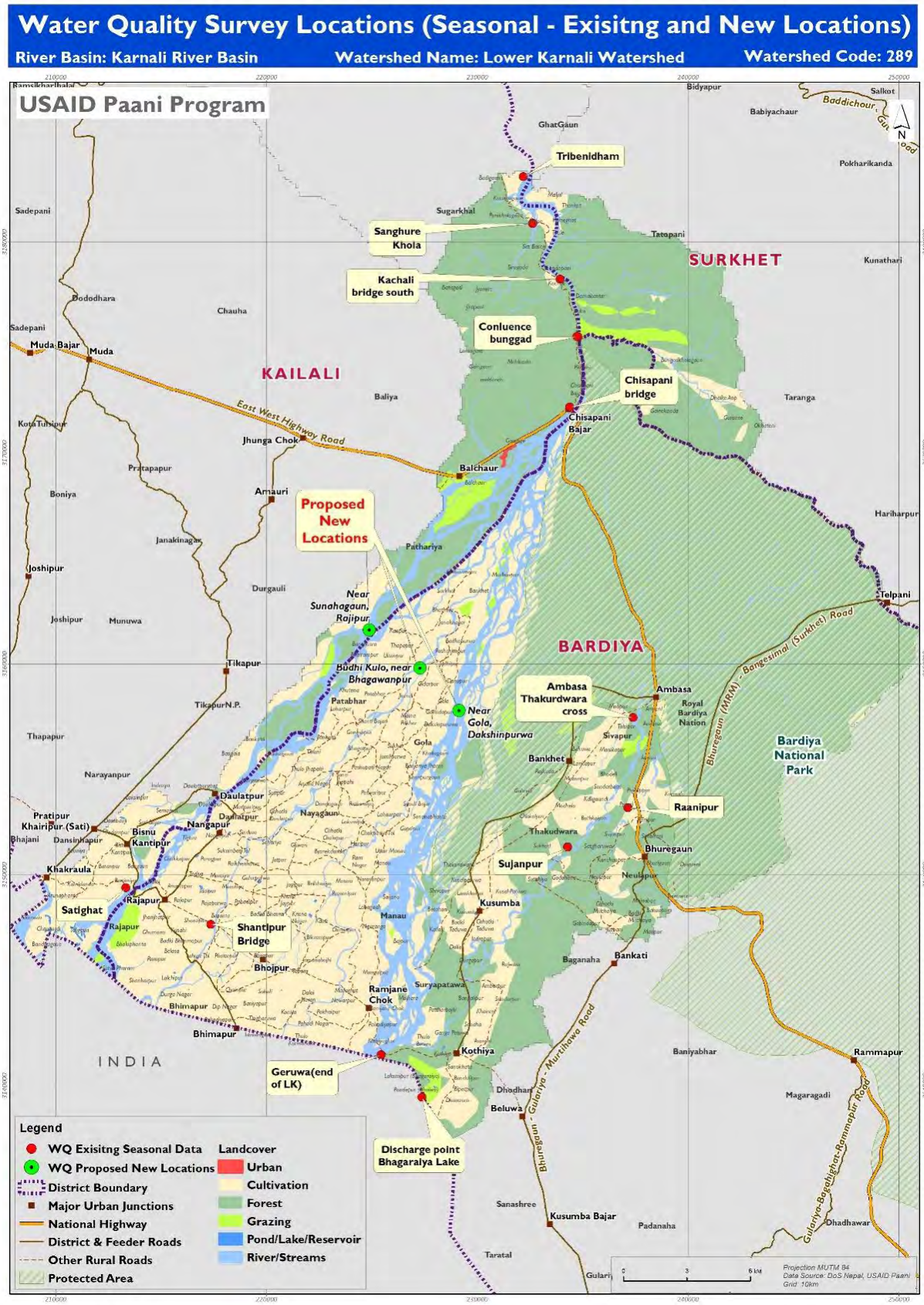

Figure 5: Water quality testing sites in the Lower Karnali watershed

On the issue of water availability, ground water provides the primary source of domestic water in Lower Karnali. Fifty-seven percent of households extract this water using tube wells, while 25% use traditional wells, and 13% draw from private and public taps. Despite the apparent abundance of water in Lower Karnali, local perceptions of availability were mixed: 56% of households (n=1,452) said water sources had been drying up within the last 5-10 years, and 83% said they experienced difficulty obtaining enough water to meet daily needs throughout the year. Only 4.5% of respondents in the survey said they spent more than 30 minutes per day obtaining water for daily needs.
Equal water access does not appear to be a concern in Lower Karnali, as 89% of households reported having no issues vis-à-vis other households in terms of access to water sources. Accordingly, water conflicts between households and/or different social groups is not a source of present interest.

Water accessibility, on the other hand, indicates the degree of ease for users to obtain water. 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. This is not a large concern in Lower Karnali: 89.5% of households said they have equal access to drinking water.

Today, the Karnali River is considered a "free flowing" waterway. Water access concerns in the future will revolve around the balance between domestic and commercial needs. While irrigation is relatively wide-spread in the watershed, most of the schemes are farmer-managed and modestly-sized. However, plans are underway, with assistance from development partners and the government, to expand and modernize these systems, which will increase their capacity to withdraw and redirect water. While proper governmence of FMIS has been lauded as a success, more analysis is needed to undertand how multipe uses and users of water will be managed in the long-term.

Furthermore, major infrastructure projects threaten the free-flowing nature of the Karnali upstream, which will impact downstream users in Lower Karnali. The Upper Karnali Hydroelectric Project is a 900 MW dam upriver in Achhham and Dailekh districts that will impound water and restrict the migration of fish in that area. A second hydropower project at Chisapani (~10,000 MW) has been proposed. Downstream, closer to Lower Karnali, just south of the Indian border, the Girijapuri barrage restricts fish movement during spawning season (April to June). The barrage is open only for approximately 15 days from March to April, at the discretion of the Indian government. In the monsoon season, the gates are open only 2-3 hours daily, which exacerbates flood conditions for upstream households.

Related annexes
Annex 4: Precipitation and temperature
Annex 14: Water quality

2.3 LAND USE AND LAND COVER

In terms of land use and cover (Figure 6), forest occupies 55% of the Lower Karnali watershed, followed by cultivated land (34%), water bodies (9%), and grazing land (2%). The forest land measures 482 km^2, 69% of which sits in Bardiya National Park.

Generally, local perceptions about land cover and use were positive. Community forestry and buffer zone groups around the national park have been an effective means for managing natural resources. More and more land is being converted to agriculture to accommodate a growing population with an increasing interest in fruits and cash crops to diversify produce offerings and

build resilience into household farms. Officials interviewed in the District Forest Office (DFO) expressed satisfaction with the high vegetative cover of the watershed.

However, data from Global Forest Watch offers potential reason for long-term concern. From 2000-2016, the Lower Karnali watershed lost 9% of its forest cover in some areas while reforesting only 2% for a net loss of 7% over that period. The areas of greatest loss were concentrated on the banks of the Geruwa and Karnali rivers, and along the East-West Highway, which enters Lower Karnali in the northwest and cuts across the watershed through Bardiya National Park (BNP) (Figure 7).

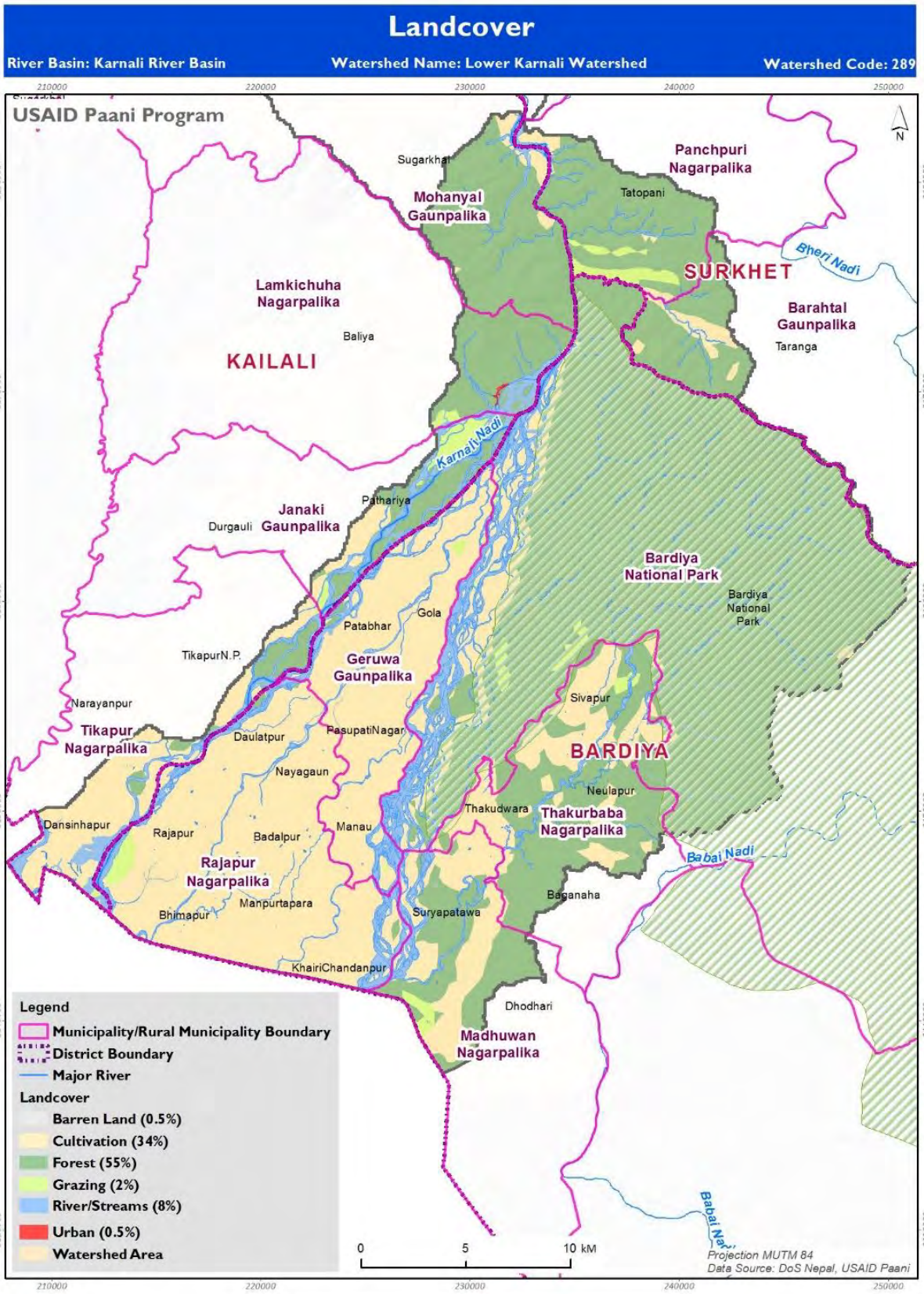

Figure 6: Land cover and land use in the Lower Karnali watershed

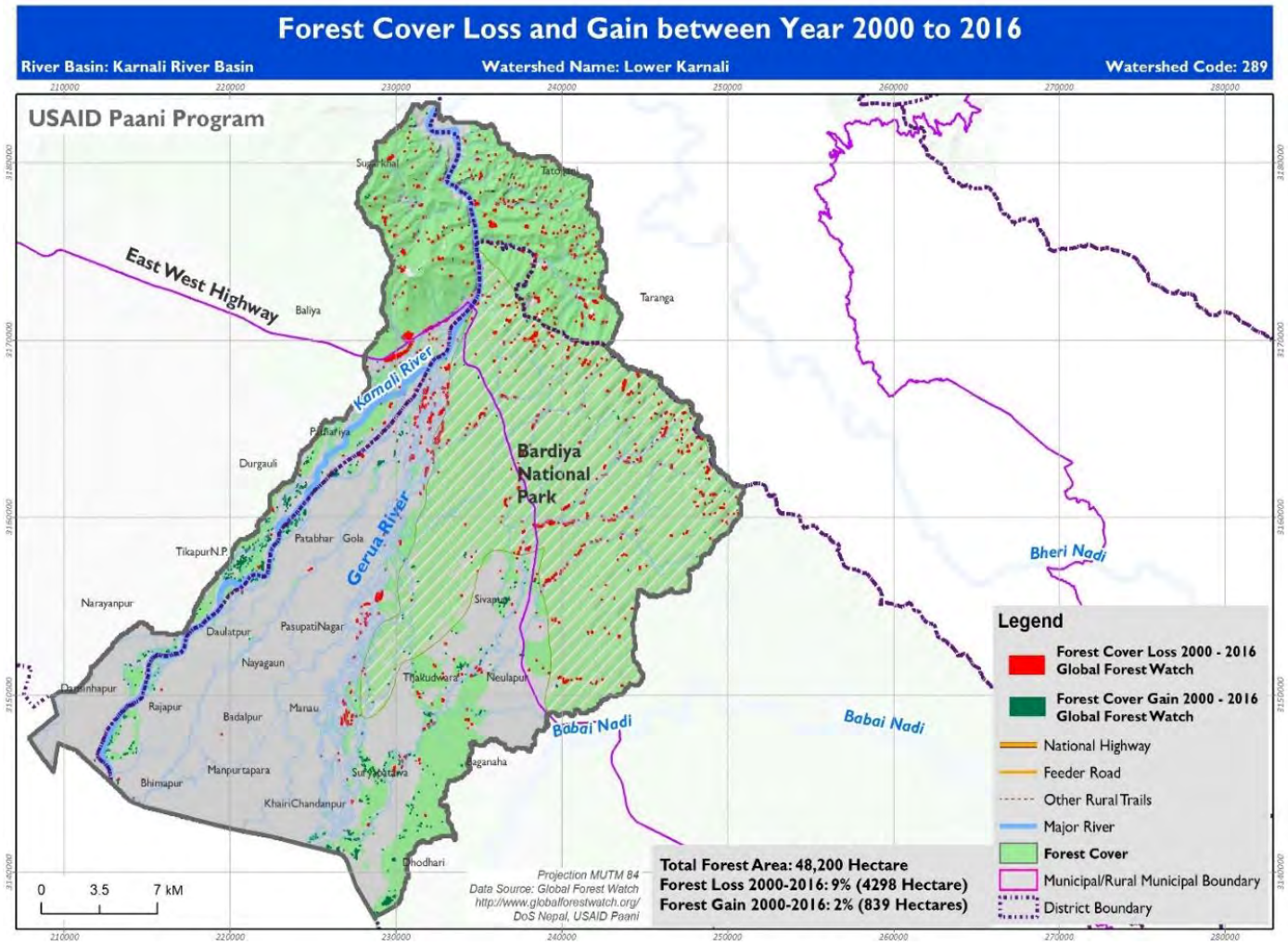

Figure 7: Map of forest loss and gain in the Lower Karnali watershed, 2000-2016

Related annexes

Annex 2: Land use and land cover

Annex 5: Lakes, ponds, and wetlands

Annex 6: Forest types and composition

2.4 BIODIVERSITY AND INVASIVE SPECIES

Given the large portion of the Lower Karnali contained within Bardiya National Park (BNP), the watershed's function and importance as a biodiversity "hotspot" is difficult to understate.

The Khata Forest is a corridor that links BNP to the Katerniaghat Wildlife Sanctuary in India and provides safe passage for terrestrial wildlife between the locations. The World Wildlife Fund, which sponsored the Khata Forest, is also planning for a Karnali River Corridor (Figure 8), which would run from Chisapani Bazaar to the Indian border and cover more than 14,500 ha[2]. Notably, it would be the country's first river *and* forest corridor, facilitating movement for terrestrial and aquatic species, such as the Gangetic dolphin and other endangered animals.

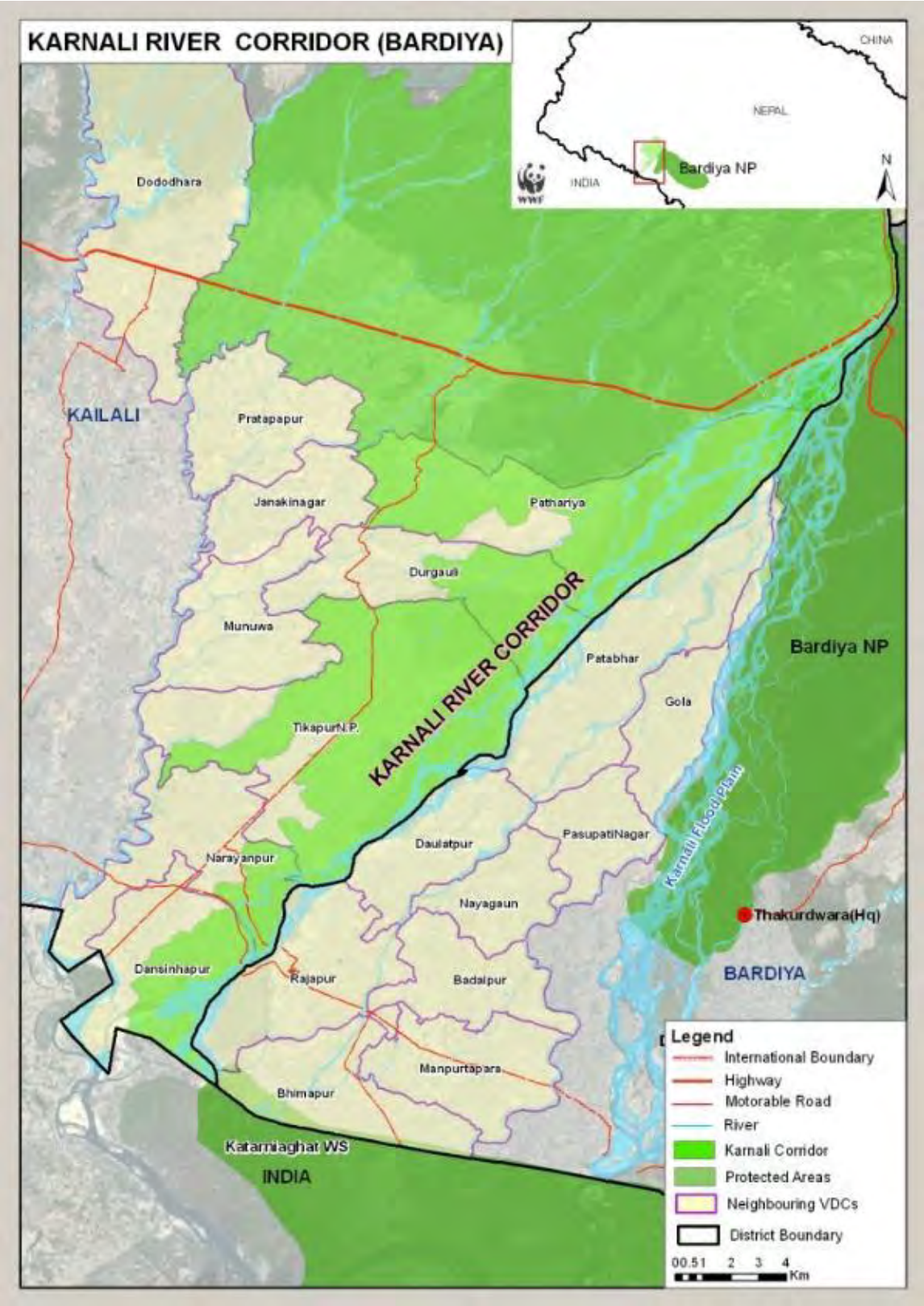

Figure 8: Map of the Proposed Karnali River Corridor

The Karnali and Khata corridors face certain obstacles to their effectiveness, however, in the form of highway, hydropower (e.g, Upper Karnali) and irrigation (e.g., Rani Jamara Kulariya) projects that bisect the area at various places. Biodiversity advocates must work concertedly with these infrastructure schemes to produce sustainable designs that minimize impact on watershed wildlife.

Aquatic species diversity in the watershed is relatively rich compared with other parts of Nepal, though increasing fishing pressures and growing infrastructure for development are issues of concern. Previous studies have identified 186 native fish species in the watershed and 11 exogenous species from 23 families under 9 orders (Petr, Swar et al., 2002). Fifty-nine of these fish are designated as cold-water species for which migration northward for spawning is paramount. A full listing of these species is available in Annex 8.

Fisherfolk interviewed for this study provided details on fish reproduction in the watershed (Figure 9). In May, fish begin migrating upstream to lay eggs. The eggs then float downstream in July and August to warmer waters where they hatch. Some species (i.e, Sujha, Sauro, and Thed) protect their fingerlings in havens along the river banks.

Other anecdotal reports about fish cited the Rohu fish as a species found in the watershed only after 1990. Other households say the Snow trout disappeared from local rivers around 2007. Today, the Sahar (Golden mahaseer/Tor putitora), Gardi (carp/Labeo pangusia), and Kalanch (Labeo angra) are key fish species for consumption and commercial value.

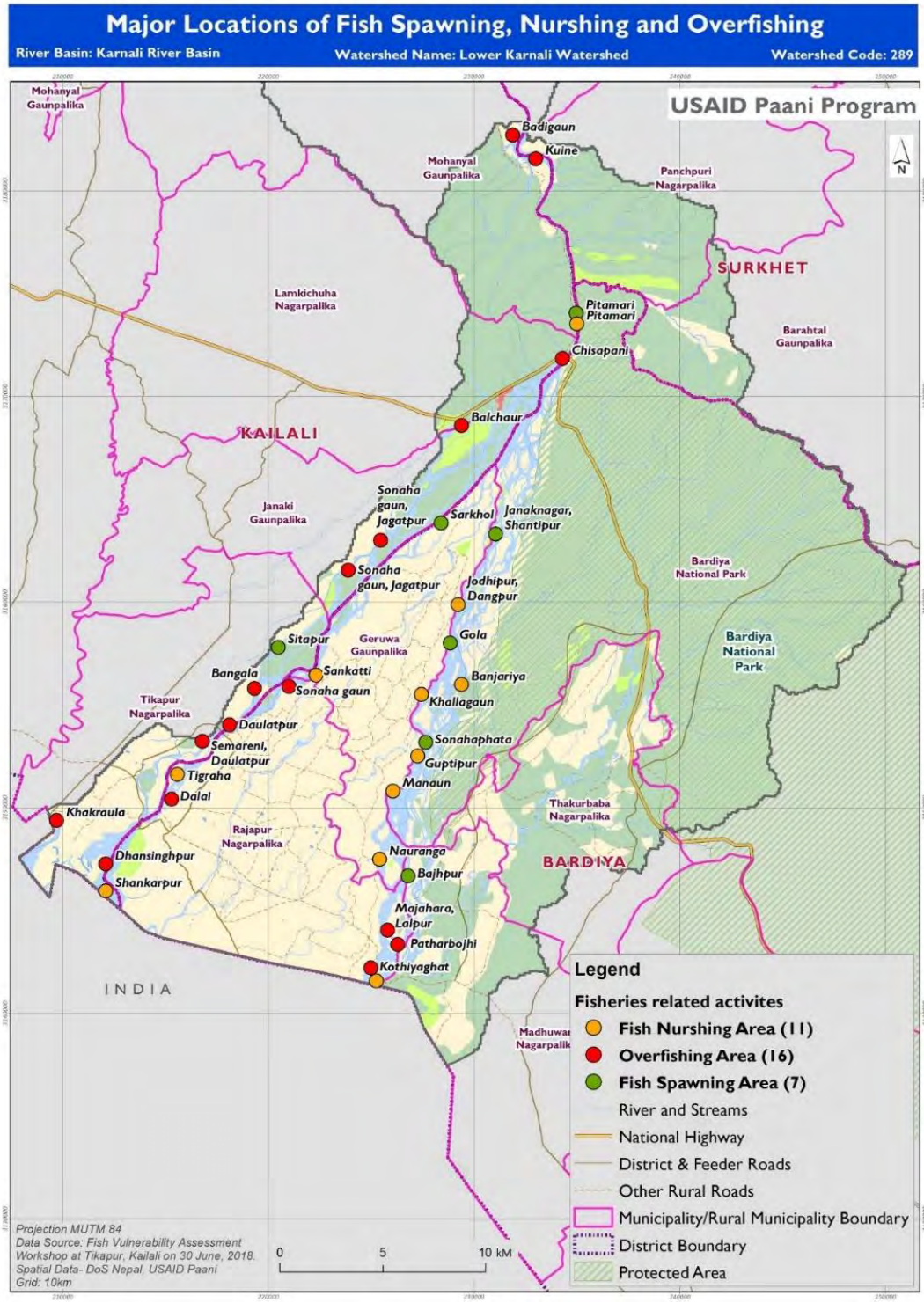

Figure 9: Fish nursing, spawning, and overfishing sites in the Lower Karnali watershed

Water hyacinth is the major invasive plant species in the Lower Karnali watershed, occupying significant space in the lakes and wetlands, and drawing away important resources from fish, crocodile, tortoises, and wetland birds.

Related annexes

Annex 8: Fish and aquatic life in the Lower Karnali watershed
Annex 9: Mammals in the Lower Karnali watershed
Annex 10: Reptiles in the Lower Karnali watershed
Annex 11: Birds in the Lower Karnali watershed

2.5 RAINFALL AND CLIMATE

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

2.5.1 RAINFALL

Long-term rainfall data records in Lower Karnali watershed are available at Chisapani and Rajapur, which lie in the northern and southern parts of the watershed, respectively. Rainfall stations at Tikapur, Bargadha, Rani Jaruwa Nursery, and Jamu, which lie just outside the watershed, were also used to gauge the spatial variations of rainfall in the watershed.

The Theissen polygon method was used to estimate the average rainfall of the Lower Karnali watershed. The comparison between the estimated average monthly rainfall in the watershed and the observed average monthly rainfall at Chisapani and Rajapur are shown in Figure 10. The figure shows that the estimated rainfall of the basin is lower than the rainfall at Chisapani but higher than that of Rajapur. Highest and lowest rainfall in the watershed are observed in the months of July and November, respectively. The dry season rainfall (November – May), monsoon rainfall (June – October) and the annual rainfall were estimated at 193 mm, 1,600 mm and 1,793 mm, respectively.

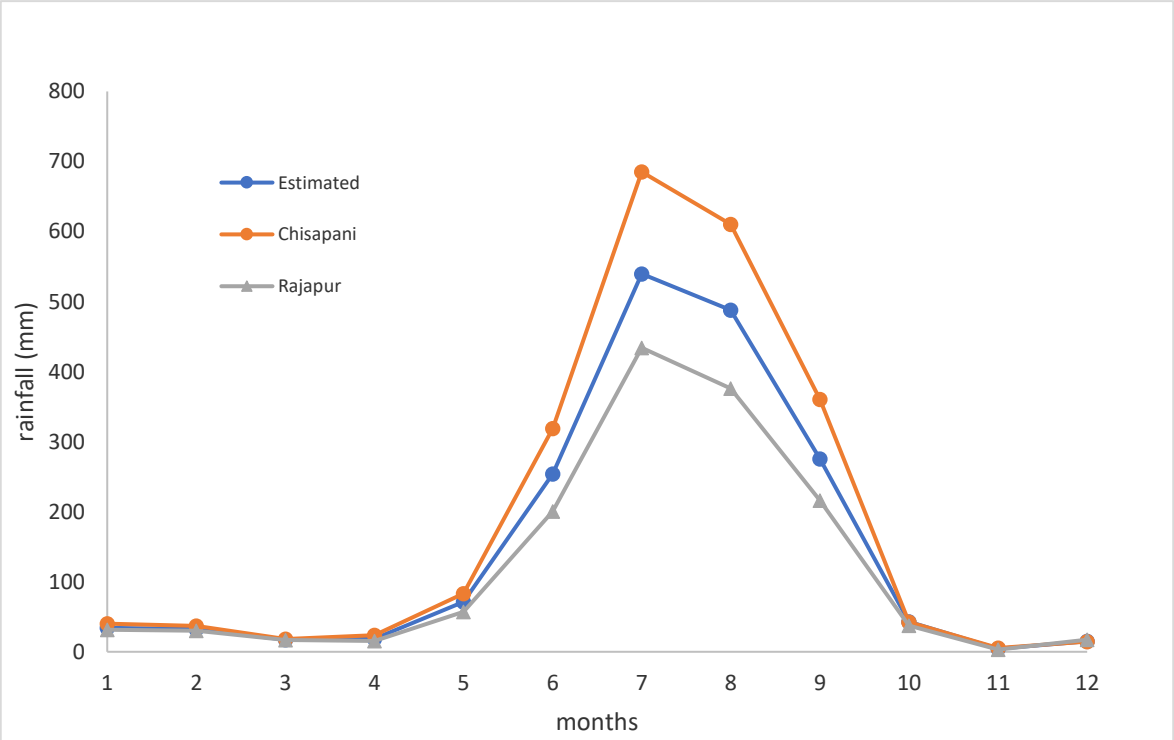

Figure 10: Long-term average monthly rainfall (in mm) estimated for the Lower Karnali watershed

Looking at spatial varations in rainfall, consistent patterns are absent: annual rainfall in the north is increasing (10 mm/year) while decreasing (-10 mm/year) in the south (Figure 11). Similarly, mean monsoon rainfall has been increasing at a rate of 10 mm/year throughout the watershed, while winter month rainfall shows a 1.5 mm/year increase. Post-monsoon rainfall, comparatively, is decreasing at a rate of -1 mm/year.

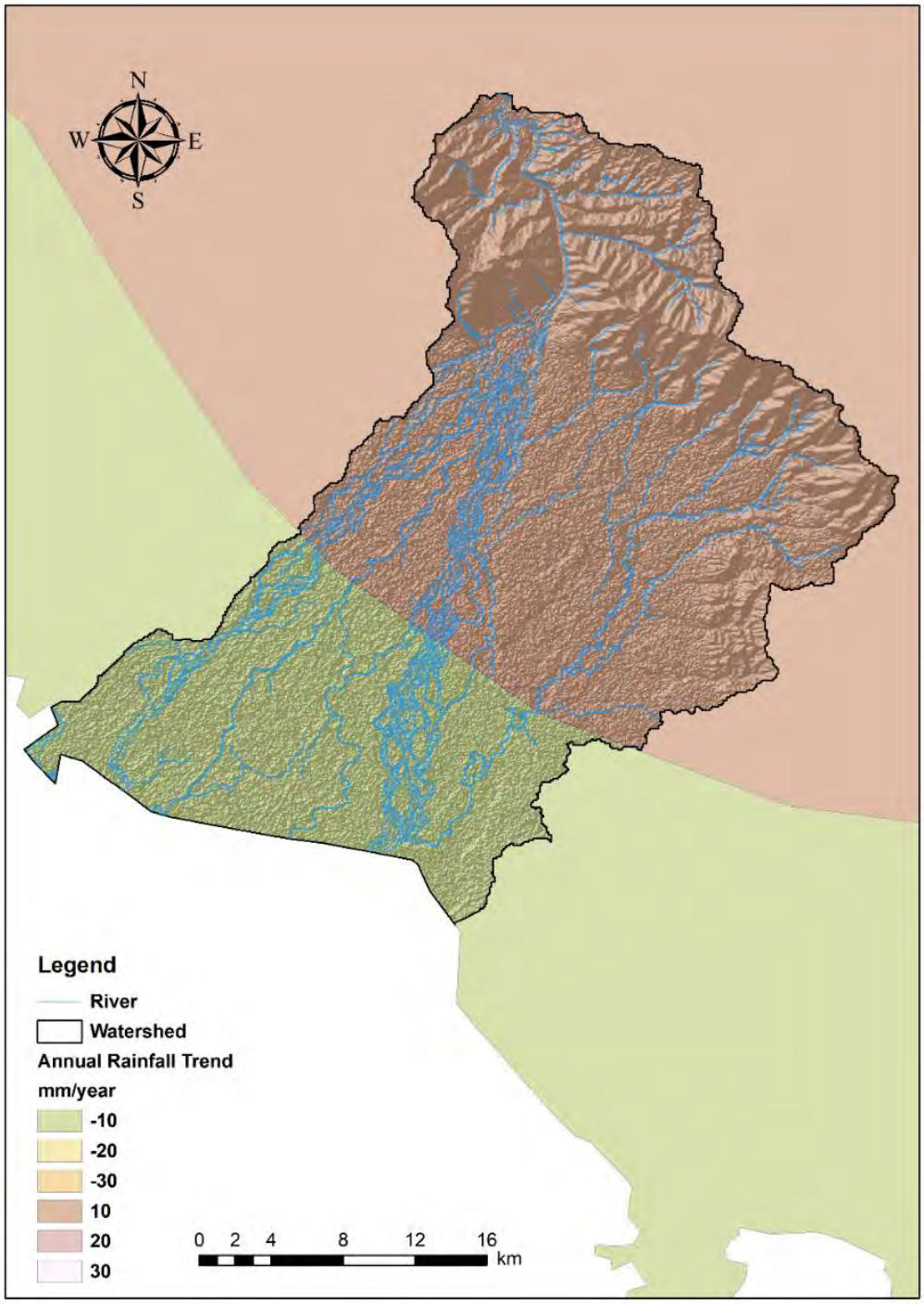

Figure 11: Long-term annual mean rainfall trend (mm/year) observed in Lower Karnali watershed

2.5.2 TEMPERATURE

To derive temperature forecasts for Lower Karnali, long-term data was collected from a recording station at Chisapani and triangulated with data from Tikapur and Rani Jaruwa.

Long-term average monthly temperature variations (daily average) in Lower Karnali watershed are shown in Figure 12. The average monthly temperature of the watershed varies from 14.5°C in winter to approximately 30°C in summer. Similarly, the minimum and maximum monthly temperatures vary from 8.57°C to 20.37°C in winter and from 23°C to 37°C in the summer. Looking from north to south, we find average annual temperature varies from 12°C in the north to 24.5°C in the south.

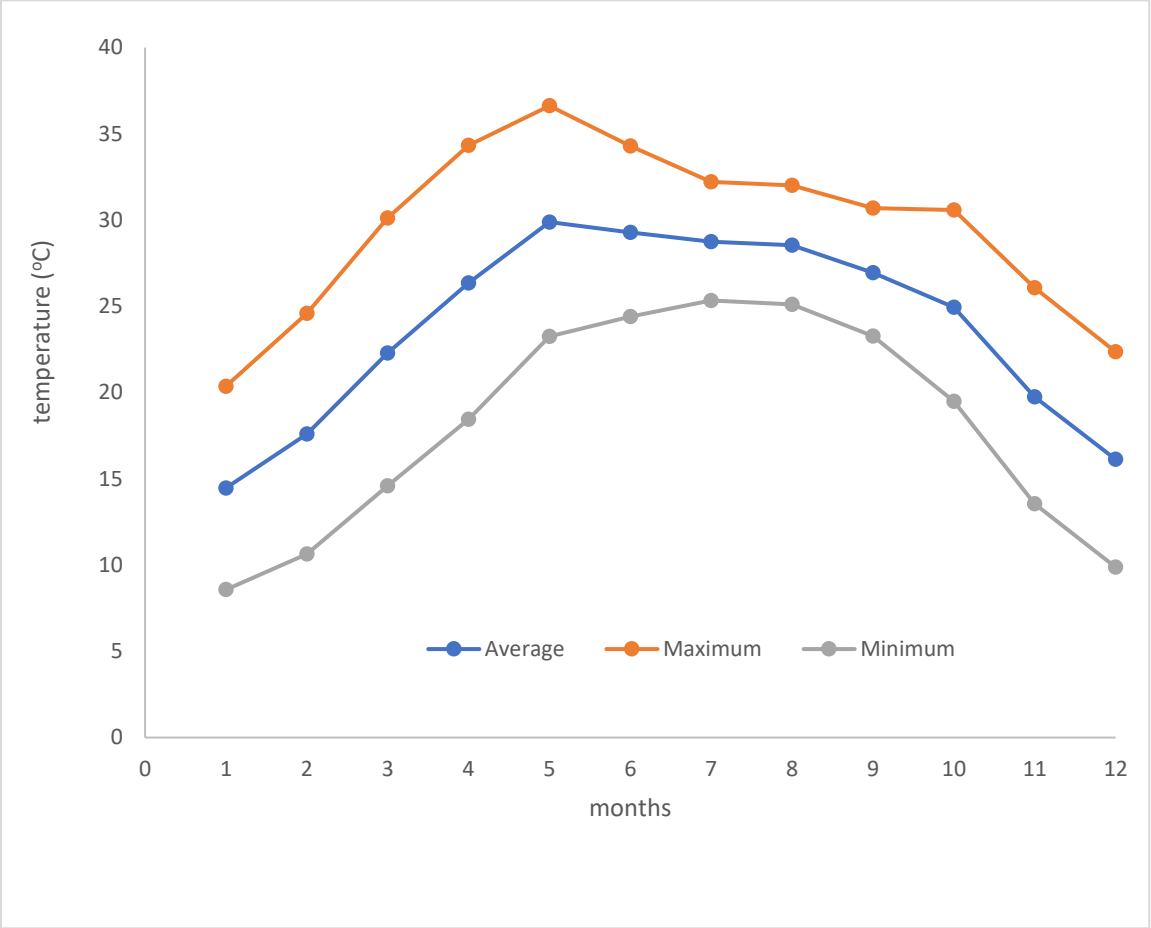

Figure 12: Maximum, minimum and average long-term monthly temperatures (°C) in the Lower Karnali watershed

Climate change impacts on rain and temperature were evaluated by the Nepal Country Vulnerability Study Team in 2009. They concluded that single day precipitation amounts were likely to continue increasing, raising the likelihood of flash flooding, as well as continuous days of no rain that will challenge agricultural production.

Related annexes

Annex 4: Temperature and precipitation

2.6 CLIMATE RESILIENCE AND DISASTER RISK REDUCTION

With the onset of climate change impacts, watershed residents are starting to realize the importance of climate resilient activities to fortify their livelihoods in the short- and long-terms.

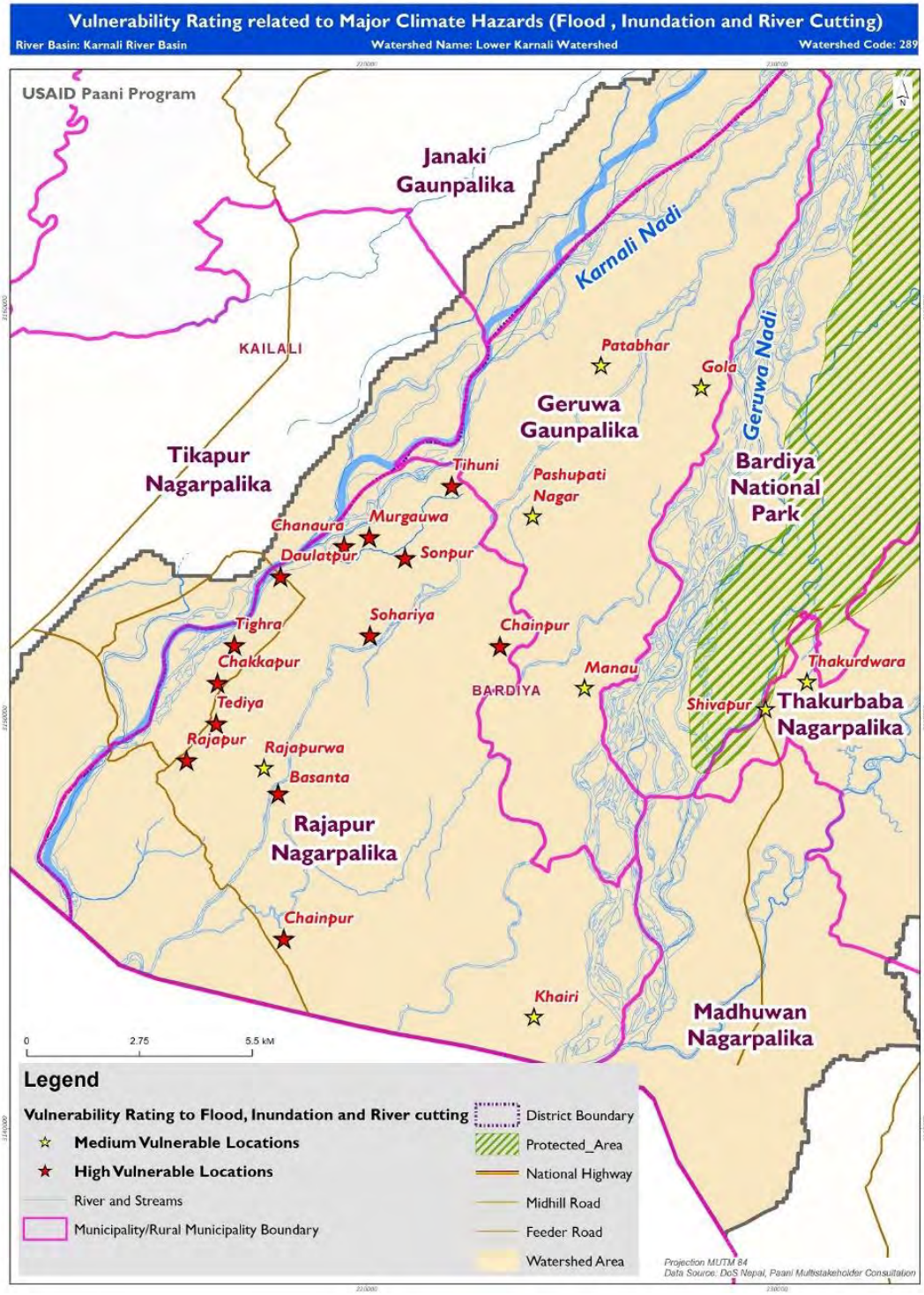

Figure 13: Vulnerability ratings for climate hazards by location in the Lower Karnali watershed

As Figure 13 illustrates, concerns about flooding and river cutting are uniform throughout the watershed, informed by recent disasters, such as the 2014 floods at Tikapur when 14,500 homes were destroyed, 80,000 people affected, and 2,000 hectares of land cut by the swollen river. In the wake of this event, many households in our survey reported that government agencies had been delinquent in developing and sharing disaster preparedness plans.

Despite this high risk for flooding (Figure 14), the Lower Karnali watershed has only two locations equipped with early warning capacity: Chepang (in Bansgadhi NP) and Ghaibari (in Kalimati GP). These systems can be manually and automatically tripped to transmit messages about potential flood conditions to the district emergency operations center and district police office. Chepang and Ghaibari are approximately 6 and 9 hours upstream, respectively, of the first communities that would be affected by flood waters, providing residents with crucial minutes to move to higher ground with family and important personal belongings.

In these conditions, finding and utilizing climate-smart and climate-resilient practices is crucial. In our surveys and through field observations, the USAID Paani Program team noted several technologies and activities in the Lower Karnali watershed. Most common were households involved in spring source conservation (620 hh), followed by those replanting barren lands (525 hh) and installing Gabion boxes to mitigate soil and hillside erosion (275 hh). Other climate-smart practices include drip irrigation, higher quality seeds, plastic pond construction, maintain irrigation canals, solar lift irrigation, and tunnel farming.

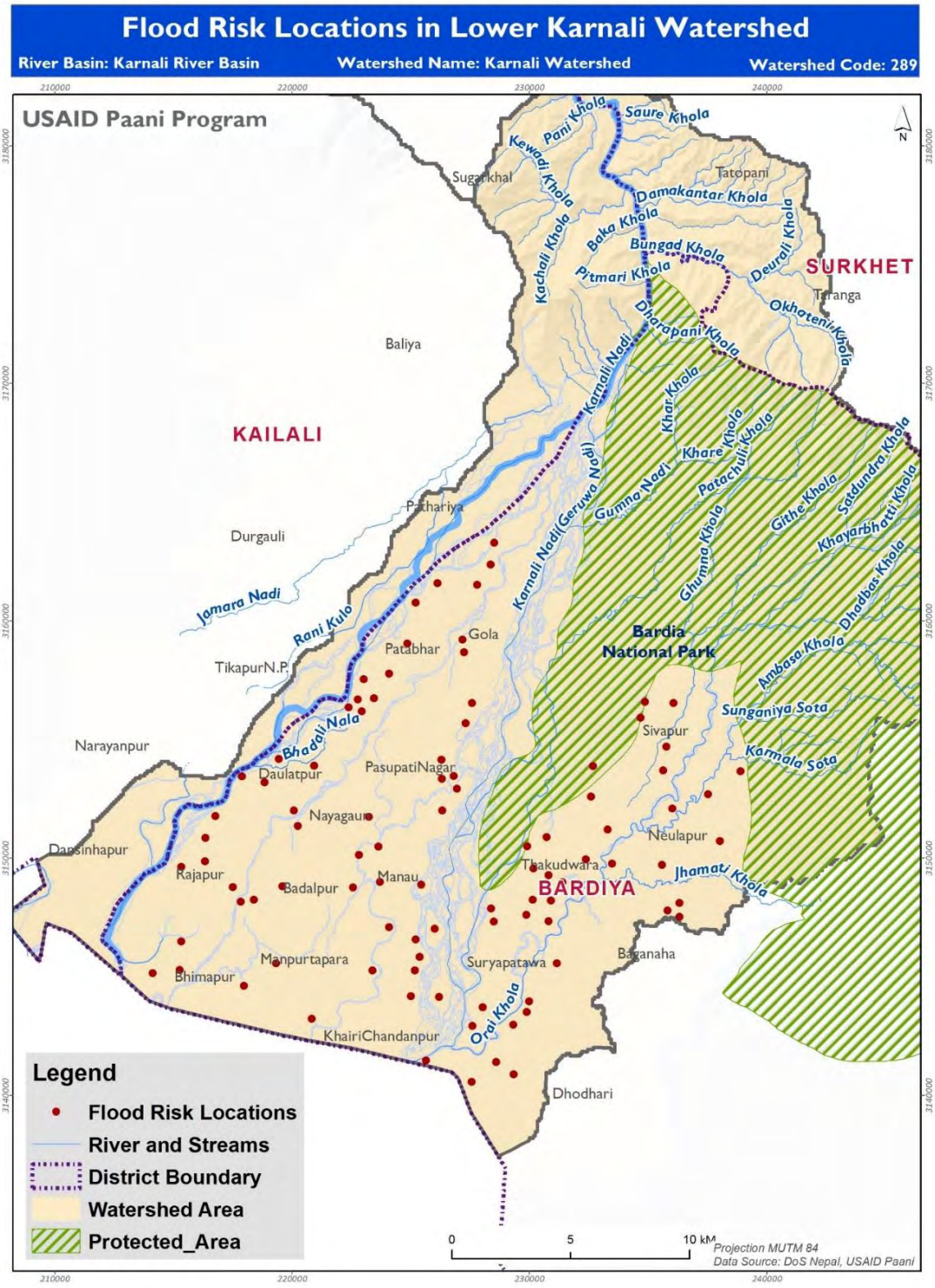

Figure 14: Flood prone areas in the Lower Karnali watershed as identified by stakeholders

Related annexes

Annex 7: Climate change impacts in the Lower Karnali watershed

3. WEALTH

Historically, the Lower Karnalil watershed has been occupied by Janajati groups, mostly Tharu. But the eradication of malaria in the 1960s opened the area to significant migration from the hill regions of the country seeking land and more opportunity.

Among a population of approximately 172,926, census data from 2011 notes 53 different social groups living in Lower Karnali: 55% Janajati, 32% BCT, and 12% Dalit. Among the Janajati are numerous traditional fishing groups who are disproportionately vulnerable to environmental impacts that complicate their reliance on the river for resources and settlement.

Agriculture is the main source of livelihood (Table 6) at 54% followed by wager laborers at 25%. The remainder of households are scattered across numerous occupations, many related to tourism in the watershed and transit through the watershed.

Table 6: Primary income source by type in the Lower Karnali watershed

Income source	Percentage
Livestock rearing	3.9
Agriculture	54.4
Seasonal migration	2.2
Remittance	1.9
Daily wage	25.0
Fishing	4.7
Other	7.8
Total	**100.0**

Paani Household Survey 2017

Related annexes
Annex 3: Population

3.1 FISHING PRACTICES

Due to the commercial importance of fish and large number of traditional fishing groups in the Lower Karnali watershed, fishing draws much attention from policymakers, researchers, and local households alike.

Fishing community settlements (Kumal, Majhi, Tharu, Sonaha, and Musahar) are scattered throughout the gaunpalika (GP) and nagarpalika (NP) of the watershed, most of them concentrated in Geruwa GP, Rajapur NP, Tikapur NP, and Madhuban NP. Of the watershed's total population (171,943), 54.3% belong to a fishing community.

In this study, value chain assessment found that approximately 1,000 kgs of fish are consumed per day in the watershed. Half of these fish are taken from the Karnali River, 20% from lakes, and 30% from private

fish farms in Nepal and India. Based on these estimates, approximately 255 metric tons of fish are captured and traded in the Lower Karnali watershed each year.

In the 1980s and 90s, fishing was lightly regulated by the District Development Committee (DDC) through the issuance of licenses to traditional fishing groups at 1,000 rupees per household – an affordable price for most households. With this license, there were no restrictions on quantity or size of fish harvested. Mahaseer and dolphin harvesting were not permitted.

Anecdotal evidence in the study suggests that fish numbers have declined in the Geruwa River. In 2000, fishermen reported catching 10-12 kg of fish per day, but today struggle to catch 8 kg, bringing in 15,000 rupees per month, or 150 USD, before accounting for expenses. Due to these low figures, more fishermen are opting for migration opportunities in Kathmandu and abroad. The outmigration has diminished the capacity for forming cooperatives in the watershed, as a mimimum number of 25 is necessary for formalization.

For some traditional fishing groups, who are also usually landless, riverbed farming is becoming more popular through support from the District Agriculture Development Office (DADO). DADO now supports 55 groups, providing pumps, seeds, and farming tools in Daulatpur, Manau, Patabhar, and Khairi-Chandanpur.

3.2 AGRICULTURE PRODUCTIVITY

As noted above, farming is the most common occupation in the watershed and the alluvial soil is fertile and conducive to high yields. Crops like rice, maize, and wheat are the major crops grown, but more farmers are turning to mustard, lentils and a variety of fruits to diversify their offerings (Table 7). For surplus production, households can distribute to one of 11 market centers in the watershed, where fruit and vegetables are taken to the nearest urban settlements (e.g., Nepalgunj) or to local hotels and restaurants.

Table 7: Major crops grown in the Lower Karnali watershed by area, tonnage, and tonnage per hectare

SN	Crop	Area (ha)	Metric tons	Tons per hectare
1	Rice	52,000	213,000	4.10
2	Wheat	19,500	64,300	3.30
3	Maize	7,200	18,100	2.51
4	Lentil	18,000	13,500	0.75
5	Pea	1,470	2,650	1.80
6	Aarahar	1,510	1,057	0.70
7	Mustard	9,550	8,850	0.93

8	Liseed	690	414	0.60
9	Sunflower	200	250	1.25
10	Sugarcane	300	6,300	21.00
11	Potato	4,100	53,300	13.00
12	Vegetables	1,900	61,710	32.48

3.2.1 SOIL MANAGEMENT AND FERTILITY

Despite the high levels of productivity in the Lower Karnali watershed, concerns about declining soil fertility are common: 81% of households say they believe soil fertility to be poorer compared with 5-10 years ago. However, contrary to that reporting, data from DADO show that cereal, pulse, oil, and vegetable crop production all exceed watershed population needs based on daily nutrition requirements (Table 8). The difference was primarily due to the ways fertility is interpreted and measured. DADO measure productivity by estimating crop cutting while local people explain fertility considering the overall soil fertility situation.

Table 8: Need and actual agricultural production in Lower Karnali watershed

Crop type	Production requirement (mt)	Actual production (mt)	Surplus	Percentage surplus
Cereals	78,918	118,800	39,881	50.1
Pulse	15,697	18,845	3,149	20.0
Oil	9,592	9,845	253	2.6
Vegetables (including potato)	47,525	126,350	78,825	265

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 roads on steep slopes can increase soil erosion and landslides. Similarly, hydropower plants (such as Upper Karnali) 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 farmer populations.

3.3.1 HYDROPOWER

While providing a relatively inexpensive and renewable energy to populations that struggle to obtain electricity for household needs, hydropower brings environmental trade-offs by impeding fish migration and water flow (and related ecosystem services) downstream, and raises the potential for flooding and inundation upstream above the impound area. At present, there are five large schemes of note in various

stages of development that will have impact on the Lower Karnali watershed. A fuller illustration of planned and operating hydro schemes is presented in Figure 15.

Rani Jamar Kulariya (status: under construction): The Rani Jamar Kulariya project will be a 4.7 MW scheme that draws its water from the similarly named irrigation project in the northern part of the watershed, near the Chisapani bridge. The powerhouse for this project is located 4 km downstream of the irrigation intake canal. This hydropower project is a collaborative effort between the Government of Nepal and the World Bank.

Karnali Chisapani Multipurpose Project (status: planning): This 10,800 MW dam would be built in Chisapani near the Karnali Suspension Bridge. As a multipurpose project, the dam is proposed to support an irrigation system that provides water to 191,000 hectares in Nepal and 3,200,000 hectares in India. Proponents of the project also promote the navigational benefits of the dam, as it will be able to hold water back during turbulent weather, making boat travel safer.

Upper Karnali Hydropower Project (status: early stages of construction, stalled; projected completion in 2021): The Upper Karnali project will provide 900 MW of electricity, however, only 12% of that energy will remain in Nepal and the rest will be exported to India. This detail is a source of great contention in Nepal between civil society groups and government officials. Nepal also receives a 27% stake of equity in the project, which could promise significant revenue for government programs. The environmental impact assessment (EIA) associated with Upper Karnali has been hotly contested, and additional EIAs are expected in the next 1-2 years.

Nalsingaad Hydropower Project (status: under construction): Nalsingaad is located in Jajarkot district (outside the watershed), but the corresponding river of this 410 MW project flows southwest into Bardiya, affecting aquatic life and human settlements in those areas.

West Seti Hydropower Project (status: planning): Like Nalsingaad, West Seti sits far upstream of Lower Karnali, but the Seti River is a major contributor to the Karnali River. West Seti is planned to be a storage dam with a large reservoir (1.5km^3) holding water from a massive catchment area (4,022km^2).

Bheri Babai Diversion Project (status: planning): Bheri Babai is an inter-basin water transfer project, intended to provide irrigation to 51,000 hectares in Banke and Bardiya districts. In this movement of water from one basin to another, there are also plans to construct a small hydropower project to provide electricity to the immediate area.

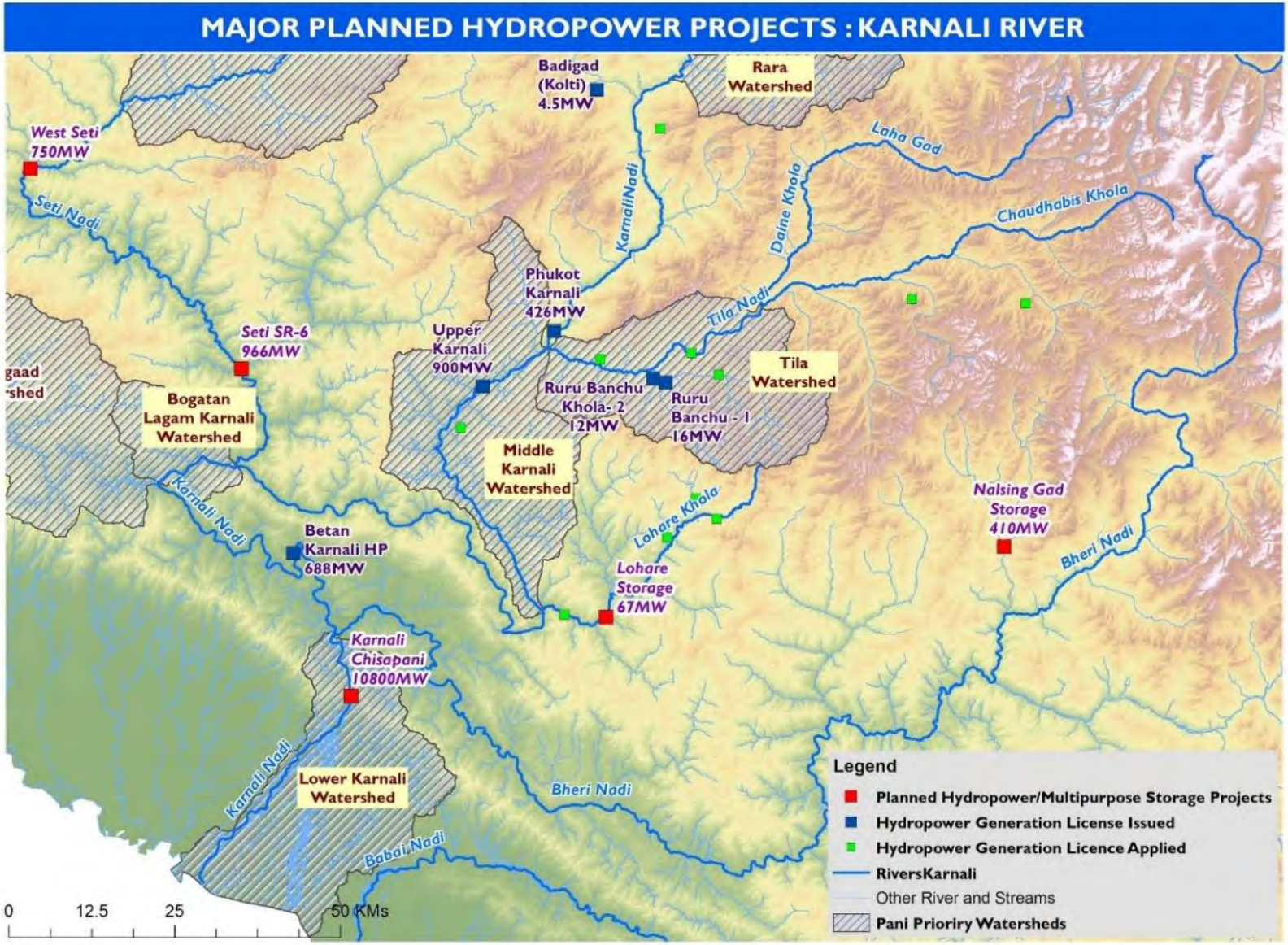

Figure 15: Map of planned and operating hydropower schemes in the Lower Karnali watershed

3.3.2 GRAVEL MINING

Some mining in the watershed is necessary annually to combat sedimentation of the river, which can aggravate flooding and degrade aquatic habitats. But prior to 2012, commercial interest in gravel mining was almost negligible. Since then, given the rise in commercial and infrastructure work in the region, interest in mining as an occupation and source of income has risen.

Household surveys (n=2,456) reflect this change, as only 5% of households listed mining as a primary occupation, but 13% say they are considering mining as a supplementary form of paid work.

Table 9: Gravel mining sites in the Lower Karnali watershed, including amounts and type

River	Location	Maximum amount permitted for extraction annually (m^3)	Sand	Gravel	Stone	Soil
Duduwa Khola	Shantipurghat	40,392	X	X	X	
	Chakhhapurghat	18,750	X	X	X	X
	Daulatpur	26,250	X	X	X	X
Rajapur Karnali	Tighraghat	16,800	X	X	X	X
	Tediyaghat	16,800	X	X	X	X
	Above bridge	16,800	X	X	X	X
	Below bridge	16,800	X	X	X	X
Kothiyaghat Geruwa	Kothiyaghat-1	22,500	X	X	X	X
	Kothiyaghat-2	22,500	X	X	X	X
	Lalpurghat	22,500	X	X	X	X

To date, the District Coordination Committee has held the authority to distribute mining contracts. But with the ongoing shift in governance to a federal system, mining contracts will be established by local governments under the supervision of the Ministry of Federal Affairs and General Administration (MoFAGA). Local governments will also assume responsibility for carrying out IEE's prior to issuing those contracts. Table 9 shows the materials allowed for mining at various sites in the watershed, including the maximum amounts that can be withdrawn annually. Figure 16 provides the geographic locations of these sites throughout the Lower Karnali.

In focus group discussions, respondents expressed concern about how mining will impact the Sonaha community, which pans for gold as a primary occupation. As a mostly landless group, gold panning and fishing are crucial to their existence.

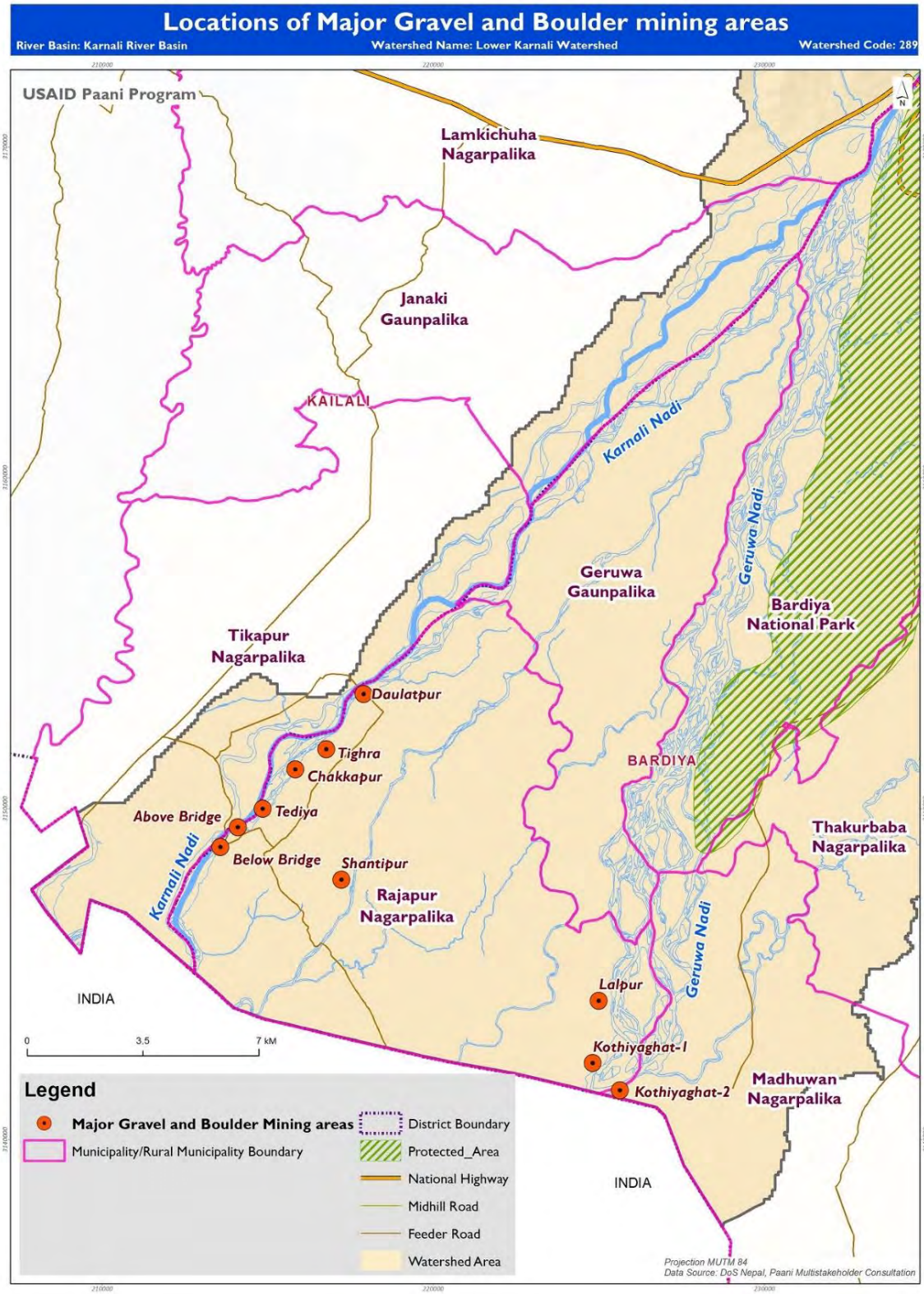

Figure 16: Locations of gravel and boulder mining in the Lower Karnali watershed

Related annexes

Annex 16: Mining in the Lower Karnali watershed

3.3.3 ROADS

There are 426 km of road in the Lower Karnali watershed, separated into four different classes: village core network, district core network, feeder network, and highway. The East-West Highway and Postal Highway are the main strategic roads in Lower Karnali, asphalt lanes constructed on raised earthen beds that occasionally dam and alter surface water flow patterns.

In terms of environmental impact, roads running from east to west tend to be more disruptive, as they interrupt ecological flows that run from north to south and restrict the amount of water reaching downstream areas.

Two strategic roads (the Postal highway and East-West highway) run east to west through the Lower Karnali watershed. The elevated roadbeds of these highways interrupt water flow and restrict the amount of water reaching downstream areas. They also have a dam-like effect, which causes water to pond and inundate some locations upstream of the highways. All of these features impact aquatic habitats, migration pathways, and breeding areas of many species, including the Gangetic Dolphin and Golden Mahaseer. A fuller illustration of the road network in the watershed is featured in Figure 17.

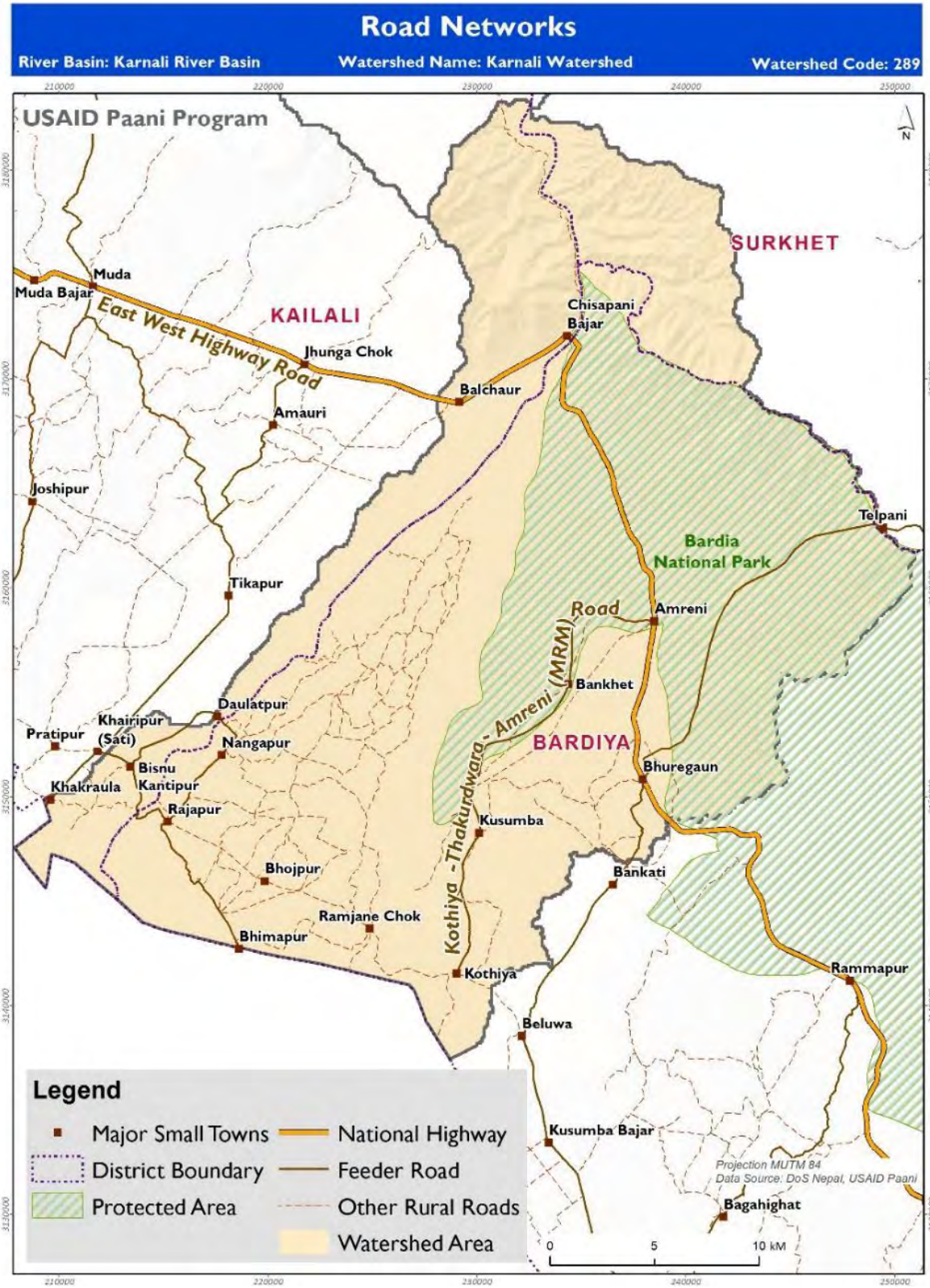

Figure 17: The road network in the Lower Karnali watershed

Related annexes

Annex 12: Roads in the Lower Karnali watershed

3.3.4 IRRIGATION

The history of irrigation in the Lower Karnali watershed has been largely positive, as the area is nationally renowned for its Farmer Managed Irrigation Systems (FMIS), which have enabled agriculture to flourish in this flood plain. Two of these systems – Budhi Kulo and Rani Jamara Kulariya – have operated for more than a century. Focus group discussions with community leaders and irrigation users show that FMIS participants exhibit an advanced understanding of how design can impact biodiversity and water access. This is a promising finding.

Table 10 provides a breakdown of water sources for irrigation in the watershed, while Figure 18 plots the locations of FMIS systems through Lower Karnali.

Table 10: Sources of irrigation water in the Lower Karnali watershed

Source	# of HH	Percent
Rain	557	40.6
Groundwater	449	32.7
Lake	70	5.1
Irrigation pond	69	5.0
Water harvesting	5	0.4
Solar pump	1	0.0
Other	221	16.1
TOTAL	1,372	100

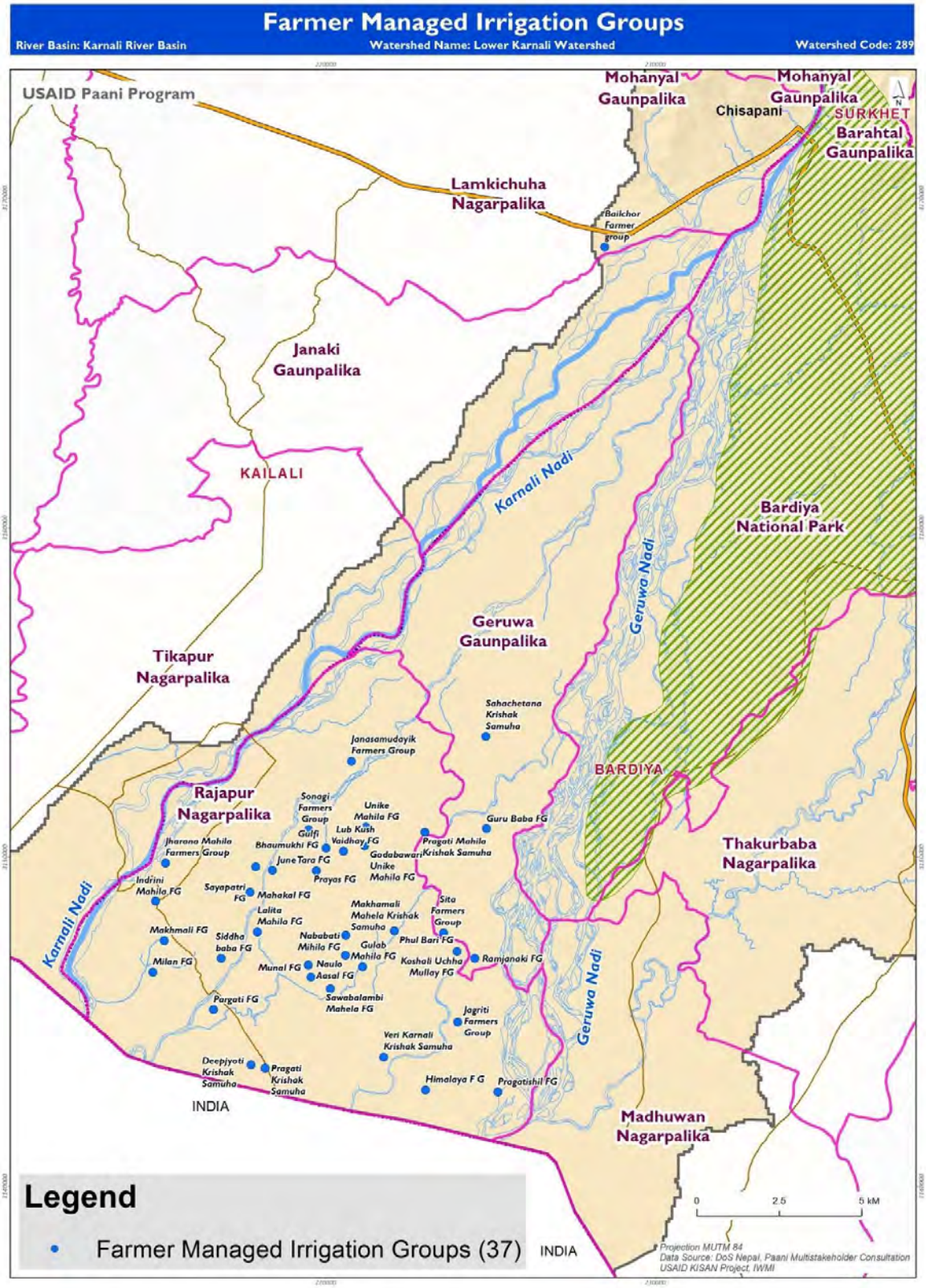

Figure 18: Farmer Managed Irrigation Systems in the Lower Karnali watershed

For drinking water, 80% of households have their own private water sources, while the remainder draw from public taps and springs. Of those 80% with private water sources, 57% use tube wells, 25% piped water, and 13% use stone spouts.

To support responsible water use and access, there are 10 drinking water and sanitation user groups in the watershed who collectively advocate for households with government agencies and moderate water use among its members. In an interview with FEDWASUN, the national organization for water and sanitation rights, representatives reported no significant issues of governance but did say more funding from the government was needed to support activities.

There are two widely known FMIS in Lower Karnali: Budi Kulo and Ranijamara Kulariya. These two schemes have been upgraded in the past decade with concrete gateways, dividing canals, and regulating gates. The funding was provided by the World Bank and Asian Development Bank.

Related annexes
Annex 13: Irrigation in the Lower Karnali watershed

3.4 SOLID WASTE AND MANAGEMENT

As municipalities have started allocating budget for solid waste management-related activities, they can be said to have begun implementing the provisions laid out in the Solid Waste Management Act 2011, which requires local authorities to provide infrastructure such as transfer station, landfill sites, and composting plants that will enable proper waste disposal and processing. The need for this infrastructure is great in Lower Karnali, as surveys found that 25% of households dispose their waste directly into nearby waterways.

There are some promising examples in the watershed already. In Rajapur NP, 1.2 million rupees have been allocated to purchase a tractor and trolley specifically for waste collection. In Tikapur NP, the government has earmarked 5 million rupees for the construction of a solid waste disposal plant and another 5 million for the purchase of a suction machine and truck to aid with waste collection.

Related annexes
Annex 15: Pollution and solid waste in the Lower Karnali watershed

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 Lower Karnali watershed. Analysis indicates there is a need to better understand how current institutional arrangements related to 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 Lower Karnali watershed.

4.1.1 ACCESS TO WATER FOR DOMESTIC AND AGRICULTURAL USE

As noted in section 2.2, water availability and access are not acute concerns in the Lower Karnali watershed. However, more than half of the households surveyed did note that water sources had been drying up over the past 5-10 years, and 83% said they faced difficult in obtaining sufficient water for their daily needs. On the question of access, 89% of households said they had equal access to water sources vis-à-vis other households.

Irrigation is also a relative success story in the watershed, as FMIS has proven a satisfying modality for managing systems sustainably in the watershed.

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

These new governance responsibilities suggest the time is appropriate to work closely with local authorities to develop plans to promote improved watershed health. The following agencies are the main agencies responsible in the Lower Karnali watershed for water resource management:

- Department of Water-Induced Disaster Prevention (Bardiya, Kailali, Surkhet)
- Karnali River Management Office (Rajapur, Bardiya)
- Department of National Parks and Wildlife Conservation (DNPWC)
- District Soil Conservation Office (Kailali, Surkhet)
- District Forest Office (Bardiya, Kailali, Surkhet)

Related annexes
Annex 20: Water and sanitation user groups
Annex 21: Key stakeholders and agencies

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

Bardiya district is one of the most flood-prone and flood-affected regions in the country. Every year, flood waters claim lives and exact high loss of property on vulnerable communities in terms of crops and livestock. In some parts of the watershed, flood waters wash away or wash out roads, which impede personal and commercial traffic, affecting the area's economy.

Despite this history, as noted in section 2.6, there are only two locations equipped with an early warning system: Chepang (in Bansgadhi NP, Bardiya district) and Ghaibari (in Kalimati GP, Salyan district). These systems are manual and automatic and transmit messages about potential flood conditions to the district emergency operations center and district police offices. Chepang and Ghaibari are approximately 6 and 9 hours upstream, respectively, of the first communities (in of Badhyatal GP, Bansgadhi NP, Barbardiya NP, and Gulariya NP) that would be affected by flood waters, providing residents with crucial minutes to move to higher ground with family and important personal belongings.

At Chisapani, a rain gauge station informs district administration when rainfall intensity reaches potentially threatening levels. Warning information is then disseminated to people in Rajapur by mobile phones through the nation's two largest cell providers: NCELL and Nepal Telecom.

4.1.3 ACCESS AND INCLUSION IN LOCAL NRM PLANNING

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

Additionally, because of the BNP's presence in the watershed, buffer zone management is another important resource for ensuring sustainable governance. The Buffer Zone Management Committee (BZMC) oversees 19 user committees, 36 buffer zone community forests (BZCF), and 364 community forst user groups in the areas surrounding BNP. The BZMC also maintains an emergency relief fund and provides compensation to families in cases when wildlife may harm residents.

By law, user groups are to have 33% female membership and women amongst the leadership. The Chief Warden of the BNP says that BZMCs currently do not meet this standard.

Each BZCF contains a community-based anti-poaching unit (CBAPU), five-to-seven member committee to monitor potential violations such as the use of destructive fishing practices or harvesting a protected animal within the park. The CBAPU also bears responsibility for organizing awareness-raising activities (e.g., poaching control youth mobilization) and providing emergency patrols to rescue and release injured wildlife when necessary. There are 89 CBAPUs working in buffer zones in Bardiya and Kailali districts with a combined total of 641 members (418 male, 223 female).

Surveys found that awareness of local planning processes was particularly low among residents. Only 6% said they had been aware of either LAPA or CAPA processes, which, by design, are intended to be participatory and inclusive.

In the Lower Karnali watershed, 54% of respondents claimed affiliation with at least one community group: either a savings credit group (41%), cooperative (36%), CFUG (30%), farmers group (8%), drinking

water (4%), disaster risk reduction (3%), and water user and irrigation (2%). Regarding leadership positions, only 9.6% claimed to be in decision-making roles.

Related annexes
Annex 17: Community user forest groups
Annex 19: Irrigation user groups
Annex 20: Water and sanitation user groups

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.

Climatic hazards like inundation, river cutting and deposition are the major issues of this watershed. Marginalized communitis have been vulnerable due to frequent events every year in the flood plain of the watershed. People in the watershed are adopting different methods to cope with the situation. Water source protection, plantation, gabion wall construction, and early warning system (DRR information system) are the major coping strategies of people in the watershed. In fact, 27.5% of households were found using at least one coping strategy.

4.2.1 CLIMATE CHANGE ADAPTATION AND DISASTER RISK REDUCTION

In the Lower Karnali watershed, floods and river cutting mean that climate-smart and climate-resilient practices are crucial for households to recover from natural hazards and minimize future ones. Surveys found that only 28% of households currently employ a climate adaptation practice while 20% have adopted three or more (table 11).

Table 11: Percentage of households adopting various climate adaptation practices and technologies

Adaptation practice or technology	% of households adopting (n=2,261)
Adopting alternative livelihood	6.3
Bio-embankment	19.0
Drip irrigation	1.0
Drought resistance varieties	2.4
Gabion boxes	44.3
Irrigation canals	0.8
Plastic pond or cement tank	0.3

Re-plantation of barren land	84.7
Resettling household	20.1
Shallow tube well	20.0
Solar irrigation	1.1
Tunnel farming	1.3
Using improved seeds	2.4
Water source protection	100.0

A vulnerability assessment of the watershed (Table 12) conducted by the Ministry of Foresty and the Environment emphasized the need for systematic adapation and disaster risk reduction planning. Local Adapation Plans of Action (LAPAs) and Community Adapation Plans of Action (CAPAs) are two vehicles for establishing such plans with input of potentially-affected stakeholders. To date, 16 LAPAs and 43 CAPAs have been prepared across 19 VDCs in the Lower Karnali watershed (Figure 19).

Despite these seemingly impressive numbers, very few respondents claimed knowledge about these planning processes: only 28% were aware of LAPAs, and 21% aware of CAPAs in their regions.

Table 12: Vulnerability ratings by VDC and prepared LAPAs and CAPAs in each

District	VDC	Vulnerability rating	# of LAPA	# of CAPA
Bardiya	Bhimapur	Moderate	1	5
	Daulatpur	Moderate	0	6
	Dhodhari	Moderate	1	0
	Gola	Very high	1	0
	Khairi Chandanpur	High	1	0
	Manau	Very high	1	0
	Neulapur	High	1	3
	Patabhar	High	1	3
	Rajapur	Moderate	0	8
	Sivapur	High	1	0
	Suryapatawa	High	1	0
	Thakudwara	High	1	0
Kailali	Baliya	Very high	1	5

	Dhansinghapur	Very high	1	2
	Durgauli	High	0	2
	Narayanpur	High	1	2
	Pathariya	High	1	4
	Sugarkhal	Very high	1	1
	Tikapur	High	1	2
		TOTAL	**16**	**43**

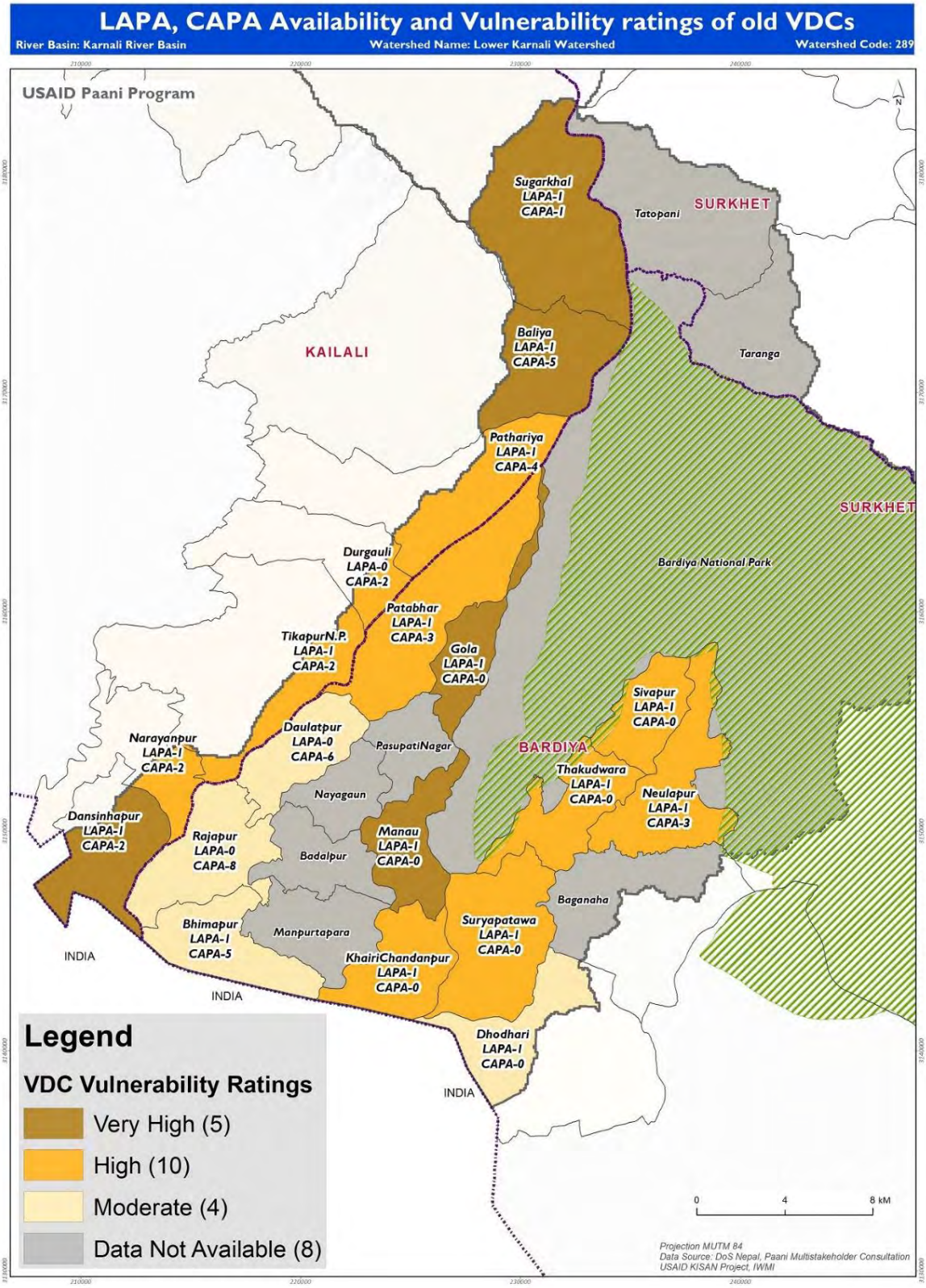

Figure 19: Map of VDCs that have implemented LAPA and/or CAPA

Key informant interviews in the watershed turned up other important examples of adapation planning. In Tikapur NP, the local government will deduct 3% of its annual capital budget to provide relief to disaster victims. Similar, though less specific, stipulations will also be included in the annual plans of Lamkuchuha NP and Geruwa GP.

4.2.2 NATURAL RESOURCE MANAGEMENT (NRM) GROUPS AND ACTIVITIES

As in most watersheds in Nepal, the user group is the central form of community-based NRM – for forests, irrigation, and water and sanitation. There are 176 community forest user groups (CFUG) in Lower Karnali, responsible for 18,152 ha of forests and representing 42,636 households. In addition, there are 35 buffer zone community forest groups (BZCF) in Lower Karnali. These groups monitor and take responsibility for 2,410 ha of forests on the periphery of Bardiya National Park and represent 4,349 households.

As noted above (section 3.3.4), the FMIS in Lower Karnali is renowned for its success in providing water to farmers and families throughout the year. The success of this system has helped to spawn a large and sophisticated administrative system to oversee its operation. Fifty-seven *maujas* (community irrigation groups) manage systems that cover more than 6,000 hectares. The *maujas* are not only responsible for the hardware of the irrigation system, but also for dispute resolution and development activities within their boundaries. The benefits of FMIS are more than material, however. Interviews revealed that many local stakeholders and leaders credit FMIS with raising community awareness about the need for conserving biodiversity and the role of irrigation in that process.

Related annexes

Annex 17: Community user forest groups
Annex 19: Key stakeholders – organizations and offices

4.3 GOVERNANCE

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

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

Watersheds, however, present a unique challenge to local governance. As Lower Karnali extends over three provinces and 11 municipalities, there is not a regulatory framework in place to help local governments coordinate efforts and collaborate on biodiversity and natural resource issues. However, it should be noted that this lack also presents a promising opportunity.

Related annexes

Annex 18: Existing policy provisions and status of enforcement
Annex 19: Key stakeholders – organizations and offices

5. PRIORITIZING THREATS IN THE WATERSHED

Stakeholders in the Lower Karnali watershed were asked to list their environmental concerns, particularly in relation to associated anxieties related to sustainability and livelihoods. As many residents in the Lower Karnali depend closely on natural resources to support their households, stakeholders cited declining fish numbers and vulnerability to natural hazards as major concerns. The full summary of environmental priorities is presented in Table 13.

Table 13: Environmental issues by theme and priority in the Lower Karnali watershed

Theme	Issue	Priority
Aquatic life	Declining fish numbers and aquatic biodiversity	Very high
	Loss of traditional fishing communities	Very high
	Invasive water hyacinth	Very high
Water management	Shrinking lakes, ponds and wetlands	High
Disaster risk reduction	Climate-induced hazrds such as andslides and river cutting	High

Source: Multi Stakeholder Consultation Workshop

6. THREATS AND OPPORTUNITIES

Having identified the major threats to biodiversity and sustainable natural resource use, stakeholders then noted potential opportunities where concerted action could bring about desired change (Table 14).

Table 14: Environmental threats and opportunities in the Lower Karnali watershed

Theme	Issue	Opportunities
Aquatic life	Declining fish numbers and aquatic biodiversity	• Identify spawning, nurturing and fishing zones in the river to assess fish vulerability • Control runoff and soil erosion in the upstream areas • Promote community awareness about the need for improved aquatic habitats
	Loss of traditional fishing communities	• Mobilize river-dependent community groups to support aquatic life initiatives • Support local government to enforce conservation-related laws and policies • Brand and promote marketing for fish products • Support livelihood diversification for traditional fishing communities that link them with eco-tourism initiviates
	Invasive water hyacinth	• Promote awareness of the effects of invasive species • Coordinate water hyacinth removal efforts
Water management	Shrinking lakes, ponds and wetlands	• Strengthen wetland conservation committees
Disaster risk reduction	Climate-induced hazrds such as landslides and river cutting	• Establish early warning system for the watershed • Promote bio-engineering methods to alleviate natural hazard impacts • Integrate aquatic biodiversity elements into local environmental plans (e.g., LAPA, CAPA, LDRMP).

7. VISION AND MISSION OF THE LOWER KARNALI WATERSHED

7.1 VISION FOR THE LOWER KARNALI WATERSHED

At a vision-building workshop held in December 2017, participants were divided into three groups (nature, wealth and power) to draft separate statements for the watershed as they wished to see it 20 years from now. These three statements were then combined for a single vision statement: "For a Lower Karnali watershed with equitable access to natural resources, and sustainable use that conserves biodiversity."

7.2 COMMITMENT TO CONSERVATION OF THE LOWER KARNALI WATERSHED

Using the threats and opportunities to watershed health (Table 15), participants at the exit workshop described what they intended to do within their capacity to act (i.e., as resident, government official, or NGO representative) and the outcomes expected from this activity.

Table 15: Action commitments and expected outcomes by theme

SN	Theme	Major Activities	Expected outcomes
1	Climate change and aquatic biodiversity conservation	• Mobilizing CBAPUs • Capacity building of river communities • Implement river stretch management • Support regulatory framework • Use bioengineered and low-cost technologies for adaptation measures • Strengthen capacity of NRM user groups • Extend in-situ conservation program • Conserve aquatic habitats and fish species	• Improved regeneration of forests and biodiversity • Strengthened cooperation between upstream and downstream communities • Improved support for sustainable resource management • Improved fish populations and fish species diversity • Improved resilience to climate change impacts • Improved waste sanitation in the watershed
2	Physical infrastructure and disaster management	• Plantation and embankment • Promotion of bioengineering • Check dam and spur construction • Prepare master plan for rural road construction • Implement building codes	• Enhanced plant and forest cover and hillside stability • Improved responsiveness to disaster management • Increased capacity to adapt to climate change impacts

SN	Theme	Major Activities	Expected outcomes
		• Prepare LAPAs, LDRMPs, and WUMPs	
3	Water availability and water quality	• Sewage management • Solid waste management • Protect and improve water sources • Conserve natural ponds and construct artificial ponds and rainwater harvesting systems • Employ more solar pumps • Use Dhiki pumps • Manage waste and sludge disposal • Strengthen forest management and forest fire control	• Increased access to water and more sustainable use of water • Fewer conflicts over water use • Improved water quantity and quality • Fewer water-borne diseases • Increased ground water availability • Increased food production • Improved food security nutrition status for all families
4	Livelihoods	• Livelihood diversification • Promotion of fish farm • Engage stakeholders to minimize flood and landslide risks • Prepare mining guidelines at local level • Promote awareness about the long-term impacts of pesticide use • Provide training on composting manure • Conserve traditional skills and livelihood options • Develop commercial potential of traditional skills	• Incomes of fish-dependent communities will improve • Reduction in destructive fishing methods • Decreased use of pesticides • Improved watershed and human health • Increased employment opportunities • Protection and development of traditional skills to seam with current markets
5	Governance, policy, and gender and social inclusion (GESI)	• Initiate dialogue with park for easy access to regulated fishing in park area • Promote sustainable fishing practices • Form policy and guidelines at local level for biodiversity conservation and climate change adaptation • Form a joint committee of the watershed's four rural municipalities to discuss watershed health-related issues • Conduct more studies on the impacts of sand and gravel mining in the watershed	• Greater implementation of policy and guidelines • More evidenced-based studies to inform policy-making • Formal policy to create joint watershed team formalized • A common understanding of conservation issues and watershed health developed

8. RECOMMENDATIONS

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

- Register the Bhagaraiya Lake Management Committee with local government authorities and strengthen its capacity to address current environmental challenges in that water body (e.g., shrinking; diminishing water quality);
- Implement and support community-based river stretch management to enable more effective biodiversity conservation through local action and regulation;
- Complete a biodiversity registry for the Lower Karnali watershed, including list of key fish species and their movement patterns;
- Promte in-situ and ex-situ conservation practices for capture fishery in Parashuram Kund lake;
- Enforce prohbitions and penalties against destructive fishing practices and overharvesting of fish in the watershed;
- Promote eco-tourism options (e.g., rafting) for river-based communities as an alternative livelihood option;
- Introduce mitigation measures for reducing agricultural runoff and soil erosion in the upstream areas of the watershed;
- Support development of inclusive and progressive capture fishery policies by providing relevant information to local decision-makers;
- Mobilize CBAPUs to monitor key fish species in the watershed;
- Strengthen capacity of lake management committees to manage water resources and pursue governmental and non-governmental funding;
- Develop restoration initiative for Bhagariya Lake, including invasive species removal;
- Increase collaboration with local stakeholders and minimize effects of flooding through improved soil erosion management;
- Strengthen adapative capacities of traditional communities are dependent on water and river-related natural resources for maintaining their livelihoods;
- Form networks linking upstream and downstream communities to generate coordinated water use and disaster risk reduction plans;
- Install early warning systems throughout the watershed to improve reaction time and awareness of floods and flood conditions;
- Support local government institutions to develop inclusive planning documents such as LAPA, CAPA and WUMP, with input from local stakeholders;
- Open dialogue with downstream barrage authorities (at Kailashpuri and Girijapuri) to negotiate increased fish passage through the area; and
- Gather georeferenced data on aquatic biodiversity and biodiversity hotspots to inform future decision-making.

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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 Lower 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 Lower 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 Lower Karnali area where PANI and other projects can provide support; and
- Providing a platform for consultation and advocacy for Lower 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

    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 explore in-depth information related to issues identified from multi-stakeholder consultation workshop.

5. KIIs were also conducted to collect qualitative information related to issues collected from multi-stakeholder consultation workshop. 6. The consolidated data collected through these methods were presented in exit MSC workshop to share findings from watershed profiles, and prioritizing watershed health issues in Lower Karnali watershed. The HH survey data (Table 16) 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. To complement the surveys, we conducted 8 FGDs and 13 KIIs to investigate the key issues identified from entry multi-stakeholder

consultation workshop. Water quality and discharge were measured by Paani staff using the Akvo Flow Mobile App.[5]

Figure 20: Methodological approach illustrated

Table 16: Household surveys by topic and number conducted

Subject	Number conducted
Biodiversity and climate change	2,261
Water sources	1,452
Livelihood and well-being	2,456
Water quality and sanitation	2,185
TOTAL	8,354

Table 17: Number of participants by caste/ethnicity participating in detailed research fora

Method	Number of events	Dalit	Janajati	BCT
Multi-stakholder consultation	3	19	47	36
Key informant interview	15	2	2	11
Focus group discussion	17	24	26	142
	35	**45**	**75**	**189**

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

Annex 2: Land use and land cover

Table 18: Land use and land cover by type, area, and percentage in the Lower Karnali watershed

Type	Area (km^2)	Percentage
Cultivation	298.88	34
Forest	481.97	55
Grazing	15.71	2
Settlement	0.12	0
Lake, pond, reservoir	0.22	0
Rivers and streams	78.43	9
TOTAL	**875.34**	**100**

(Source: Survey Department Nepal, 2002)

Annex 3: Population

Table 19: Population by municipality, sex, and caste/ethnicity

Location	Male	Female	Janajati	BCT	Dalit	Madhesi	Newar	Other	Total
Barahtal GP	361	369	79	585	65	0	0	0	729
Geruwa GP	16,434	18,437	23,574	8,066	2,312	314	119	485	34,871
Janaki GP	1,560	1,966	2,191	848	487	0	0	0	3,526
Madhuwan NP	7,257	7,936	11,981	2,133	989	7	8	74	15,193
Mohanyal GP	1,659	1,954	144	2,067	1,376	0	0	25	3,613
Panchpuri NP	1,010	1,192	24	1,462	693	0	23	0	2,202
Rajapur NP	28,921	30,632	47,508	7,099	2,729	802	160	1,255	59,553
Thakurbaba NP	17,756	20,226	22,082	12,534	2,917	213	117	118	37,982
Tikapur NP	6,271	6,986	3,835	7,080	1,374	364	203	400	13,257
TOTAL	**81,229**	**89,698**	**111,418**	**41,874**	**12,942**	**1,700**	**630**	**2,357**	**170,926**

Annex 4: Precipitation and Temperature

Table 20: Meteorological stations in the Lower Karnali watershed

Station	Type	District	Latitude	Longitude	Elevation (m)
Chisapani (Karnali)	Meteorological	Bardiya	28.39	81.16	225
Gulariya	Precipitation	Bardiya	28.10	81.21	215
Rajapur	Precipitation	Bardiya	28.26	81.06	129
Shyano shree (Chepang)	Precipitation	Bardiya	28.21	81.42	510
Rani Jaruwa Nursery	Meteorological	Bardiya	28.23	81.21	200
Tikapur	Meteorological	Kailali	28.32	81.07	140
Jamu (Tikuwa Kuna)	Precipitation	Surkhet	28.47	81.20	260

Annex 5: Lakes, streams, rivers, and wetlands in the Lower Karnali watershed

Table 21: Water bodies in the Lower Karnali watershed

Type	Name	Location	Length (km)
River	Karnali River	NA	32.191
	Geruwa River	NA	52.263
Stream	Ambasa Khola	NA	29.31
	Khaurohi Khola	NA	38.552
	Rani Khola	NA	14.462
	Orai Khola	NA	42.02
	Dondra Khola	NA	15.081
	Githe Khola	NA	22.323
Headwater stream	Badali Khola	NA	1.599
	Bahula Khola	NA	2.255
	Baka Khola	NA	3.603
	Basgadi Khola	NA	2.146
	Bhadali Nala	NA	5.518
	Bhalumare Khola	NA	2.602
	Bheri Nadi	NA	0.216
	Bhurakhan Khola	NA	3.052
	Buka Khola	NA	2.364
	Bungad Khola	NA	8.503
	Chisa Khola	NA	2.869
	Chune Pagar Khola	NA	2.731
	Chyure Khola	NA	0.11
	Dama Khola	NA	0.318
	Damakantar Khola	NA	8.782
	Deurali Khola	NA	3.397
	Dhadbas Khola	NA	7.358

	Dhanchhare Khola	NA	7.846
	Dharapani Khola	NA	3.677
	Dobhan Khola	NA	0.216
	Dundre Khola	NA	9.832
	Gumna Nadi	NA	7.071
	Hadepani Khola	NA	1.719
	Jamara Nadi	NA	4.68
	Jhamati Khola	NA	9.226
	Jyamire Khola	NA	0.056
	Kachali Khola	NA	7.59
	Karmala Sota	NA	9.761
	Kewadi Khola	NA	6.493
	Khahare Khola	NA	4.397
	Khar Khola	NA	10.624
	Khare Khola	NA	6.887
	Khayarbhatti Khola	NA	5.683
	Kholi Bajar Khola	NA	2.924
	Madesepani Khola	NA	3.422
	Mahagad Khola	NA	0.047
	Male Pagara Khola	NA	4.339
	Mohana Nadi	NA	4.318
	Okhateni Khola	NA	5.149
	Pani Khola	NA	3.342
	Pitmari Khola	NA	3.229
	Rajkada Khola	NA	2.345
	Sagure Khola	NA	5.042
	Salghari Khola	NA	3.02
	Satdundra Khola	NA	5.633

	Saure Khola	NA	3.324
	Siddha Khola	NA	2.231
	Sunganiya Sota	NA	7.882
	Taule Khahare	NA	2.371

Table 22: Rates of river and stream discharge at various temporal scales

Name	Latitude	Longitude	Elevation (m)	Date of measurement	Estimated discharge (L/S)
Banka Khola	28.68309047	81.28095158	156.0	28-01-2018	NR
Kachali Khola	28.69776331	81.27724904	160.0	28-01-2018	50
Kuhine	28.72132264	81.26337982	219.0	28-01-2018	NR
Bungaad	28.67337534	81.28669067	182.0	30-01-2018	168.3
Chisapani (#7 Khola)	28.6312318	81.26201573	180.0	30-01-2018	NR
Chisapani (#8 Khola)	28.63317344	81.26584434	238.0	30-01-2018	NR
Karnali Chisapani	28.64310719	81.28350618	103.0	30-01-2018	NR
Tarawa	28.73137978	81.24748652	172.0	30-01-2018	8.3
Badhi Gaun	28.74562923	81.24309509	195.0	30-01-2018	156.6
Karseni Khola	28.74258643	81.27556922	177.0	30-01-2018	NR
Tribeni Dham (Karnali)	28.74127165	81.25832194	152.0	30-01-2018	NR
Sanghure Khola	28.72138168	81.26325451	164.0	30-01-2018	45.402
Ambasas Khola (Ambasa to Thakurdwara Crossing)	28.51125805	81.31745188	125.0	31-01-2018	30.456
Raanipur	28.4720912	81.31577016	131.0	31-01-2018	111.25
Sujanpur	28.45563408	81.28365538	106.0	31-01-2018	1287.5
Orahi (Raanipur to Thakurdwara Crossing)	28.47675302	81.30565939	108.0	31-01-2018	493.4
Jamti (Bhurigaun to Bagnaha road crossin)	28.43702777	81.31809099	114.0	31-01-2018	13.8
Bhudkaiya Kulo	28.4893151	81.29909269	127.0	31-01-2018	49.6
Orahi (confluence with Geruwa)	28.37338504	81.21362674	89.0	1/2/2018	NR
Kothiya Ghaat	28.36680374	81.20204634	100.0	1/2/2018	NR
Bhagaraiya Lake	28.34691476	81.21938431	82.0	1/2/2018	NR
Orahi (Thakurdwara to Orali Bazar Crossing)	28.39677594	81.24039574	77.0	1/2/2018	NR
Taratal	28.28356571	81.24550765	115.0	1/2/2018	NR
Satt Ghaat	28.43349422	81.07383666	80.0	2/2/2018	NR
Geruwa	28.36376309	81.19694377	84.0	2/2/2018	NR

Kalakunda	28.45519046	81.02496955	76.0	2/2/2018	NR
Geruwa (Rajapur side branch)	28.37278409	81.19515219	74.0	2/2/2018	NR
Geruwa (Khairichandanpur)	28.36928398	81.18956168	100.0	2/2/2018	NR
Shantipur Bridge	28.41865874	81.11532325	86.0	2/2/2018	NR

Discharge

Long-term daily discharge measurement in Karnali River was carried out at Chisapani and was analyzed from 1962 to 2006 to obtain flow characteristics. The mean monthly flow is shown in Figure 21. Mean flow during pre-monsoon (Mar - May), monsoon (Jun – Sep), post-monsoon (Oct – Nov) and winter (Dec – Feb) seasons are 507 m3/s, 2,993 m3/s, 959 m3/s, 368 m3/s and 39.3 m3/s, respectively. The observed long-term average annual discharge shows an increasing trend at the rate of 0.612 m3/s/ year (figure 22). Discharges during pre-monsoon, post-monsoon are also observed to have increasing trend. However, the river discharge trend during the monsoon season is observed to be decreasing at the rate of 0.76 m^3/s year. Since Lower Karnali watershed is located at, the outlet of the Karnali River basin the trend observed in the river discharge is the result of changes in climatic variables at the river basin scale rather than the changes at the Lower Karnali watershed scale.

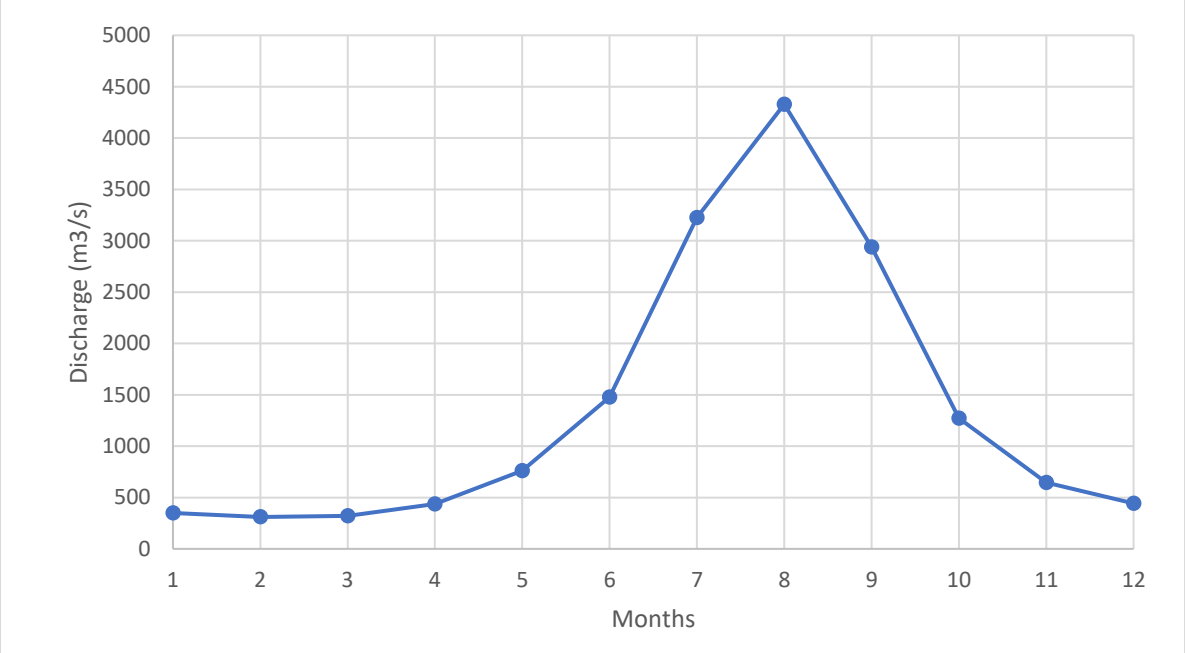

Figure 21: Average monthly flow rate measured on the Karnali River at Chisapani station

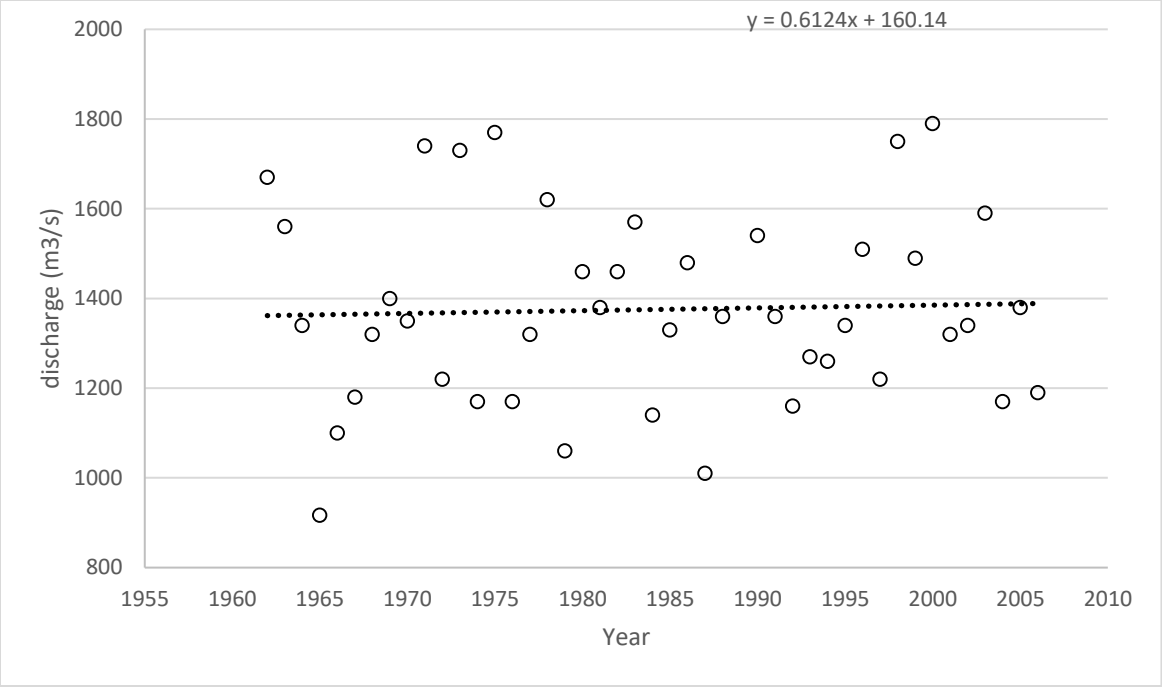

Figure 22: Average annual rates in the Karnali River at Chisapani station

Annex 6: Forest types and species

Table 23: Forest types in the watershed area

Forest Type	Area (km^2)	Percentage
Mixed hardwood	215.4	45
Sal Forest	242.3	50
Mixed hardwood	14.2	3
Pine Forest	6.5	1
Sisau (sisam)	3.5	1
Total	**481.9**	**100**

Source: DFRS 2014, Department of Forest, Nepal

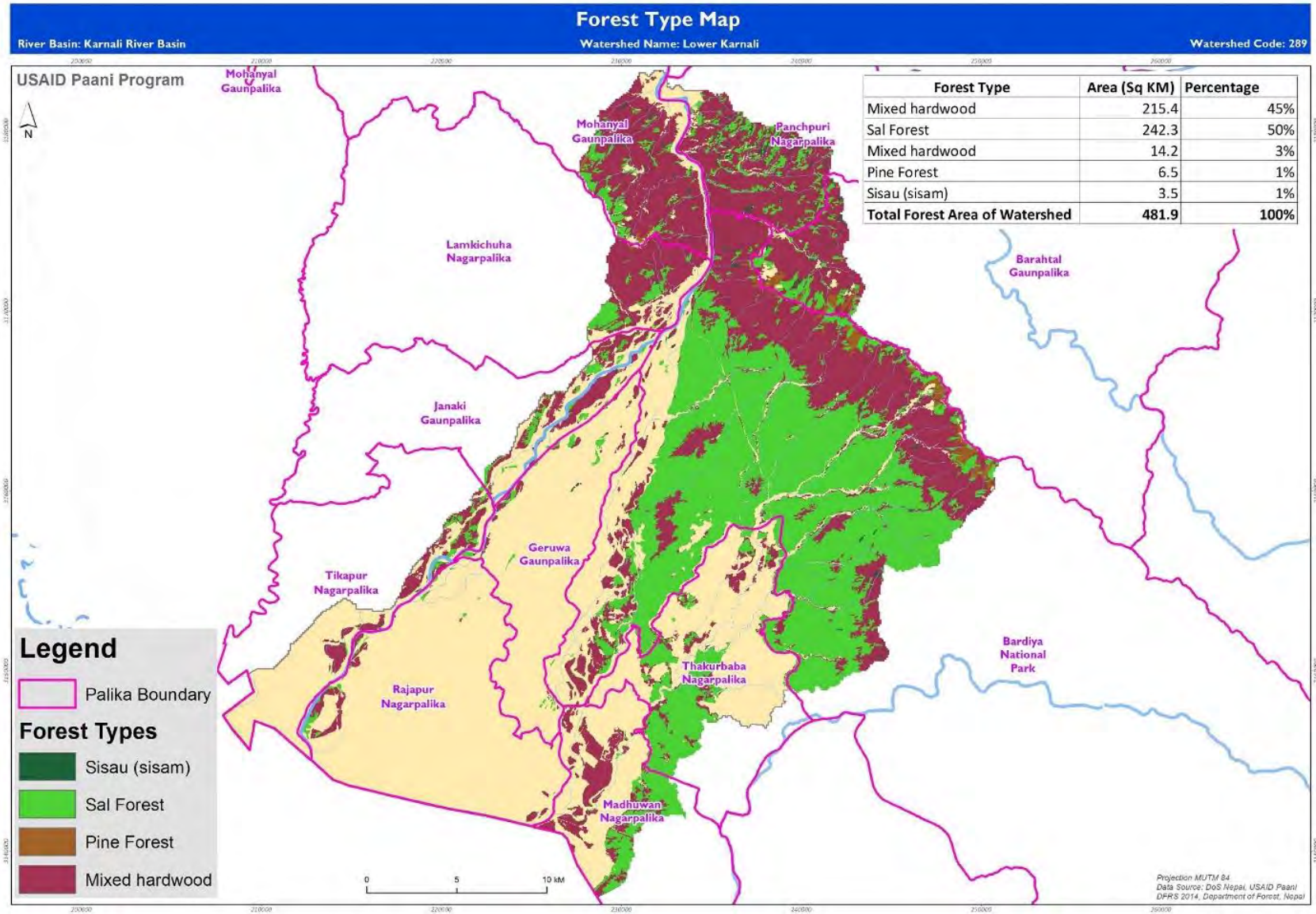

Figure 23: Map of forest cover in the Lower Karnali watershed by type

Annex 7: Climate change impacts biodiversity and vulnerabilities

Table 24: Climate hazards in the Lower Karnali watershed, related impacts, and communities affected

Type	Affected communities	Impacts	Priority	Basis of prioritization
Flooding	Tikapur, Narayanpur, Dhansinghpur, Madbuban, Geruwa, Rajapur, Thakurbaba	Loss of cultivable land Human and property loss Loss of aquatic animal	Very high	MSC
Inundation	Tikapur, Narayanpur, Dhansinghpur, Madbuban, Geruwa, Rajapur, Thakurbaba	Deposition Human and property loss Loss of cultivable land	Very high	MSC
River cutting, soil erosion	Mohonyal, Tikapur, Panchapuri, Barahatal, Dhansinghpur, Narayanpur	Loss of agricultural land Degradation of aquatic habitat	High	Field observation
Drought	Mohonyal, Panchapuri, Barahatal	Productivity loss	Moderate	Field observation

Annex 8: Fish in the Lower Karnali watershed

Table 25: Fish diversity by order, family and species in the Lower Karnali watershed

SN	Order	Family	# of species
1	Clupiformes	Clupeidae	2
		Notopteridae	2
2	Cypriniformes	Cyprinidae	50
		Psilorhynchidae	2
		Homalopteridae	1
		Cobitidae	11
3	Siluriformes	Bagridae	6
		Siluridae	2
		Schilbeidae	6
		Saccobranchidae	1
		Claridae	1
		Amblycipitidae	1
		Sisoridae	12
4	Antheriniformes	Belonidae	1
5	Channiformes	Channidae	5

Table 26: Spawning, nurturing and fishing zones in the Lower Karnali watershed area

River or stream	Nearest settlement	Nursing site	Spawning site	Overfishing site
Geruwa	Bajhpur		X	
	Banjariya	X		
	Gola		X	
	Guptipur	X		
	Janaknagar, Shantipur		X	
	Jodhipur, Dangpur	X		
	Khallagaun	X		
	Kothiyaghat	X		X
	Majahara, Lalpur			X
	Manaun	X		
	Nauranga	X		
	Patharbojhi			X
	Pitamari	X	X	
	Sonahaphata		X	
	Badigaun			X
	Balchaur			X
	Bangala			X
	Chisapani			X
	Dalai			X

River or stream	Nearest settlement	Nursing site	Spawning site	Overfishing site
Karnali	Daulatpur			X
	Dhansinghpur			X
	Khakraula			X
	Kuine			X
	Sankatti	X		
	Sarkhol		X	
	Semareni, Daulatpur			X
	Shankarpur	X		
	Sitapur		X	
	Sonaha Gaun			X
	Sonaha Gaun, Jagatpur			X
	Tigraha	X		

Table 27: Threats to key fish species in the Lower Karnali watershed

SN	Threats	Kalanch	Mahaseer	Gardi
1	Destructive fishing practices	High	Very high	High
2	Decreasing water levels in rivers and lakes	High	Medium	-
3	Gravel mining	Medium	Very high	High
4	Lack of regulations and enforcement	High	Very high	-
5	Overharvesting	High	High	-
6	Increased pesticide use	Low	Medium	Low
7	Fishing during breeding season	-	Very high	Very high
8	Floods and poisonous weeds	-	High	High
9	Rising demand for fish in the market place	-	Very high	Medium
10	Degradation of aquatic habitats	-	Very high	-

Source: Paani fish vulnerability assessment 2018

Table 28: Full list of fish species found in the Lower Karnali watershed, including local names

Order	Family	Species	Local names
Clupiformes	Clupeidae	Gudusia chopra	Suiya, Darahai, Fuliya
		Gudusia godanahiai	Suiya, Darahai, Fuliya
	Notopteridae	Notopterus notopterus	Golhai, Darahai, Fuliya
		Notopterus chitala	Mohi, Patara
Cypriniformes	Cyprinidae	Accrossocheilus hehexagonolepis	Katle
		Aspidoparia jaya	Mara
		Aspidoparia morar	Harda, Bhegna, Karangi, Karhawa

Order	Family	Species	Local names
		Amblypharyngodon mola	Piruwa
		Barilius barila	Chahale
		Barilius barma	Faketa, Poti
		Barilius bendelisis	Feketa, Gudari, Jhojha
		Barilius bola	Bola
		Barilius jalkapoorei	Jalkapoor
		Barilius shacra	Fageta, Jhilke
		Barilius tilea	Tikahinia
		Barilius vagra	Tikahinia
		Catla catle	Bhakur, Catlogi
		Changunius changuniyo	Patherchatti, Gorahi, Kubre
		Cirrhinus mrigala	Rewa, Naini
		Cirrhinus reba	Rewa
		Crossoheilus latius	Kachara, Lohori
		Chela cacius	
		Chela laubuca	Deduwa
		Daniyo dangila	Deduwa
		Daniyo devariyo	Chitharipothi
		Daniyo reriyo	Zebra
		Esomus danricus	Darai, Deduwa
		Garra annanndalei	Buduna
		Garra lamta	
		Labeo angra	Thed, Thunde, Klanch
		Labeo baga	Thilke
		Labeo calbasu	Klanch, Basarahill
		Labeo dero	Gurdi, Rohu, Kathalegi
		Labeo dyocheilus	Gurdi, Kalancha
		Labeo rohita	Rohu
		Osteobrama cotio	Chanawro, Gurda
		Oxygraster argentea	Namsehara
		Oxygraster bacaila	Chelwa
		Oxygraster gora	
		Oxygraster phulo	
		Puntius Chilinoides	Sidhra
		Puntius chola	Sidhara, Sidre, Pothi
		Puntius conchonius	Sidhara, Sidre
		Puntius gelius	
		Puntius sarana	Kunde, Bada, Pothi, Sidhara
		Puntius sophore	Pothi, Sidhara, Chandapothi
		Puntius ticto	Sidhara, Pothi, Potina, Darahi
		Rosbora daniconius	Dedhawa
		Schizothoraichthys annandalei	Thude, Asala
		Schizothoraichthys progastus	Chuche, Asala
		Schizothorax plagioustomus	Asala
		Semiplotos semiplotus	Padhani, Chepti
		Tor putitora	Chawar, Sahar, Mahseer

Order	Family	Species	Local names
		Tor tor	Sahar
	Psilorhynchidae	Physilorhynchus balitora	
		Physilorhynchus sucatio	Pathachatti
	Homalopteridae	Balitora brucei	Titae, Patherchatti
	Cobitidae	Botia almorhae	Baghe
		Botia lohachata	Getu, Baghe
		Botia dayi	Getu
		Lepidocephalichthys guntea	Lata, Goira
		Noemacheilus beavani	Gadela, Pate Goira, Kanelani
		Noemacheilus botia	Gadela
		Noemacheilus corica	Kholumachha
		Noemacheilus rupicola	Gadela
		Noemacheilus rupecola var inglishi	Kholumachha
		Noemacheilus Savona	
		Somileptus gongota	Latani, Goira
Siluriformes	Bagridae	Mystus bleekeri	Tengra, Katena
		Mystus Cavasius	Tengra, Punge, Palawa, Katena
		Mystus Seenghala	Kanti, Sujnha
		Mystus Tengara	Tengri
		Mystus Vittatus	Tengra
		Rita tita	Rita, Belunda
	Siluridae	Ompok bimaculatus	Voktam, Chottari, Pabata, Lalmuha, Chachara
		Wallago attu	Buhari, Padani, Ghoptari, Ghugunes
	Schilbeidae	Ailia coila	Sutara, Patanga
		Clupisoma garua	Baikha
		Uutropichthys vacha	Baikha, Bachawa
		Pseudeutropius atherinoides	Jalkapoor, Patasi)
		Pseudeutropius mirius	Baikha, Jalkapur
		Silonia silondia	
	Saccobranchidae	Hetetopneustes fossilis	Singhi
	Claridae	Clarias batrachus	Mungri, Mangur
	Amblycipitidae	Amblyceps mangois	Bindhar, Pichhi
	Sisoridae	Bagarius bagarius	Gonch, Thend, Gochara, Baghai
		Erethistes pussilus	
		Gagata cenia	Tikthi, Gogta
		Glyptothorax cavia	Capree, Vendro
		Glyptothorax conirostris	
		Glyptothorax horai	Kotel, Kathel
		Glyptothorax pectinopterus	Karasingha, Capree, Dupmachha
		Glyptothorax ribeiroi	
		Glyptothorax telchitta	Kotel

Order	Family	Species	Local names
		Glyptothorax trilineatus	Kavre
		Hara hara	
		Pseudecheneis sulcatus	Kavre, Marcha
Antheriniformes	Belonidae	Xenentodon cancila	Chuchche Bam, Kauwar, Dangawa, Sui
Channiformes	Channidae	Channa gachua	Hilae, Charangi, Chenga
		Channa marulius	Sauri, Bhaura
		Channa orientalis	Chanrangi
		Channa punctatus	Hilae, Charangi, Bhote, Gauri
		Channa striatus	Charangi, Sauri
Synbranchiformes	Amphipnoidae	Amphipnous cuchia	Bam
Perciformes	Centropomidae	Chanda nama	Nata channa
		Chanda Ranga	Bhitte, Chanri
	Nandidae	Badis badis	Khesalei, Khesaki
		Nadus nandus	Dhala, Dewan
	Mugilidae	Siscamugil cascasia	Rewa
		Rhinomugil corsula	
	Gobiidae	Glossogobius giuris	Bulla
	Anadantidae	Anabas testudinus	Kabai, Kerkhi
		Kolisa fasciata	Katara, Khesra
		Kolisa lalia	
Anguilliformes	Anguillidae	Anguilla bengalensis	Rajbam
Mastacembeliformes	Masticembelidae	Macrognathus aculeatus	Gainchi, Bamali
		Mastacembelus armatus	Chusi Bam
		Mastacembelus pancalus	Kath Gainchi

Annex 9: Mammals in the Lower Karnali watershed

Table 29: List of mammals in the Lower Karnali watershed, including IUCN Red List Status

Scientific name	Common	Nepali	IUCN Red List Status
Macaca assamensis	Assam Macaque	Asami Rato Bandar	Vulnerable
Manis pentadactyla	Chinese Pangolin	Kalo Salak	Endangered
Manis crassicaudata	Indian Pangolin	Tame Salak	Endangered
Caprolagus hispidus	Hispid Hare	Laghukarna Kharayo	Endangered
Canis lupus	Grey Wolf	Bwanso	Critically endangered
Ursus arctos	Brown Bear	Himali Rato Bhalu	Critically endangered
Ailurus fulgens	Red Panda	Habre	Endangered
Prionodon pardicolor	Spotted Linsang	Silu Biralo	Endangered
Felis bengalensis (Prionailurus bengalensis)	Leopard Cat	Chari Bagh	Vulnerable
Felis lynx (Lynx lynx)	Lynx	Pahan Biralo	Vulnerable
Neofelis nebulosa	Clouded Leopard	Dwanse Chituwa	Endangered
Panthera tigris	Royal Bengal Tiger	Pate Bagh	Endangered
Panthera uncia (Uncia uncial)	Snow Leopard	Hiun Chituwa	Endangered
Elephas maximus	Asian Elephant	Hatti	Endangered
Rhinoceros unicornis	One-horned Rhino	Gainda	Endangered
Sus salvanius	Pygmy Hog	Pudke Bandel	Endangered
Moschus chrysogaster	Alpine Musk Deer	Kasturi Mriga	Endangered
Cervus duvauceli	Swamp Deer	Bahrasingha	Endangered
Antilope cervicapra	Blackbuck	Krishnasar	Critically endangered
Tetraceros quadricornis	Four-horned Antelope	Chauka	Data deficient
Hyaena hyaena	Striped Hyaena	Hundar	Endangered
Platanista gangetica	South Asian River Dolphin	Shons	Critically endangered

Annex 10: Reptiles in the Lower Karnali watershed

Table 30: List of reptiles in the Lower Karnali watershed

Scientific name	Common	Nepali
Gavialis gangeticus	Gharial Crocodile	Gharial Gohi
Python molurus	Asiatic Rock Python	Ajingar
Varanus flavescens	Golden Monitor Lizard	Sun Gohoro

Annex 11: Birds in the Lower Karnali watershed

Table 31: List of birds in the Lower Karnali watershed, including IUCN Red List status

Scientific name	Common	Nepali	IUCN Red List status
Buceros bicornis	Giant Hornbill	Raj Dhanes	Rare
Catreus wallichii	Cheer Pheasant	Cheer	Rare
Houbaropsis bengalensis (Eupodotis bengalensis)	Bengal Florican	Khar Mayur	Rare
Ciconia nigra	Black Stork	Kalo Bhundiphor	Vulnerable
Ciconia ciconia	White Stork	Seto Bhundiphor	Rare
Tropan satyra	Crimson-horned Pheasant	Munal	Rare
Sypheotides indica (Eupodotis indica)	Lesser Florican	Sano Khar Mayur	Rare
Grus antigona	Saras Crane	Saras	Rare

Table 32: Full list of bird species found in Bardiya National Park

	Common name	Scientific		Common name	Scientific
1	Great Crested Grebe	Podeceps cristatus	217	Imperial Eagle	Aquila heliaca
2	Little Grebe	Tachyboptus ruficollis	218	Bonelli's Eagle	Hieraatus fasciatus
3	Darter	Anhinga melanogaster	219	Booted eagle	Hieraatus pennatus
4	Great Cormorant	Phalacrocorax corba	220	Rufous Bellied Eagle	Hieraatus kienerii
5	Little Cormorant	Phalacrocorax niger	221	Changeable Hawk Eagle	Sprizaetus cirrhatus
6	Little Egret	Egretta garzetta	222	Mountain Hawk Eagle	Sprizaetus nipalensis
7	Great Egret	Casmerodius albus	223	Collared Falconet	Microhierax caerulescens
8	Intermediate Egret	Mesophoyx intermedia	224	Common Kestrel	Falco tinnunculus
9	Cattle Egret	Bubulcus ibis	225	Eurasian Hobby	Falco subbuteo
10	Indian Pond Heron	Ardeola grayii	226	Oriental Hobby	Falco severus
11	Grey Heron	Ardea cinerea	227	Peregrine Falcon	Falco peregrinus
12	Purple Heron	Ardea purpurea	228	Egyptian Vulture	Neophron percnopterus
13	Little Heron	Butorides striatus	229	White-rumped Vulture	Gyps bengalensis
14	Black-crowned Night Heron	Nycticorax nycticorax	230	Long-billed Vulture	Gyps indicus

	Common name	Scientific		Common name	Scientific
15	Yellow Bittern	Lxobrychus sinensis	231	Eurasian Griffon	Gyps fulvus
16	Cinnamon Bittern	Lxobrychus cinnamoneus	232	Cinereous Vulture	Aegypius monachus
17	Black Ibis	Pseudibis papillosa	233	Red-headed Vulture	Sacrogyps calvus
18	Painted Stork	Mycteria leucocephala	234	Indian Pitta	Pitta brachyura
19	Asain Openbill	Anastomus oscitans	235	Hooded Pitta	Pitta sordida
20	Wolly-necked Stork	Ciconia episcopus	236	Long Tailed Broadbill	Psariosomus dalhousiae
21	Black Stork	ciconia nigra	237	Golden Fronted Leafbird	Chloropsis aurifrons
22	Black-necked stork	Ephippiorhynchus asiaticus	238	Orange Bellied Leafbird	Chloropsis hardwickii
23	Lesser Adjutant	Leptoptilos javanicus	239	Brown Shrike	Lanius cristatus
24	Sarus Crane	Grus antigone	240	Bay-backed Shrike	Lanius vittatus
25	Demoiselle Crane	Grus virgo	241	Long-tailed Shrike	Lanius schach
26	Common Crane	Grus grus	242	Southern Grey Shrike	Lanius meridionalis
27	Black Francolin	Francolinus francolinus	243	Grey Backed Shrike	Lunius tephronotus
28	Grey Francolin	Francolinus pondicerianus	244	Red Billed Blue Magpie	Urocissa enthrorhyncha
29	Swamp Francolin	Francolinus Gularis	245	Common Green Magpie	Cissa chinensis
30	Common Quail	Coturnix coturnix	246	Rufous Treepie	Dendrocitta vagabunda
31	Small Button Quail	turnix sylvatica	247	Grey Treepie	Dendrocitta formosae
32	Red Jungle fowl	Gallus gallus	248	House Crow	Corvus splendens
33	Kalij Pheasant	Lophura leucomelanos	249	Large-billed Crow	Corvus macrorhynchos
34	Indian Peafowl	Pavo cristatus	250	Ashy Woodshallow	Artamus fuscus
35	Greylag Goose	Anser anser	251	Eurasian Golden Oriole	Oriolus oriolus
36	Bar-headed Goose	Anser indicus	252	Black-hooded Oriole	Oriolus xanthornus
37	Lesser Whistling Duck	Dendrocygna javanica	253	Maroon Oriole	Oriolus traillii
38	Ruddy Shelduck	Tadorna ferruginea	254	Large Cuckooshrike	Coracina macei
39	Common Shelduck	Tadorna tadarna	255	Black-winged Cuckooshrike	Coracina melaschistos
40	Comb Duck	Sarkidiornis melanotos	256	Black-headed Cuckooshrik	Coracina melanoptera
41	Cotton-Pygmy Goose	Nettapus coromandelianus	257	Rosy Minivet	Pericrocotus roseus
42	Gadwall	Anas strepera	258	Small Minivet	Pericrocitus cinnamomeus

	Common name	Scientific		Common name	Scientific
43	Eurasian Wigeon	Anas penelope	259	Long-tailed Minivet	Pericrocitus ethologus
44	Mallard	Anas platyrhynchos	260	Short-billed Minivet	Pericrocotus brevirostris
45	Spot-billed Duck	Anas poecilorhyncha	261	Scarlet Minivet	Perocrocitus flammeus
46	Common Teal	Anas crecca	262	Bar-winged Flycatcher-shrike	Hemipus picatus
47	Garganey	Anas querquedula	263	Yellow-bellied Fantail	Rhipidura hypoxantha
48	Northern Pintail	Anas acuta	264	White-throated Fantail	Rhipidura albicollis
49	Northern Shoveler	Anasc clypeata	265	White-browed Fantail	Rhipidura aureola
50	Red-crested Poachard	Rhodonessa rufina	266	Black Drongo	Dicrurus macrocercus
51	Common poachard	Aythya ferina	267	Ashy Drongo	Dicrurus leucophaeus
52	Ferruginous Poachard	Aythya nyroca	268	White-bellied Drongo	Dicrurus caerulescene
53	Tufted Duck	Aythya fuligula	269	Crow-billed Drongo	Dicrurus annectans
54	Common Goldeneye	Bucephala clangula	270	Bronzed Drongo	Dicrurus aeneus
55	Common Merganser	Mergus merganser	271	Spangled Drongo	Dicrurus hottentottus
56	Eurasian Wryneck	Jynx torquilla	272	Lesser Racket-tailed Drongo	Dicrurus remifer
57	Rufous Woodpecker	Celeus brachyurus	273	Greater Racket-tailed Drongo	Dicrurus paradiseus
58	Great Slaty Woodpecker	Mulleripicus pulverulentus	274	Black-napped Monarch	Hypothymis azurea
59	Brown-capped Pygmy Woodpecker	Dendrocopos nanus	275	Asian Paradise-flycatcher	Terpsiphone paradisi
60	Grey-capped Pygmy Woodpecker	Dendrocopos canicapillus	276	Common Iora	Aegithina tiphia
61	Fulvous-breasted Woodpecker	Dendrocopos macei	277	Large Wood shrike	Tephrodornis gularis
62	Brown Fronted Woodpecker	Dendrocopos auriceps	278	Common Wood Shrike	Tephrodornis pondicerianus
63	Yellow-crowned Woodpecker	Dendrocopos mahrattensis	279	Brown dipper	Cinclus pallasii
64	Lesser Yellownape	Picus chlorolophus	280	Blue-capped Rock Thrush	Monticola cinclorhynchus
65	Greater Yellownape	Picus flavinucha	281	Blue Rock Thrush	Monticola solitarius
66	Scaly Bellied Woodpecker	Picus squamatus	282	Blue Whistling Thrush	Myophonus caeruleus
67	Grey Headed Woodpecker	Picus canus	283	Orange-headed Thrush	Zoothera citrina
68	Himalayan Flame back	Dinopium shorii	284	Scaly Thrush	Zoothera douma

	Common name	Scientific		Common name	Scientific
69	Black Rumped Flame back	Dinopiun benghalensis	285	Tickell's Thrush	Turdus unicolor
70	Greater Flame back	Chrysocolaptes lucidus	286	Dark Throated Thrush	Turdus ruficollis
71	White Naped Woodpecker	Chrysocolaptes festivus	287	Mistle Thrush	Turdus viscivorus
72	Streak-throated Woodpecker	Picus xanthopygaeus	288	Grey Winged Blackbird	Turdus boulboul
73	Great Barbet	Megalaima virens	289	White Collered Blackbird	Turdus albocinctus
74	Brown Headed Barbet	Megalaima zeylanica	290	Eurasian Blackbird	Turdus merula
75	Lineated Barbet	Megalaima lineate	291	White Browed Shortwing	Brachypteryx major
76	Blue Throated Barbet	Megalaima asiatica	292	Lesser Shortwing	Brachypteryx leucophrys
77	Coppersmith Barbet	Megalaima haemacephala	293	Asian Brown Flycatcher	Muscicapa dauurica
78	Indian Grey Hornbill	Ocyceros birostris	294	Slaty-backed Flycatcher	Ficedula hodgsonii
79	Great Hornbill	Buceros bicornis	295	Red-throated Flycatcher	Ficedula parva
80	Oriental Pied Hornbill	Anthracoceros albirostris	296	Dark-sided Flycatcher	Muscicapa sibirica
81	Common Hoopoe	Upupa epops	297	Rufous-gorgeted Flycatcher	Ficedula strophiata
82	Indian Roller	Coracias benghalensis	298	Snowy-browed Flycatcher	Ficedula hyperythra
83	Dollarbird	Eurystomus orientalis	299	Little Pied Flycatcher	Ficedula westermanni
84	Common Kingfisher	Alcedo atthis	300	Ultramarine Flycatcher	Ficedula superciliaris
85	Stork-billed Kingfisher	Halcyon capensis	301	Slaty blue Flycatcher	Ficedula tricolour
86	White Throated Kingfisher	Halcyon smyrnensis	302	Verditer Flycatcher	Eumyias thalassina
87	Black-capped Kingfisher	Halcyon pileata	303	Blue Throated Flycatcher	Cyornis rubeculoids
88	Crested Kingfisher	Megaceryle lugubris	304	Tickell's Blue Flycatcher	Cyornis tickelliae
89	Pied Kingfisher	Ceryle rudis	305	Rufous-bellied Niltava	Niltava sundara
90	Blue-eared kingfisher	Alcedo meninting	306	Small Niltava	Niltava macgrigoriae
91	Blue-bearded Bee eater	Nyctyornis athertoni	307	Grey Headed Canary Flycatcher	Culicicapa ceylonensis
92	Green Bee eater	Merops orientalis	308	Pale Blue Flycatcher	Cyornis unicolor
93	Blue-tailed Bee eater	Merops philippinus	309	Siberian Rubythroat	Luscinia calliope
94	Chestnut-headed Bee eater	Merops leschenaultia	310	White-tailed Rubythroat	Luscinia pectoralis
95	Pied cuckoo	Clamator jacobinus	311	Blue Throat	Luscinia svecica
96	Common Hawk Cuckoo	Hierococcyx varius	312	Indian Blue Robin	Luscinia brunnea

	Common name	Scientific		Common name	Scientific
97	Indian Cuckoo	Cuculus micropterus	313	Oriental Magpie Robin	Copsychus saularis
98	Banded Bay Cuckoo	Cacomantis sonneratii	314	White-rumped Shama	Copsuchus malabaricus
99	Grey-bellied Cuckoo	Cacomantis passerinus	315	Indian Robin	Saxicoloides fulicata
100	Plaintive Cuckoo	Cacomantis merulinus	316	Black Redstar	Phoenicurus ochruros
101	Drongo Cuckoo	Surniculus lugubris	317	Blue Fronted Redstar	Phoenicurus frontalis
102	Asian Koel	Euidynamys scolopacea	318	White-capped Water Redstar	Chaimarrornis leucocephalus
103	Green-billed Malkoha	Phaenicophaeus tristis	319	Plumbeous Water Redstar	Rhycornis fuliginosus
104	Sirkeer Malkoha	Phaenicaphaeus leschenaultii	320	Black-backed Forktail	Enicurus immaculatus
105	Greater Coucal	Centropus sinensis	321	Slaty-backed Forktail	Enicurus schistaceus
106	Lesser Coucal	Centropus bengalensis	322	Common Stonechat	Saxicola torquata
107	Alexandrine Parakeet	Psittacula eupatria	323	White Tailed Stonechat	Saxicola leucura
108	Rose-ringed Parakeet	Psittacula krameri	324	Pied Bushchat	Saxicola caprata
109	Slaty-headed Parakeet	Psittacula himalayana	325	Grey Bushchat	Saxicola ferrea
110	Plum-headed Parakeet	Psittacula cyanocephala	326	Hodgson's Bushchat	Saxicola insignis
111	Red-Breasted Parakeet	Psittacula alexandri	327	Chestnut-tailed Starling	Sturnus malabaricus
112	Himalayan Swiftlet	Collocalia brevirostris	328	Brahminy Starling	Sturnus pagodarum
113	White Rumped Needletail	Zoonavena sylvatica	329	Common Starling	Sturnus vulgaris
114	White Throated Needletail	Hirundapus caudacutus	330	Asian pied Starling	Sturnus contra
115	Alpine Swift	Tachymarptis melba	331	Common Myna	Acridotheres tristis
116	Asian Palm Swift	Cypsiurus balasiensis	332	Bank Myna	Acridotheres ginginianus
117	House Swift	Apus affinis	333	Jungle Myna	Acridotheres fuscus
118	Crested Treeswift	Hemiprocne coronata	334	Hill Myna	Gracula religiosa
119	Sand Martin	Riparia riparia	335	Chestnut-bellied Nuthatch	Sitta castanea
120	Plain Martin	Riparia paludicola	336	White-tailed Nuthatch	Sitta himalayensis
121	Barn Swallow	Hirundo rustica	337	Velvet fronted Nuthatch	Sitta frontalis
122	Wire-tailed Swallow	Hirundo smithii	338	Wallcreeper	Tichodroma muraria
123	Red-rumped Swallow	Hirundo daurica	339	Eurasian Treecreeper	Certhia familiaris

	Common name	Scientific		Common name	Scientific
124	Grass Owl	Tyto capensis	340	Rusty-flanked Treecreeper	Certhia nipalensis
125	Collared Scops Owl	Otus bakkamoena	341	Great Tit	Parus major
126	Eurasian Eagle Owl	Bubo bubo	342	Green-backed Tit	Parus monticolus
127	Spot-bellied Eagle Owl	Bubo nipalensis	343	Black-lored Tit	Parus xanthogenys
128	Brown Fish Owl	Ketupa zeylonensis	344	Lesser Whitethroat	Sylvia curruca
129	Brown Wood Owl	Strix leptogrammica	345	Black-crested Bulbul	Pycnonotus melanicterus
130	Collared Owlet	Glaucidium brodiei	346	Red-whiskered Bulbul	Pycnonotus jocosus
131	Asian Barred Owlet	Glaucidium cuculoides	347	Himalayan Bulbul	Pycnonotus leucogenys
132	Jungle Owlet	Glaucidium radiatum	348	Red-vented Bulbul	Pycnnontus cafer
133	Spotted Owlet	Athene brama	349	Black Bulbul	Hypsipetes leucocephalus
134	Brown Hawk Owl	Ninox scutulata	350	Ashy Bulbul	Hemixos flavala
135	Short-eared Owl	Asio flammeus	351	Zitting Cisticola	Cisticola juncidis
136	Dusky Eagle Owl	Bubo coromandus	352	Bright Headed Cisticola	Cisiticola exilis
137	Oriental Scops Owl	Otus sunia	353	Striated Prinia	Prinia criniger
138	Grey Nightjar	Caprimulgus indicus	354	Grey Brested Prinia	Prinia hodgsonii
139	Large-tailed Nightjar	Caprimulgus macrurus	355	Graceful Prinia	Prinia gracilis
140	Indian Nightjar	Caprimulgus asiaticus	356	Jungle Prinia	Prinia sylvatica
141	Savanna Nightjar	Caprimulgus affinis	357	Yellow Bellied Prinia	Prinia flaviventris
142	Rock pigeon	Columba livia	358	Ashy Prinia	Prinia socialis
143	Orange Breasted Green Pigeon	Treron bicincta	359	Plain Prinia	Prinia inornata
144	Pompadour Green pigeon	Treron pompadora	360	Grey-crowned Prinia	Prinia cinereocapilla
145	Yellow Footed Green Pigeon	Treron apicauda	361	Oriental White-eye	Zosterops palpebrosus
146	Pin Tailed Green Pigeon	Treron apicauda	362	Grey Bellied Tesia	Tesia cyaniventer
147	Oriental Turtle Dove	Streptopelia orientalia	363	Pale-footed Bush Warbler	Cettia pallidipes
148	Spotted Dove	Streptopelia chinensis	364	Brownish Flanked Bush Warbler	Cettia fortipes
149	Red Collared Dove	Streptopelia tranquebarica	365	Aberrant Bush Warbler	Cettia flavolivacea
150	Eurasian Collared Dove	Streptopelia decaocto	366	Grey Sided Bush Warbler	Cettia brunnifrons
151	Emerald Dove	Chalcophaps indica	367	Puddy Field Warbler	Acrocephalus agricola

	Common name	Scientific		Common name	Scientific
152	Bengal Florican	Houbaropsis bengalensis	368	Blyth's Reed Warbler	Acrocephalus dumetorum
153	Purple Swamphen	Porphyrio porphyrio	369	Common Chiffchaff	Phylloscopus collybita
154	Common Moorhen	Gollinula chloropus	370	Common Tailorbird	Orthotomus sutorius
155	White Brested Waterhen	Amaurornis phoenicurus	371	Dusky Warbler	Phylloscopus fuscatus
156	Slaty-lagged Crake	Rallina eurozoides	372	Smoky Warbler	Phylloscopsus fuligiventer
157	Pintail Snipe	Gallinago stenura	373	Tickell's Leaf Warbler	Phylloscopus affinis
158	Common Snipe	Gallinago gallinago	374	Buff-barred Warbler	Phylloscopus pulcher
159	Eurasian Curlew	Numenius madagascoriensis	375	Lemon-rumped Warbler	Phylloscopus chloronotus
160	Greater Painted Snipe	Rostratula benghalensis	376	Hume's Warbler	Phylloscopus humei
161	Common Redshank	Tringa tetanus	377	Greenish Warbler	Phylloscopus trochiloides
162	Common Greenshank	Tringa nebularia	378	Western Crowned Warbler	Phylloscopus occipitalis
163	Marsh Sandpiper	Tringa stagnatilis	379	Blyth's Leaf Warbler	Phylloscopus reguloides
164	Green Sandpiper	Tringe ochropus	380	Ashy Throated Warbler	Phylloscopus maculipennis
165	Wood Sandpiper	Tringe glareola	381	Golden-spectacled Warbler	Seicerus burkii
166	Common Sandpiper	Actitis hypoleucos	382	Grey-hooded Warbler	Seicerus xanthoschistos
167	Little Stint	Calidris minuta	383	Chestnut-crowned Warbler	Secicerus castaniceps
168	Temmincks Stint	Calidris temminckii	384	Striated Grassbird	Megalurus palustris
169	Pheasant Tailed Jacana	Hydrophasianus chirurgus	385	Rufous-rumped Grassbird	Graminicola bengalensis
170	Bronze Winged Jacana	Metopidius indicus	386	White-throated Laughingthrush	Garrulax alboagularis
171	Whimbrel	Numenius phaeopus	387	White-crested Laughingthrush	Garrulax leucolophus
172	Eurasian Thick-knee	Burhinus oedicnemus	388	Abbott's Babbler	Malacocincla abbotti
173	Great Thick-knee	Esacus recurvirostris	389	Puff-throated Babbler	Pellorneum ruficeps
174	Ibisbill	Ibidorhyncha struthersii	390	White-browed Scimitar Babbler	Pomatorhinus schisticeps
175	Black Wing Stilt	himantopus himatopus	391	Tawny-bellied Babbler	Dumetia hyperythera

	Common name	Scientific		Common name	Scientific
176	Pied Avocet	Recurvirostra avosetta	392	Striped tit babbler	Macronous gularis
177	Pacific Golden Plover	Pluviasis fulva	393	Chestnut-capped Babbler	Timalia pileata
178	Little Ringed Plover	Charadrius dubius	394	Yellow-eyed Babbler	Chrysomma sinense
179	Kentish Plover	Charadrius alexandrinus	395	Pigmy Wren Babbler	Pnoepyga pusilla
180	River Lapwing	Venellus duvaucelii	396	Black-chinned Babbler	Stachyris pyrrhops
181	Red Wattled Lapwing	Vanellus indicus	397	Grey-throated Babbler	Stachyris nigriceps
182	Oriental Pratincole	Glareola maldivarum	398	Spiny Babbler	Turdoides nipalensis
183	Small Pratincole	Glareola lactea	399	Striated Babbler	Turdoides earlei
184	Yellow-legged Gull	Larus cachinnans	400	Large Grey Babbler	Turdoides malcolmi
185	Pallas's Gull	Larus ichthyaetus	401	Jungle Babbler	Turdoides striatus
186	Black-headed Gull	Larus ridibundus	402	Silver-eared Mesia	Leiothrix argentguris
187	Caspian Tern	Sterna caspia	403	White-billed Yuhina	Yuhina zanthileuca
188	River Tern	Sterna aurantis	404	Rufous-winged Bushlark	Mirafra assamica
189	Little Tern	Sterna albifrons	405	Ashy-crowend Sparrow Lark	Eremopterix grisea
190	Black-bellied Tern	Sterna acuticauda	406	Sand Lark	Calandrella raytal
191	Osprey	Pandion haliaetus	407	Crested Lark	Galerida cristata
192	Oriental Honey Buzzard	Pernis ptilorhyncus	408	Oriental Skylark	Alauda gulgula
193	Black-shouldered Kite	Elanus caeruleus	409	Thick-billed Flower Pecker	Dicaecum agile
194	Black Kite	Milvus migrans	410	Pale-billed Flower Pecker	Dicaecum erythrorynchos
195	Brahminy Kite	Haliastur indus	411	Purple Sunbird	Nectarinia asiatica
196	Pallas's Fish Eagle	Haliaeetus leucoryphus	412	Crimson Sunbird	Aethopyga siparaja
197	White Tailed Eagle	Haliaeetus albicilla	413	Fire-tailed Sunbird	Aethopyga ignicouda
198	Lesser Fish Eagle	Ichthyophaga humilis	414	Green Tailed Sunbird	Aethopyga nipalensis
199	Grey-headed Fish Eagle	Ichthyophaga ichthyaetus	415	Streaked Spider Hunter	Arachnothera magna
200	Short-toed Snake Eagle	Circaetus gallicus	416	Little Spider Hunter	Arachnothera longirostra
201	Crested Serpent Eagle cheela	Spilornis	417	House Sparrow	Passer domesticus
202	Hen Harrier	Circus cyaneus	418	Eurasian Tree Sparrow	Passer montonus
203	Pallid Harrier	Circus macrourus	419	Chestnut-shouldered Petronia	Petronia xanthocolllis
204	Pied Harrier	Circus melanoleucos	420	White Wagtail	Motacilla alba

	Common name	Scientific		Common name	Scientific
205	Crested Goshawk	Accipiter trivirgatus	421	White Browed Wagtail	Motacilla maderaspatensis
206	Shikra	Accipiter badius	422	Citrine Wagtail	Motacilla citreola
207	Besra	Accipiter virgatus	423	Yellow Wagtail	Motacilla flava
208	Eurasian Sparrowhawk	Accipiter nisus	424	Grey Wagtail	Motacilla cinerea
209	White-eyed Buzzard	Butastur teesa	425	Richard's Pipit	Anthus richardi
210	Common Buzzard	Buteo buteo	426	Paddyfield Pipit	Anthus rufulus
211	Long-legged Buzzard	Buteo rufinus	427	Tree Pipit	Anthus trivialis
212	Black Eagle	Ictinaetus malayensis	428	Olive-backed Pipit	Anthus hogsoni
213	Lesser Spotted Eagle	Aquila pomarina	429	Rosy Pipit	Anthus roseatus
214	Tawny Eagle	Aquila rapax	430	Black Brested Weaver	Ploceus benghalensis
215	Golden Eagle	Aquila chrysaetos	431	Baya Weaver	Ploceus philippinus
216	Steppe Eagle	Aquila nipalensis	432	Red Avadavat	Amandava amandava

Annex 12: Roads in the Lower Karnali Watershed

Table 33: Road networks in the Lower Karnali watershed

SN	Places connected	Class	Length (km)
1	Bhuregaun - Gulariya – Murtihawa	Feeder Road Network	4.45
2	Bhuregaun (Mahendra Rammarg) - Bangesimal (Surkhet)	Feeder Road Network	18.77
3	Junga - Rajapur - Bhimapur	Feeder Road Network	13.83
4	Kothiya -Thakurdwara - Amreni)	Feeder Road Network	24.12
5	Mahendra Rajmarg	National Highway	32.84
6	Rajapur – Daulatpur - Sati	Feeder Road Network	10.46
7	Ratuwa River - Rangeli (Postal)	Postal Road	19.35
8	Sati (Khairipur) - Khakraula	Feeder Road Network	0.82
9	Badhi Chowk – Khairapur - Janapukha	Village Road Core Network	7.11
10	Bagnaha Chowk - Bagnaha Gaun – Jutpani – Mirchaiya - Thakurdwara	Village Road Core Network	5.94
11	Bankatti School - Tikapur	Village Road Core Network	2.09
12	Bankatti-Tikapur Ghat	Village Road Core Network	1.78
13	Batanpur – Khakraula – Kalakunda	Village Road Core Network	2.42
14	Batanpur - Masanghat	Village Road Core Network	3.12
15	Bhaura – Bhogpur - Chainpur	Village Road Core Network	5.79
16	Bhimapur – Chainpur - Manpur Tapara – Sukhard -Badalpur - Muraiya Link Road	Village Road Core Network	7.13
17	Bhurigaun Ringroad	Village Road Core Network	12.50
18	Bindra - Lahurpur	Village Road Core Network	8.21
19	Chisapani - Solta Road	District Road Core Network	14.69
20	Chotkipur – Manpuri – Daulatpur - Tikapur Ghat	Village Road Core Network	8.62
21	Daulatpur - Tikapur Ghat	Village Road Core Network	1.87
22	Daulatpur – Murgawa - Himalipur	Village Road Core Network	3.78

SN	Places connected	Class	Length (km)
23	Dhobinpur – Budikulo – Badalpur – Bashanta – Jhandi - Manau	Village Road Core Network	9.65
24	Dhobinpur - Katarniyaghat	Village Road Core Network	2.09
25	Gola Ghattatole (Ring road)-Bindra-Pashupatinagar-Guhari (Nayagau)	Village Road Core Network	5.52
26	Gola – Patabhar – Janaknagar - Aanokhariya	Village Road Core Network	4.52
27	Govindapur – Mainapokhar - Khonpur	Village Road Core Network	5.26
28	Haripur – Chainpur – Ghurahi - Nangapur	Village Road Core Network	8.84
29	Hulaki Sadak - Giri Tole - Padariya Gaun	Village Road Core Network	1.11
30	Jhapti - Dhobinpur	Village Road Core Network	3.10
31	Khata - Thakurdwara - Godana - Neulapur	District Road Core Network	21.60
32	Khusalpatuwa – Suryapatuwa - Taduwa	Village Road Core Network	5.47
33	Kothiyaghat – Dhanaura – Khata - Oralibazar	Village Road Core Network	3.42
34	Laxmipur - Guwari	Village Road Core Network	1.22
35	Lalitapur – Phattepur – Murayna - Chainpur	Village Road Core Network	4.26
36	Manau - Rajapur Road	Village Road Core Network	7.49
37	Manpurtapara - Badarpur - Nayagaun - Gola	District Road Core Network	21.24
38	Patabhar – Bankatti – Thapapur – Kathmandu – Janaknagar - Gola	Village Road Core Network	2.26
39	Patabhar - Kalika Mandir – Bhairampur - Rajapur Pahadi Tole	Village Road Core Network	4.29
40	Rajapur - Bhimapur - Khairi Chandanpur	District Road Core Network	17.04
41	Rajapur Ring Road	District Road Core Network	45.14
42	Rajapur - Badalpur	Village Road Core Network	4.64
43	Rajapur - Purva Kanpur	Village Road Core Network	2.02
44	Sati – Chaugurdi - Dhansinghpur Road	District Road Core Network	4.58
45	Sindra - Badalpur	Village Road Core Network	2.59

SN	Places connected	Class	Length (km)
46	Sugarkhal – Bhuruwa - Pratappur Sadak	Village Road Core Network	0.80
47	Sukhad - Ganeshpur	Village Road Core Network	1.12
48	Thakurdwara – Banugaun – Sivapur – Hattisar – Bandrahawa - Tadawachok	Village Road Core Network	13.92
49	Thakurdwara – Madhela – Bakuwa – Tulsipur – Motipur - Ambasa	Village Road Core Network	13.42

Annex 13: Irrigation projects

Table 34: List of irrigation projects by name, location and area coverage

Project	District	Developed Command Area (Ha)		Irrigated Command Area (ha.)			Ongoing Command Area (Ha)	
		Gross	Net	Summer	Winter	Spring	Gross	Net
Babai Irrigation	Bardiya	8750	7000	7000	40000	0	7750	6200
Budhi Kulo	Bardiya	625	500	500	500	0	0	0
Kaiyan Nala	Bardiya	250	200	200	0	0	0	0
Madirajdulo	Bardiya	250	200	200	100	0	0	0
Manau Kulo	Bardiya	375	300	300	150	0	0	0
Rajapur Irrigation	Bardiya	15790	13000	0	0	0	0	0
Taparamampur Kulo	Bardiya	1000	800	800	600	0	0	0
Tara Tal	Bardiya	25	20	20	20	0	0	0
Titariya Bandh	Bardiya	188	150	150	0	0	0	0
Ranijamara	Kailali	**3125**	**2500**	**2500**	**1600**	**0**	**0**	**0**

Annex 14: Water quality

Table 35: Water quality testing in the Lower Karnali watershed

	Location of measurement					Water quality standards		
	Geruwa Khola below Kothiyaghat Bridge	Geruwa Khola near Indian border	Geruwa Khola above the	Geruwa Khola below west part of	Karnali River at Sati Ghat	* Drinking	** Irrigation	** Aquaculture
Conductivity (µS/cm)	158.3	160.7	179.5	156.5	165.5	1,500		
Temp °C	22.7	22.7	24.2	22.3	22.5			4 to 30
Iron (mg/L)	0.0	0.4	0.2	0.2	0.4	0.3 (3)	5	0.01
pH	6.8	5.9	6.0	7.5	7.1	6.5-8.5	6.5-8.5	6.5-9.0
Nitrate Nitrogen (mg/L)	0.6	2.6	0.9	0.6	0.0	50		<300
Nitrite Nitrogen (mg/L)	0.0	0.0	0.0	0.0	0.0		<5	
Ammonium (mg/L)	0.0	0.0	0.0	0.0	0.0	1.5		0.025
Phosphate (mg/L)	0.3	2.4	3.0	5.1	5.8	0.4 EEC		

	Location of measurement					Water quality standards		
	Karnali River at Sati Ghat	Karnali River upstream of Chisapani Bridge	Karnali River at Sugarkhal	Ambasa Khola at Neulapur	Orahi Khola at Neulapur	* Drinking	** Irrigation	** Aquaculture
Conductivity (µS/cm)	149.0	148.7	149.0	421.9	583.3	1,500		
Temp °C	22.0	20.4	20.6	29.9	29.7			4 to 30
Iron (mg/L)	0.2	0.2	0.8	0.5	0.2	0.3 (3)	5	0.01
pH	6.4	6.4	6.8	7.5	7.6	6.5-8.5	6.5-8.5	6.5-9.0
Nitrate Nitrogen (mg/L)	1.0	3.8	0.2	1.1	0.7	50		<300

Nitrite Nitrogen (mg/L)	0.0	0.0.	0.0	0.0	0.0		<5	
Ammonium (mg/L)	0.0	0.0	0.0	0.0	2.0	1.5		0.025
Phosphate (mg/L)	1.8	0.9	1.5	NA	4.4	0.4 EEC		

	Location of measurement					**Water quality standards**		
	Jamati Khola at Neulapur	8 Number Khola at Gorenga	7 Number Khola at Gorenga			*** Drinking**	**** Irrigation**	**** Aquaculture**
Conductivity (µS/cm)	367.1	367.5	356.1			1,500		
Temp °C	29.1	29.0	31.0					4 to 30
Iron (mg/L)	0.2	0.0	0.0			0.3 (3)	5	0.01
pH	7.3	6.3	7.8			6.5-8.5	6.5-8.5	6.5-9.0
Nitrate Nitrogen (mg/L)	0.4	0.9	1.1			50		<300
Nitrite Nitrogen (mg/L)	0.0	0.0	0.0				<5	
Ammonium (mg/L)	0.0	0.0	0.0			1.5		0.025
Phosphate (mg/L)	8.6	6.5	7.9			0.4 EEC		

Annex 15: Major pollution points in the Lower Karnali watershed

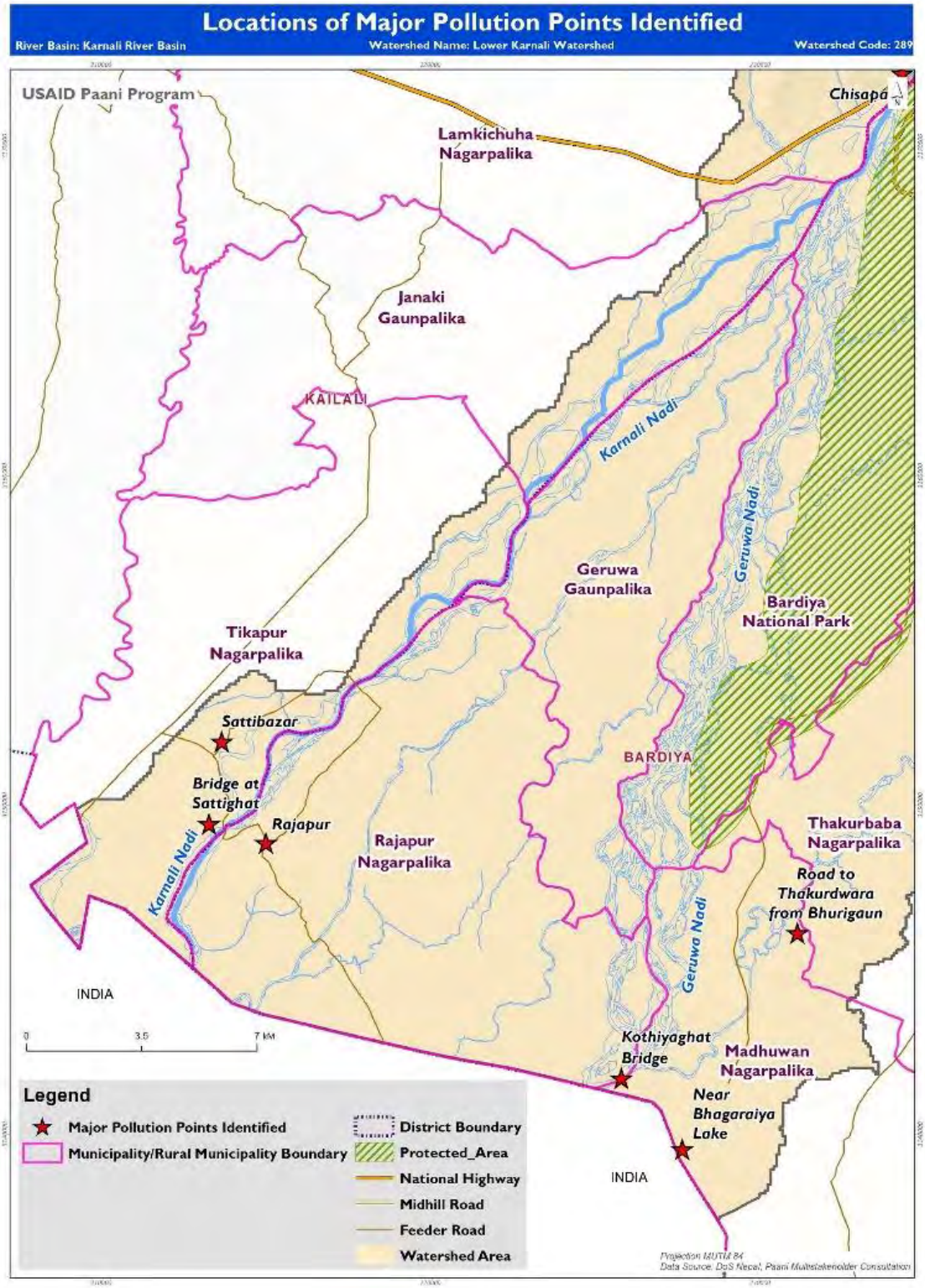

Figure 24: Major pollution points in the Lower Karnali watershed

Annex 16: Locations of gravel mining operations

Table 36: Locations of gravel mining operations

River	Location
Duduwakhola	Shantipurghat
	Chakhhapurghat
	Daulatpur
Rajapur - Karnali River (South)	Tighraghat
	Tediyaghat
	Above Bridge
	Below Bridge
Kothiyaghat - Geruwa River	Kothiyaghat-1
	Kothiyaghat-2
	Lalpurghat

Annex 17: Community user forest groups

Table 37: User groups by community forest and buffer zone community forests in the Lower Karnali watershed

SN	District	VDC	Community forest			Buffer zone community forest		
			# of CFUG	Area (ha)	HHs	# of CFUG	Area (ha)	HHs
1	Bardiya	Badalpur	2	13	1,187			
2	Bardiya	Baganaha	12	1,560.05	1,985	5	889.8	1,195
3	Bardiya	Bhimapur	8	136.67	570			
4	Bardiya	Daulatpur	9	161.38	1,519			
5	Bardiya	Dhodhari	26	1,948.47	2,490			
6	Bardiya	Gola				3	40.74	403
7	Bardiya	Khairichandanpur	7	165.76	552			
8	Bardiya	Manau				5	176.1	926
9	Bardiya	Manpur Tapara	4	13.72	228			
10	Bardiya	Naya Gaun	2		308			
11	Bardiya	Neulapur	3	169.24	382	13	662.5	1,656
12	Bardiya	Pasupatinagar				2		
13	Bardiya	Patabhar						
14	Bardiya	Rajapur	17	299.92	1,962			
15	Bardiya	Sivapur						
16	Bardiya	Suryapatawa	23	1,912.84	2,253			
17	Bardiya	Thakudwara	1	109.56	163			
18	Kailali	Baliya	9	1,084.32	5,478			
19	Kailali	Dhansinghapur	1	258.63	901			
20	Kailali	Durgauli	5	754.47	2,130			
21	Kailali	Narayanpur	4	183.79	2,068			
22	Kailali	Pathariya	16	4,819.84	10,812			
23	Kailali	Sugarkhal	10	1,618.81	1,930			
24	Kailali	Tikapur Municipality	5	778.31	3,966			
25	Surkhet	Taranga				7	640.5	169
26	Surkhet	Tatopani	12	2,163.53	1,752			
		Total	**176**	**18152.3**	**42,636**	**35**	**2,410**	**4,349**

Annex 18: Existing policy provisions and status of enforcement

Table 38: Current policy provisions and relevant observations

Policy Provision	Ground Reality	Recommendations
Municipalities (local governments) are empowered to prepare and implement programs with regard to forests, vegetation, biodiversity, soil conservation, and environmental conservation in the village development area (per section 28(h) of the LSGA, 1999). Municipalities are required to assist environment conservation by managing air, land and water pollution within their jurisdiction; this work includes conserving forest, plants and other natural assets, and collecting, transporting, and disposing solid waste of the municipality area (per section 96(1)(c) of the LSGA).	Although the LSGA has been in force for the past 18 years, local bodies have not given priority to developing separate programs for conserving biodiversity. The municipalities in the watershed area have also focused limited energy on collecting and disposing waste. People not aware of the existing Aquatic Animal Protection Act, 1961.	Need greater focus on conservation of aquatic biodiversity through site-specific policy provisions in support of local communities and establishment of strong monitoring mechanisms. Awareness raising and formulation of local level by-laws and strict implementation are needed
The National Park Regulations 1974 provide detailed provisions for hunting license issuance (rules 5-13). However, these regulations do not make specific and separate provisions regarding fish; fish are subsumed under "wildlife."	Community Based Anti-poaching Units (CBAPU) and Rapid Response Teams (RRT) have been established in the watershed but they require capacity building and support for greater effectiveness.	Conservation activities should be mainstream through development planning to ensure effective implementation.

Annex 19: Key stakeholders – organizations and offices

Table 39: Key organizations relevant to watershed health

Organization	District	Key representative	Position	Phone
Geruwa Gaunpalika	Bardiya	Jaman Singh KC	President	9858038111
Geruwa Gaunpalika	Bardiya	Hema Chaudhary	Vice President	9844837050
Geruwa Gaunpalika	Bardiya	Bhim Bahadur Khatri	Executive Officer	9810100362
Madhuwon Nagarpalika	Bardiya	Ganesh KC	Mayor	9848092555
Madhuwon Nagarpalika	Bardiya	Shubharani Tharu	Deputy Mayor	9812560667
Madhuwon Nagarpalika	Bardiya	Dharma Raj Neupane	Executive Officer	9858070111
Rajapur Nagarpalika	Bardiya	Shiva Prasad Chaudhary	Mayor	9858027167
Rajapur Nagarpalika	Bardiya	Mana Kala Chaudhary	Deputy Mayor	9812466785
Rajapur Nagarpalika	Bardiya	Lal Bahadur Yogi	Executive Officer	9858069111
Thakurbaba Nagarpalika	Bardiya	Ghan Narayan Shrestha	Mayor	9748031907
Thakurbaba Nagarpalika	Bardiya	Krishna Kushma Tharu	Deputy Mayor	9848125028
Thakurbaba Nagarpalika	Bardiya	Krishna Prasad Kharel	Executive Officer	9858072111
KISAN	Gulariya Bardiya			
Bardiya National Park	Gulariya Bardiya			
Nepal Red Cross	Gulariya Bardiya			

Nepal Federation of Irrigation Water Users' Association, Nepal (NFIWUAN)	Gulariya Bardiya			
Nepal Federation of Indigenous Nationalities (NEFIN)	Gulariya Bardiya			
Federation of Drinking Water and Sanitation Users, Nepal (FEDWASUN)	Gulariya Bardiya			
Nepal Federation of Environmental Journalists (NEFEJ)	Gulariya Bardiya			
Federation of Nepalese Chambers of Commerce and Industry (FNCCI)	Gulariya Bardiya			
International Wheat and Maize Improvement Center (CIMMYT)	Gulariya Bardiya			
Tikapur Nagarpalika				
Lamki Chuha Nagarpalika				
Baraha Tal Gaunpalika				
Panchapure Nagarpalika				
District Coordination Committee	Gulariya Bardiya			
District Forest Office	Gulariya Bardiya			
District Administration Office	Gulariya Bardiya			
Road Division	Gulariya Bardiya			
Geruwa Gaunpalika	Bardiya	Jaman Singh KC	President	9858038111
Geruwa Gaunpalika	Bardiya	Hema Chaudhary	Vice President	9844837050
Geruwa Gaunpalika	Bardiya	Bhim Bahadur Khatri	Executive Officer	9810100362
Madhuwon Nagarpalika	Bardiya	Ganesh KC	Mayor	9848092555

Madhuwon Nagarpalika	Bardiya	Shubharani Tharu	Deputy Mayor	9812560667
Madhuwon Nagarpalika	Bardiya	Dharma Raj Neupane	Executive Officer	9858070111

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