MIDDLE RAPTI WATERSHED PROFILE

STATUS, CHALLANGES AND OPPORTUNITIES FOR IMPROVED WATERSHED MANAGEMENT

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Cover photo: Tharu women fishing together with traditional fishing gear called *tapi* in the Rapti River, Dang.

Photo credit: USAID Paani Program/HWEPC/Pradeep Majgaiya

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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
DPRP	:	Disaster Preparedness and Response Plans
DSCO	:	District Soil Conservation Office/Officer
DSCWM	:	Department of Soil Conservation and Watershed Management
EAP	:	Emergency Action Plan
EIA	:	Environmental Impact Assessment
FECOFUN	:	Federation of Community Users, Nepal
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	:	Kilo Watt
LAPA	:	Local Adaptation Plan of Action
LDRMPP	:	Local Disaster Risk Management Plan
LSGA	:	Local Self-Governance Act
MOEWRI	:	Ministry of Energy, Water Resources and Irrigation
MOFSC	:	Ministry of Forest and Soil Conservation
MOAD	:	Ministry of Agriculture Development
MOFE	:	Ministry of Forests and Environment
MOFALD	:	Ministry of Federal Affairs and Local Development,
MOI	:	Ministry of Irrigation
MOPPT	:	Ministry of Physical Planning and Transportation
MOFALD	:	Ministry of Federal Affairs and Local Development
MM	:	Millimeter
MSC	:	Multi-stakeholder Consultation
MT	:	Metric tons
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 Resources Improvement
Sec.	:	Second
TAL	:	Terai Arc Landscape Program
USAID	:	United State Agency for International Development
VDC	:	Village Development Committee
WECS	:	Water and Energy Commission Secretariat
WWF	:	World Wildlife Fund
°C	:	Degrees 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 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 Gadhawa gaunpalika (GP), Rajpur GP, Rapti GP and Lamahi nagarpalika (NP), and the newly elected local government bodies engaged deeply in the assessment and prioritization and committed themselves to collaborate and integrate the priority agenda into local planning processes.

The USAID Paani Program—युएसएड पानी परियोजना—is grateful for the privilege of having been invited to support the above efforts. The Paani Program (Paani) 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 NEFIN 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 NFIWUAN, FEDWASUN, and NEFIN, and several government agencies including MOEWRI, MOFE, MOAD, MOFALD[1], and 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.

[1] After federal restructuring of government in Nepal (2018), MoFALD has been changed to the Ministry of Federal Affairs and General Administration.

EXECUTIVE SUMMARY

This profile assesses the status, major challenges and opportunities for water resource management for the multiple users within Middle Rapti watershed of Province 5.

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

This watershed profile provides critical baseline information for local governments, communities, civil society, and private sector stakeholders within the Middle Rapti watershed to strengthen water resource management in a way that benefits human development and protects the natural resource base upon which well-being depends. This profile also helps local stakeholders to design and test interventions to strengthen community resilience and conserve freshwater biodiversity, for which additional resources are available through the Paani local grants program.[2]

The Middle Rapti watershed (Figure 1) is located within Dang district in southwestern Nepal and extends across three rural municipalities, or *gaunpalika*: Rapti, Rajpur, and Gadhawa. In addition, Middle Rapti includes one municipality, or *nagarpalika*: Lamahi. A wide range of topography characterizes the watershed, from plains in the south (200 m), along a border with India and rugged Siwalik hills in the north (1,000 m). The hills are comprised of sandstone, siltstone and mudstone, which, in spite of the heavy forest cover, are fragile and create high volumes of sediment that fall into the rivers and streams below.

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

Watersheds as a unit of analysis do not align with past or current administrative units; however, as Paani's research began and ended after this change, the reader will note references to both the new and old forms – VDC, *gaunpalika* (GP) and *nagarpalika* (NP). References to liaising with or providing support to local governments are references to the units of the new federal system.

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

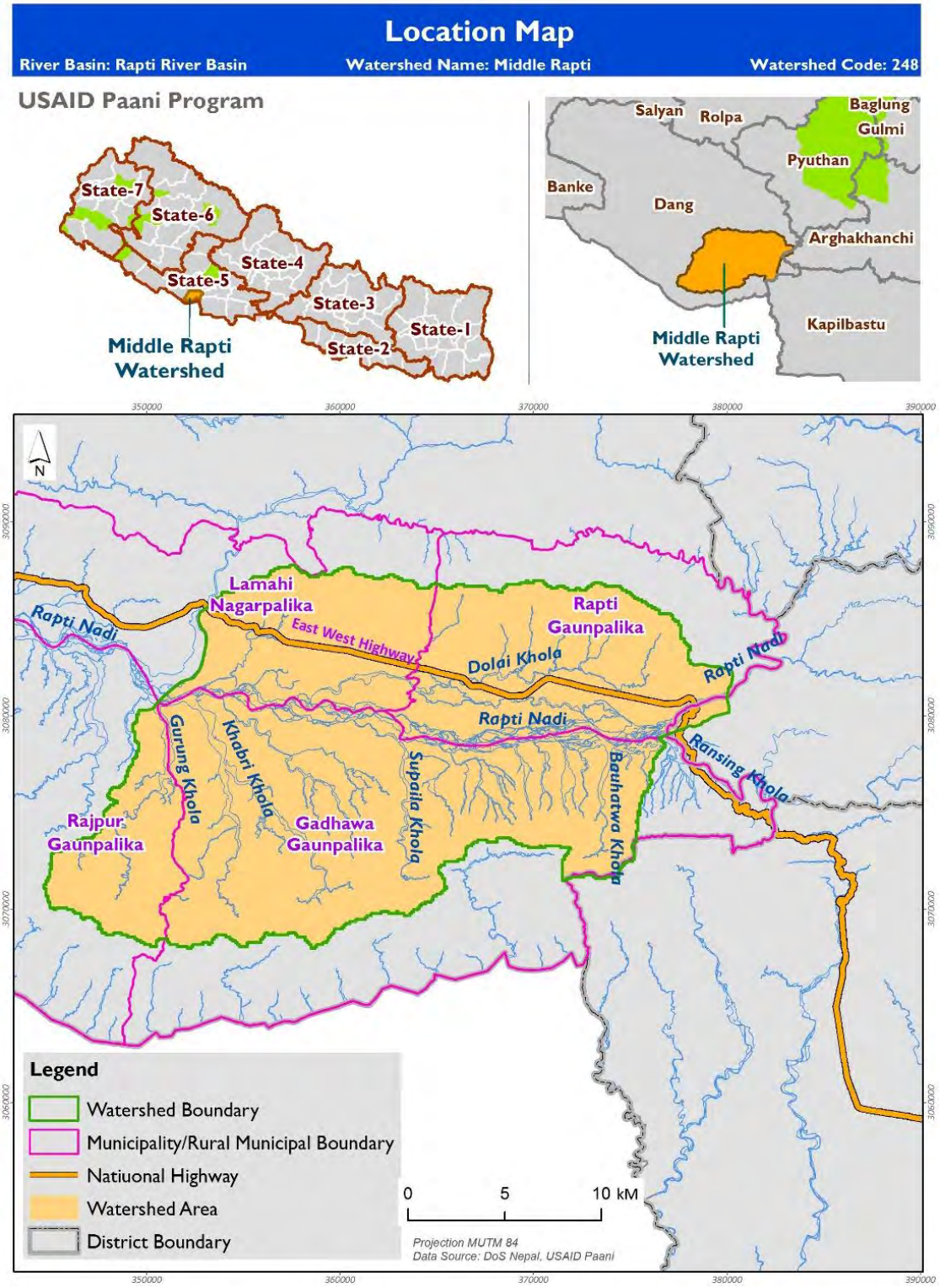


Figure 1: Map of Middle Rapti watershed including administrative units

The Rapti River starts in Gaumukhi and Naubhani in Pyuthan district at 3,000 meters before descending through the Jhimruk watershed to the north and into Middle Rapti (Figure 2). The river is a braided stream with numerous tributaries that change patterns over time, a typical feature of flood plain waterways.

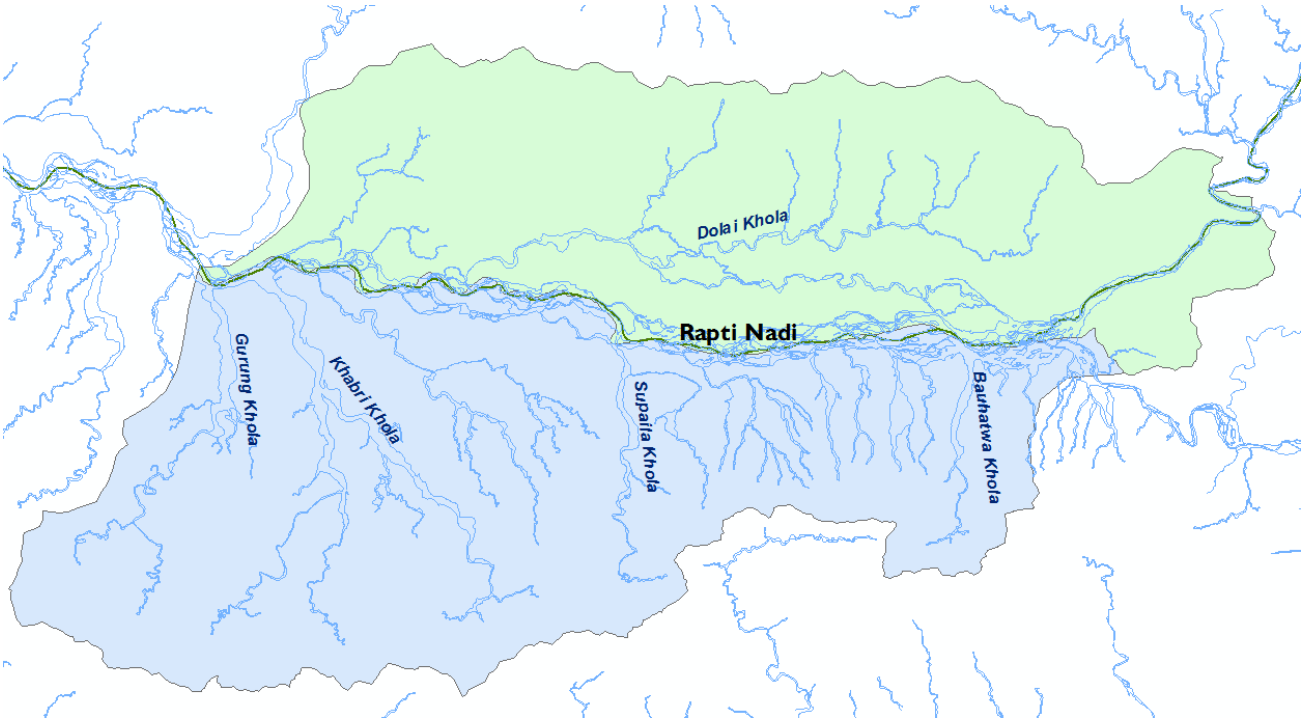


Figure 2: River network map of Middle Rapti watershed

The Middle Rapti watershed is 62% forest cover and 30% agricultural. The remaining area is comprised of rivers, lakes and ponds (8%) and small patches of grass and shrub land.

The total population of the Middle Rapti watershed is 122,313 (52% female; 48% male). More than half the population (53%) relies on agriculture as a primary livelihood, while 22% report labor-based work as their main occupation. Five percent of the population engages in "off-farm" work such as markets and retail shops. Four percent work in the service industry, and 3% raise livestock. Like many areas of Nepal, outmigration to urban centers (e.g., Kathmandu), India and further abroad is becoming more common, especially for young men. According to Paani's household survey, 6.24% of people have migrated (seasonally and abroad) for work.

The main fertile floodplain in the watershed is also known as the Deukhuri Valley – an important "watch" area not only for its agricultural production, but also for its rapid population growth. Significant migration to this valley from Rolpa, Rukum, Arghakhanchi, and Gulmi are exerting significant pressure on the fields, rivers and forests in this area.

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

Table 1: Priority issues for watershed health in Middle Rapti

SN	Priority Issue	Impacts
I	**Floods, landslides and river cutting**	The fragile geology of the Siwalik hills in the northern part of the Middle Rapti watershed are sensitive to increasing climate- and human-induced pressures on the top soil. These conditions have contributed to flooding and landslides in the area, claiming significant loss of human life and property damage. The sedimentation resulting from the landslides degrades aquatic habitats, threatening the long-term viability of fish and other species.
II	**Declining fish stocks and unsustainable fishing practices**	Increased commercial fishing in Middle Rapti, and the increasing use of destructive fishing methods (e.g., poison, gill nets, and electric current) are depleting fish stocks in the rivers and streams of the watershed. The loss of fish not only affects incomes for many families, but also further marginalizes traditional fishing communities, who rely on this occupation as their main source of income.
III	**Drying water sources**	Due to changing rainfall patterns and climate-induced pressures on the landscape, water sources are drying in many areas of the Middle Rapti watershed. The disappearance of these water sources disrupts communities, occasionally inspires conflict between households, and adds additional work burdens on families to meet their daily water needs.

I. Floods, river cutting and landslides

The fragile geology of the Middle Rapti combined with increasing pressures from climate change and human use have made the region more vulnerable to flooding, landslides and river cutting (Figure 3). Historical weather data shows that the frequency of high intensity rainfall events is increasing, particularly during the mid-monsoon period, which raises the likelihood of downstream flooding in the summer months.

Flood events have become more common in Middle Rapti, with each one causing significant human and property loss. The loss of household assets to flooding reduces families' ability to adapt and rebound from such events. As climate change impacts continue to modify and intensify, building capacity in vulnerable communities to prepare for and bounce back from such events is crucial.

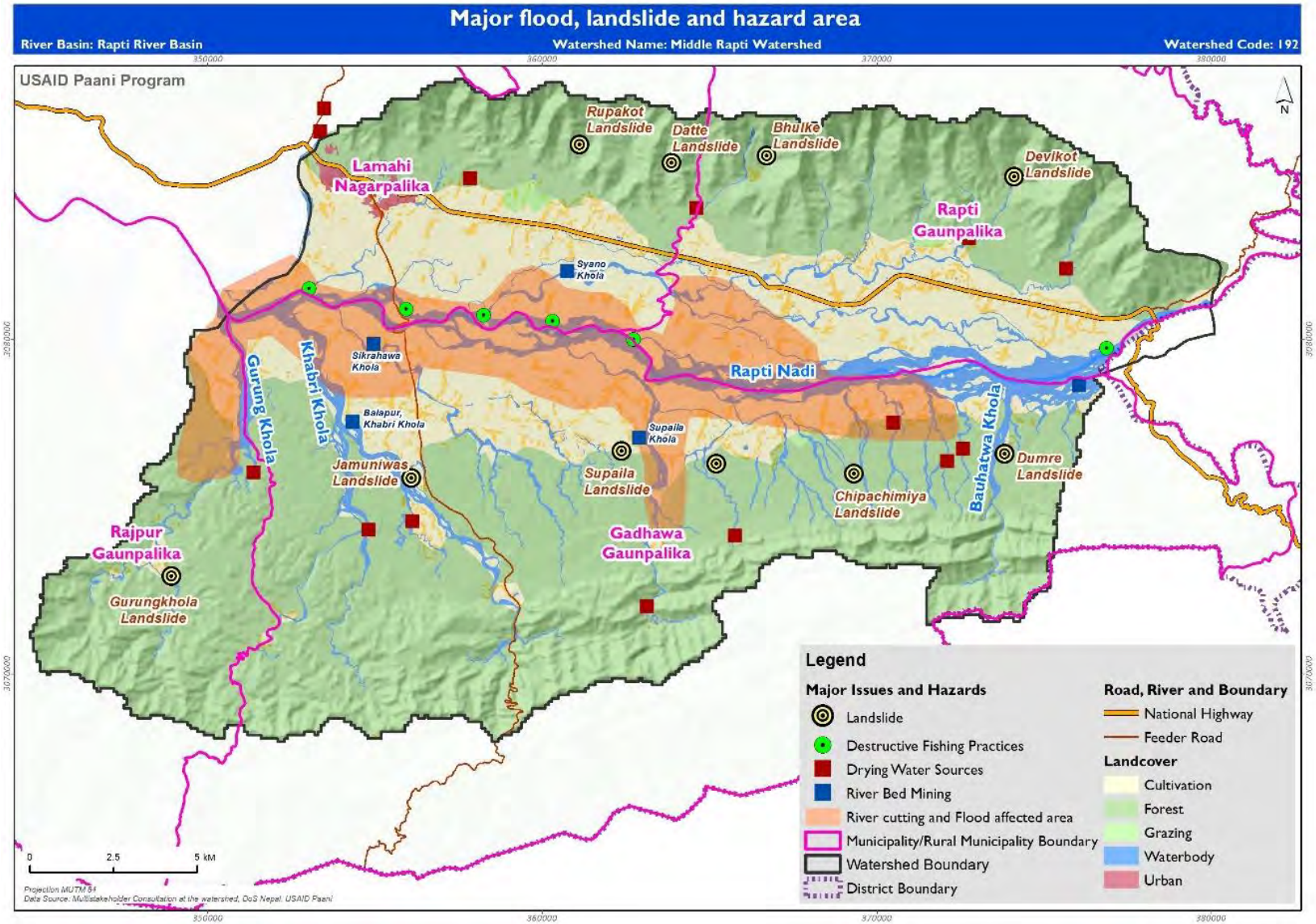


Figure 3: Map of major flood and landslide risk areas in the Middle Rapti watershed

Floods and landslides also affect aquatic species by changing water levels, altering water temperature, and increasing river sediment and turbidity. Floods also destroy aquatic habitats, leading to overall declines in fish stocks. Sediment from floods clogs irrigation systems and reduces agricultural productivity.

Recommendations

- Provide training and support for low-cost stabilization techniques for slopes and river banks;
- Provide improved support to control water runoff;
- Raise awareness about forest fires and open grazing, and the relation of these phenomena to landslides and flooding;
- Strengthen the early warning system in Middle Rapti;
- Construct raised water taps and toilets;
- Conserve wetlands to aid flood control;
- Disseminate materials through radio and print promoting watershed management best practices;
- Improve implementation of disaster preparedness and response plans (DPRP) and local disaster risk management plans (LDRMP); and
- Raise and/or relocate infrastructure (e.g., shelter houses, taps) out of flood plains and other vulnerable areas.

II. Declining fish stocks and unsustainable fishing practices

The fishing commercial contract system introduced in Middle Rapti and other parts of Nepal 25 years ago has unwittingly enabled conditions for over-fishing while marginalizing traditional fishing communities like the Kumal, Majhi, Mallah, and Bote. Destructive fishing practices (e.g., poison, electric current) have also become more common, replacing traditional methods that are more conducive to sustainable harvesting.

Recommendations

- Form fishing groups to discuss sustainability and cooperation issues on the river;
- Develop and endorse capture fishery guidelines;
- Initiate dialogue with state government agencies (once established) to discuss fishing issues;
- Conduct survey of capture fishery groups;
- Promote ecotourism as alternative livelihood option for traditional fishing communities;
- Mobilize community-based anti-poaching units (CBAPUs) to combat destructive fishing practices; and
- Build capacity in community forest user groups (CFUG) to monitor aquatic biodiversity and reduce overfishing threats.

III. Drying water sources

According to Paani surveys, 56% of respondents (n=1,031) said water resources have declined throughout the watershed, particularly in the Churiya range. Increasing deforestation is one significant factor in this trend as soil infiltration and water retention have also declined. Adopting some low-cost

technologies to collect water could be helpful in the short-term, but long-term water planning will need to focus on reducing barren land with reforestation and improving local efforts to control erosion.

Recommendations

- Restore degraded forest area by plantation and natural regeneration;
- Promote use of rain water harvesting technologies, such as rainwater tanks and water recharge ponds;
- Improve soil erosion control; and
- Conduct awareness programs on water use policies.

1. MIDDLE RAPTI WATERSHED: NATURE, WEALTH AND POWER

This Middle Rapti 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) [3]. The analysis draws on multiple data sets associated with these themes to identify critical issues and opportunities for this watershed. We introduce this watershed in terms of its local natural and social dimensions. Then we examine how climate change and other drivers threaten and impact local livelihoods and biodiversity.

In 2016-17, the USAID Paani Program conducted a series of literature reviews, household surveys, focus group discussions, and key informant interviews to assess watershed health in Middle Rapti, including the identification of priority threats and opportunities. Through an exit workshop in December 2018 in Dang district, the USAID Paani Program team shared preliminary results with multiple stakeholders based on those priority issues and environmental assets identified by location and impact groups. During the exit workshops, 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 from elected local bodies also expressed eagerness to allocate resources in support of activities in all aspects of watershed conservation.

Related annexes

Annex 1: Methodology

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

2. NATURE

In this section, we review the status of the environment and natural resources in the Middle Rapti watershed, paying special note to trends and changes that may threaten the health and sustainability of these assets. The Rapti River flows through the center of the watershed and its tributaries support a rich aquatic biodiversity, including a number of commercially important native fish species.

2.1 MIDDLE RAPTI WATERSHED

The water resources from the tributaries of the Middle Rapti watershed (453 km^2) play an essential function in providing water for agriculture, drinking and sanitation that contributes to support the livelihoods of 122,313 people. The elevation in Middle Rapti ranges from 1,000 m in the Siwalik hills in the north to 200 m in the south along the border with India. Three gaunpalika (Rapti, Gadhawa and Rajpur) and one nagarpalika (Lamahi) comprise at least some part of the watershed (figure 1).

The main channel of the Rapti River runs north to south through the middle of the watershed, and links with 47 streams and tributaries (Figure 4). The Arjun Khola, Khabhari Khola, Gurung Khola, Supaila Khola, Dolai Khola, Saano Nadi, and Kakrrahawa Khola are some of the major tributaries. Surveys find that most of these tributaries experience dry spells in the winter months. The total drainage density of the watershed is 1,304 km^3.

Forests and water are the major natural resources of the Middle Rapti watershed. The forests (62% of the land cover) are largely managed by 89 community user forest groups (CFUG), who maintain responsibility for sustainable use and conservation. The Kamdi Kapilvastu biological corridor sits in the southern part of the watershed and provides an important passageway for wildlife moving between Banke National Park and the Sohelwa Wildlife Reserve. The northern part of the forests is known as the Lamahi bottleneck area, a heavily populated area where deforestation rates are high. Local conservation officials are concerned that continued deforestation may disconnect the east to west biological corridor in that area.

The Churiya range of hills is an important base of water, providing several perennial sources, including the Bhulke water spring – the largest in the area. Some water springs have been revived in the area through the efforts of local conservation groups (Annex 2).

With its location in southern Nepal, Middle Rapti is most heavily populated by Janajati groups (66%), followed by Brahmin/Chhetri/Thakuri (19%), Madheshi (7%), and Dalit (6%).

Agriculture is the main source of livelihood in the watershed (53%), as the fertile alluvial soil is productive for staple crops such as rice, wheat, maize, lentils, and potatoes. However, as climate change has made farming productivity less reliable and riskier, farmers have begun to grow other vegetables to sell as cash crops: cabbage, cauliflower, tomatoes, carrots, cucumber, pumpkins, and onions.

Twenty-two percent of households claimed labor-based occupations as their primary livelihood, most of these in construction. Migration from the region to urban centers (e.g., Kathmandu), India (for seasonal work), and abroad has risen sharply in recently years. In 2017, 6.2% of households contained at least one member who migrated for work.

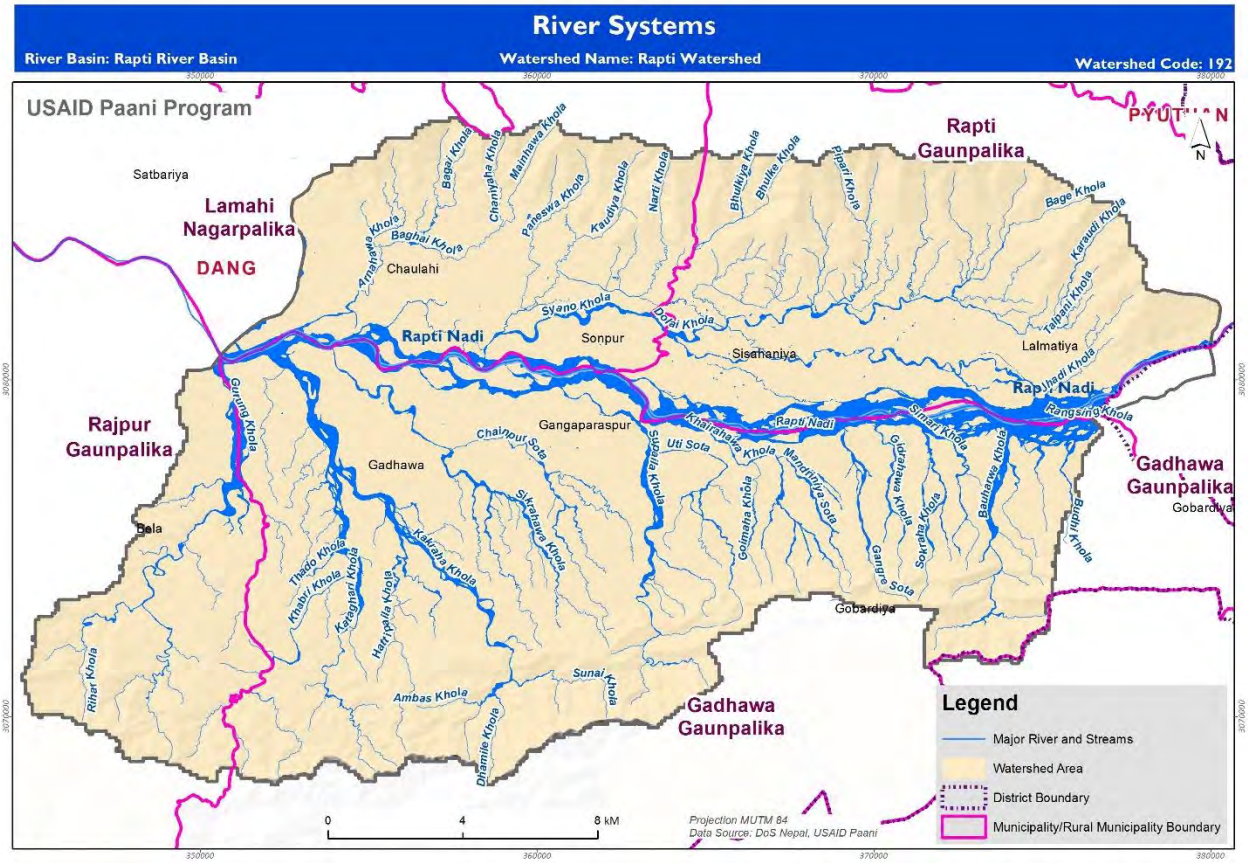


Figure 4: Map of the Middle Rapti watershed and its river network

2.2 WATER AVAILABILITY AND QUALITY

The Middle Rapti watershed has numerous small rivers and tributaries scattered throughout the watershed totaling 588 km in waterways (Figure 4). The major tributaries in this area include the Dolai, Sinea, Kaudiya, Bagasoti, Sunkholi, Gurung, and Kakrahawa, among others. These tributaries provide fish with breeding grounds during the summer months. Within Middle Rapti there are 20 sub-watersheds (Annex 5).

The discharge rates of a river can tell much about the health of the watershed and water quality. Water discharge in 21 tributaries in the Middle Rapti watershed was estimated using the float method during Paani's water quality survey in 2017 (Table 2).

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

SN	Place	Dry season avg. discharge (L/S)	Winter avg. discharge (L/S)	Monsoon season avg. discharge (L/S)	Latitude	Longitude	Elevation
1	Dolai Khola	146.31	5.2	Dry	27.85245238	82.70529934	218.0
2	Dolaikhola at kalapani	Too much water	142.2	N/A	27.84758433	82.64324571	213.0
3	Arjun khola at Kulmohar	723.3	162.39	77.18	27.88323006	82.50692875	189.0
4	Madhayanagar (@ bottom of Arjun Khola)	176.2	7.8	Dry	27.8475598	82.48026268	175.0
5	Sano Nadi @ Raneyapur	Too much water	Too much water	3787.16	27.84793592	82.58393109	203.0
6	Singhe Khola @ Narti	915.69	46.9	1010.86	27.85566741	82.61576399	202.0
7	Rapti River Bagrapur	152623.21	157.2	Too much water	27.82403047	82.63401795	194.0
8	Raniyaour Canal @ Pathargawaha	1541.44	101.2	Too much water	27.83801967	82.63389907	202.0
9	Bagai Sota @ Kholahi	217.3	27.5	31.83	27.85677341	82.52669553	186.0
10	Kulo @ Balarampur	Too much water		1192.92	27.84569779	82.53163714	183.0
11	Bhulke Spring	Too much water	46.2	3.65	27.87884301	82.64386133	291.0
12	Sano Nadi Rajpur	Too much water	145.2	2373.14	27.84370236	82.56624676	192.0
13	Gurung Khola	123.31	22.7	Dry	27.8261405	82.48640756	176.0
14	Kakrahawa Khola @ Manpur	324.56	27.1	3.00696	27.8167814	82.51347908	181.0
15	Sikrahawa Khola	522.23	25.9	850.56	27.82309939	82.53762594	184.0
16	Supaila Khola at Khaira	120	6.5	Dry	27.80757114	82.60904151	205.0
17	Kakrahawa Khola at Jamunibash	543.2	22.1	39.62	27.75221952	82.56975046	261.0

The observed long-term average annual discharge shows a decreasing trend at the rate of 0.408 m^3/s per year. Discharge during pre-monsoon, monsoon, post-monsoon and winter are also observed to have decreasing trend over time at 0.029 m^3/s year, 0.066 m^3/s year, 0.138 m^3/s year and 0.106 m^3/s year respectively.

There are only a few lakes and ponds in the Middle Rapti watershed. Jakhkera Lake at Masandi Tole serves multiple purposes as a resource for irrigation, ecotourism and fish farming. A few other smaller lakes such as Saano Jakhera, Banghushari, and Banki Jahkera, have been enhanced for water retention and recharge.

Looking at water procurement and accessibility, surveys found that 56% of households obtained water through shallow tube wells and hand pumps, while 19% have piped water, 18% use deep wells, and 3% draw water directly from the river. Accordingly, more than half (53%) of households said they needed less than 15 minutes per day to obtain sufficient water. Thirty-five percent claimed they spent 15 minutes per day fetching water, while 6% said they needed between 15-30, and four percent said they needed more than 30 minutes per day.

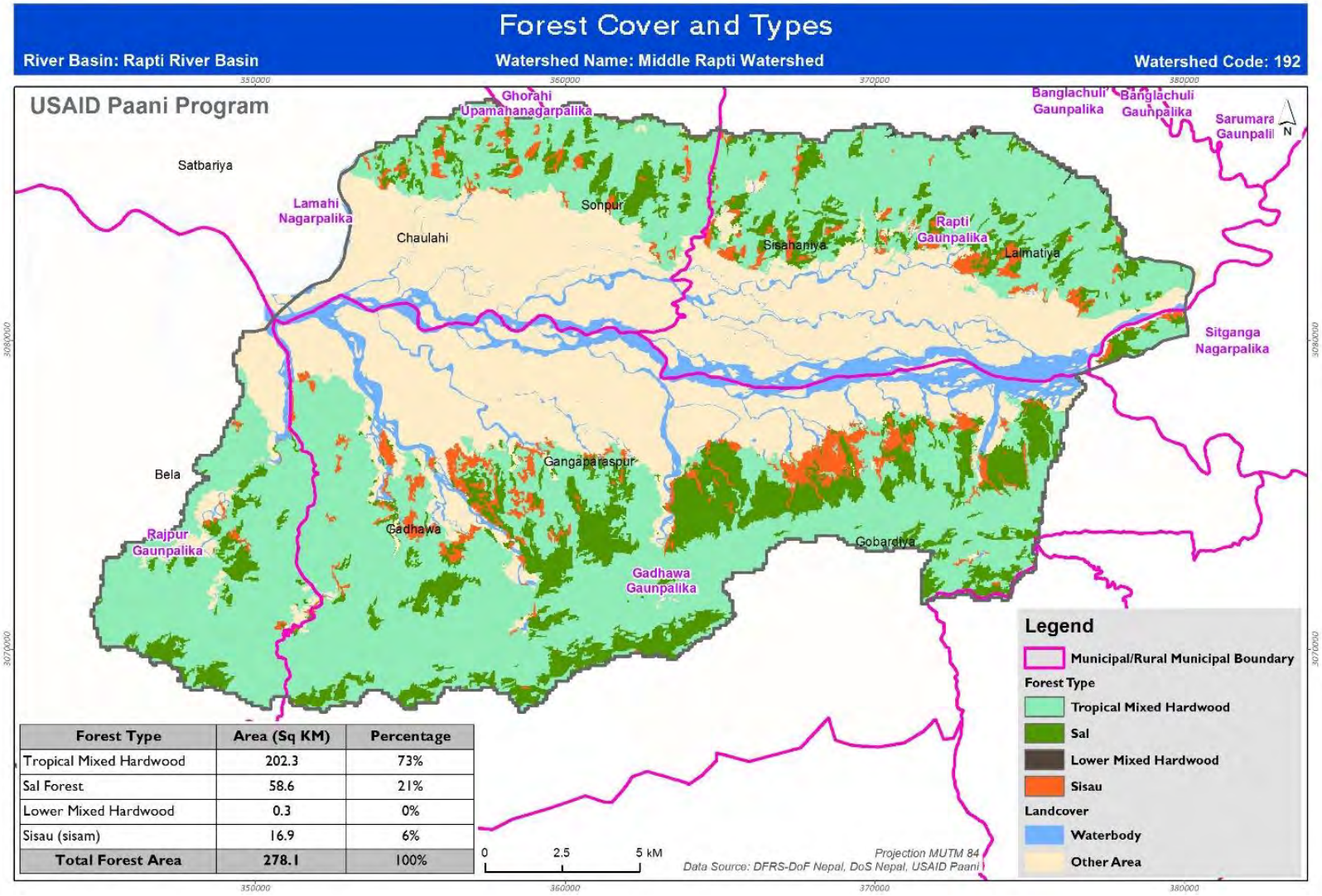
However, it should be noted that there was one report of water conflict due to drying water sources in Bela VDC at Katberuwa and Materiya.

Water quality in the watershed was determined by testing a range of parameters, including pH, nitrate nitrogen and nitrate nitrogen, ammonium, phosphate. All were found to be in the normal range for drinking, domestic use and irrigation. Ammonium and phosphate levels were slightly elevated in few locations.

Related annexes
Annex 15: Water quality

2.3 LAND USE AND LAND COVER

Forest covers 62% of the land in the Middle Rapti watershed (278 km^2), followed by 30% for agriculture, and the remaining 8% consist of rivers, streams, lakes and ponds.
Based on data from the Department of Forest Research and Survey (DFRS), 73% of the watershed is covered by tropical and mixed hardwood species, 21% by sal (Shorea robusta), and 6% by North Indian rosewood (Dalbergia sissoo). See table 5 for an illustration of the distribution.



Forest Type	Area (Sq KM)	Percentage
Tropical Mixed Hardwood	202.3	73%
Sal Forest	58.6	21%
Lower Mixed Hardwood	0.3	0%
Sisau (sisam)	16.9	6%
Total Forest Area	**278.1**	100%

Figure 5: Forest cover by type in the Middle Rapti watershed

Data from Global Forest Watch (Figure 6) shows that deforestation is outpacing reforestation in the watershed. Between 2000 and 2016, 2% of forest cover (541 ha) was lost in some areas while 0.6% (178 ha) was gained.

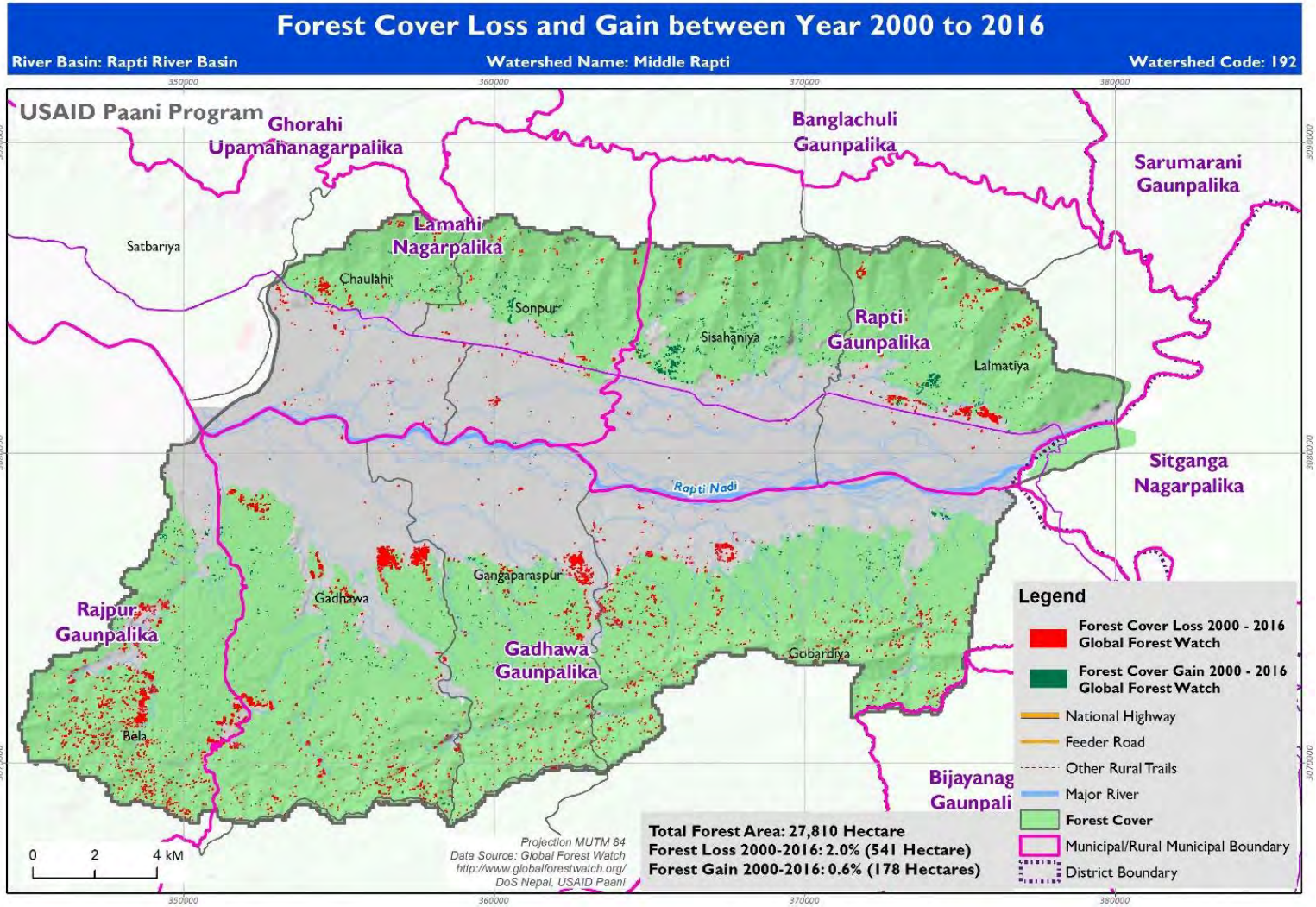


Figure 6: Forest cover loss and gain in the Middle Rapti watershed between 2000-2016.

Related annexes

Annex 6: Forest types and composition

2.4 BIODIVERSITY AND INVASIVE SPECIES

The Middle Rapti watershed provides habitat to several key aquatic and terrestrial species, including elephants, tigers and hyenas. The watershed also forms a crucial connective link between Banke National Park and the Sohelwa Wildlife Reserve wherein animals move to and from important feeding and breeding grounds. For these reasons, the World Wildlife Fund has designated the area – including Middle Rapti – as a biodiversity "hotspot."

Deforestation is a particular threat in the northern belt of the watershed, the rates of which threaten animal life in that area. To address this problem, the Nepal government instituted the Terai Arc Landscape Program (TAL) to promote conservation and sustainable livelihoods in the area. TAL programs touch on a variety of topics, including alternative energy, community forestry, anti-poaching, efficient cook stoves, and climate change adaptation.

Table 3 lists common plant species in the Middle Rapti watershed, including those that may be prone to overharvesting by communities for market and household purpoe

Table 3: Common plant species found in the Middle Rapti watershed

Nepali name	Common name	Scientific name	Remarks
Patero jhar	Cattail	Typha sp.	High volumes of this species contribute to waterlogging in some areas of the Rapti River. However, patero jhar also provides safe habitat for some bird, fish and reptile species.
Patai	Waterthyme	Hydrilla verticillata	This species is found in waterlogged areas and small irrigation canals of the watershed. They provide habitat and food for aquatic life in proximity.
Puraini	Indian lotus	Nelumbo nucifera	Puraini once grew in three adjacent VDCs (Gadhawa, Falkapur and Paharuwa), but now is found only in recharge ponds in the Kulpani community forest (Barhara).
Galbhauka	Willdenow	Persicaria glabara	Galbhauka is found in the western reaches of the watershed, primarily in waterlogged areas. The species flowers pink in autumn and is occasionally utilized medicinally to treat sexually transmitted disease.
Biriya	Lady's Thumb	Persicaria maculosa	Poisonous to fish, locals grind the vegetative parts of biriya and mix into the water where it renders fish unconscious.

Muthi gond	Lakeshore bulrush	Schoenoplectus lacustris	Tharu households use Muthi gond to weave carpets and other fabrics. This plant is on the IUCN's "redlist" for endangered species.
NA	Water spinach	Epomoea aquatic	Water spinach can be harvested and sold in the market.

As noted above, fish play a central role in the domestic and economic health of the watershed, consumed by families and sold to markets along the East-West Highway. In surveys with local residents, they listed three species, in particular, as crucial to watershed health in terms of supporting households and capture fishing: carp (Nepali name: Rawa or Sai Chalne), Pangas catfish (Nepali name: Baikha), and Labeo dero (Nepali name: Kalmuda). These three species and others face numerous threats to their health and numbers (Table 4).

Table 4: Most significant threats to fish populations in the Middle Rapti watershed

Threat	Fish species affected	Locations where threat is acute
Habitat loss (e.g., landslides, river cutting)	All species	Bhaluwang, Balrampur, Mahadev, Jhakhaira, Madhyanagar
Raised riverbeds	All species	Upper Rapti
Destructive fishing methods (e.g., poison, electric current)	Baikha	Malmala, Badahara, Balrampur, Khaira, Bagarapur, Manpur, Balrampur, Bhagwanpur, Madhyanagar, Ratanpur
Fishing during spawning season	All species	Rapti River and tributaries
Dams and weirs blocking waterflow	All species	Rapti River and tributaries

Concerns about non-native fish species are growing. Fifty-nine percent of respondents said that fish numbers had decreased over the past decade, and many attributed that decline to the rising presence of mangur (catfish) in the watershed. Fishing groups have found catfish up to five kilograms in size in the Praganna Canal and Dolai Khola. The mangur feeds on native fish species such as carp. A flood in Phalkapur in 2017 indundated several carp farms, which released 90,000 carp into local rivers. Other non-native species to have appeared the watershed in the last 40 years include the roini, tilori, budana, manara, dam and jhinga.

Several bird species feed on fish in the watershed, including the Ruddy shelduck, Egretta garzetta, Babulu ibis, Columbia livia, Kingfisher, and Todorna ferruginea. A fuller list of avian species can be found in Annex 11. Conservation efforts for vultures have been established in Middle Rapti. In response to dwindling vulture numbers in the watershed in 2011, the Kalika CFUG created a retirement home for unproductive livestock to serve as a vulture feeding ground. Since then numbers have increased to more than 300 in the area, restoring this bird's important role in the ecosystem.

There are a few noted invasive plant species in the watershed, including wild sage (Lantana camera) and cattails (Typha). Wild sage has spread widely in the forests and across the Churiya range. The cattails have flourished along the Rapti River. While the cattails grow aggressively against other plant species, they do enhance soil retention and flood control.

Related annexes

Annex 8: Fish and aquatic life species
Annex 9: Mammals and population trend
Annex 10: Plants and population trend
Annex 11: Birds and population trend

1.5 CLIMATE AND PHYSIOGRAPHY

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

2.5.1 RAINFALL

There are no long-term rainfall data stations located in the Middle Rapti watershed. Stations located close to the watershed boundaries (at Ghoria, Kiolabas, and Bhagwanpur) were used to estimate rainfall amounts and patterns using the Theissen polygon method (Annex 4).

The average dry season rainfall is 167 mm, the average monsoon rainfall is 1,474 mm, and the average annual rainfall is 1,641 mm. Figure 7 illustrates the estimates from the various stations by month, and the blue line shows the average of these estimates for the entire watershed.

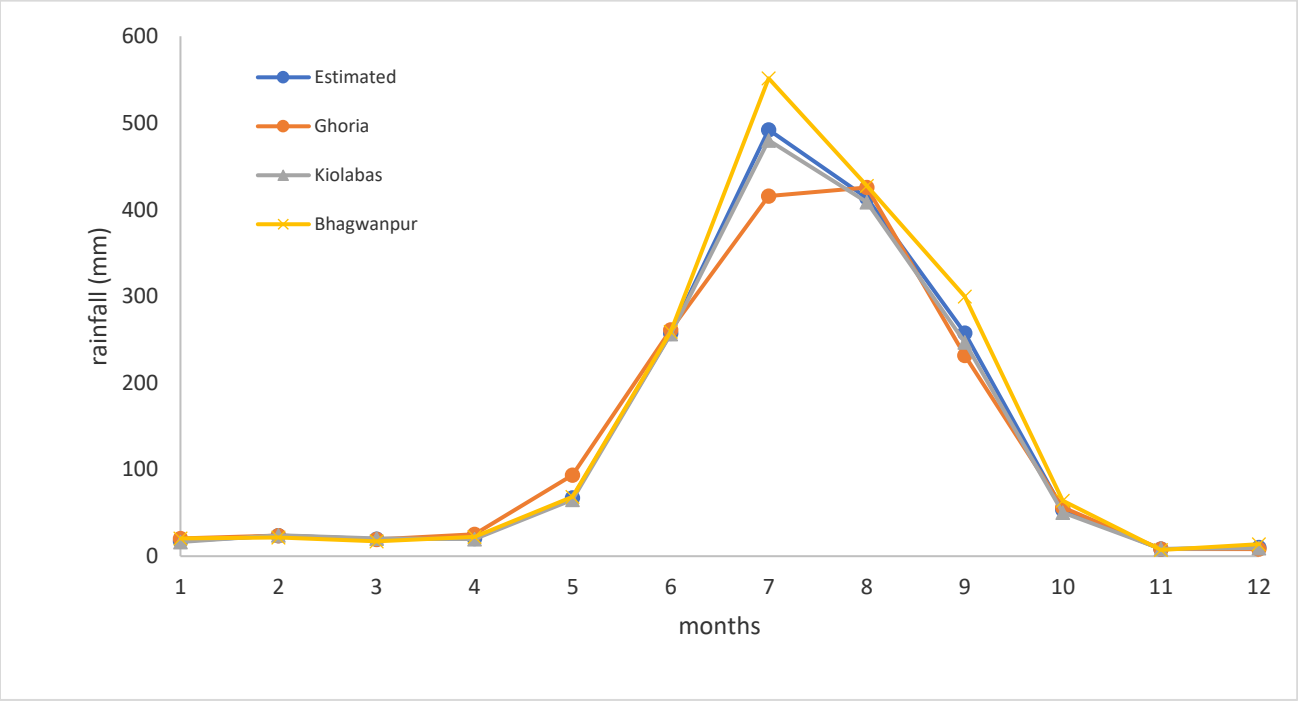


Figure 7: Long-term average monthly rainfall (in mm) estimated in the Middle Rapti watershed

Rainfall observations note a spatial variation in the watershed, though inconsistent. The annual rainfall in the northern part of Middle Rapti has been found to be decreasing at a rate of 10 mm/year while increasing in the southern portion at 10 mm/year.

2.5.2 TEMPERATURE

As for rainfall, no long-term meteorological stations sit within the Middle Rapti watershed; thus, temperature data from Ghorai Dang was used to estimate temperature trends.

Average monthly temperatures range from 14◦C in the winter to 28◦C in the summer months. The long-term average annual temperature variation in Middle Rapti watershed (figure 8) illustrates the variation across the watershed, due largely to changes in topography. In the northern portion the average annual temperature is 19◦C compared to 23◦C in the south and in the center through which the Rapti River flows.

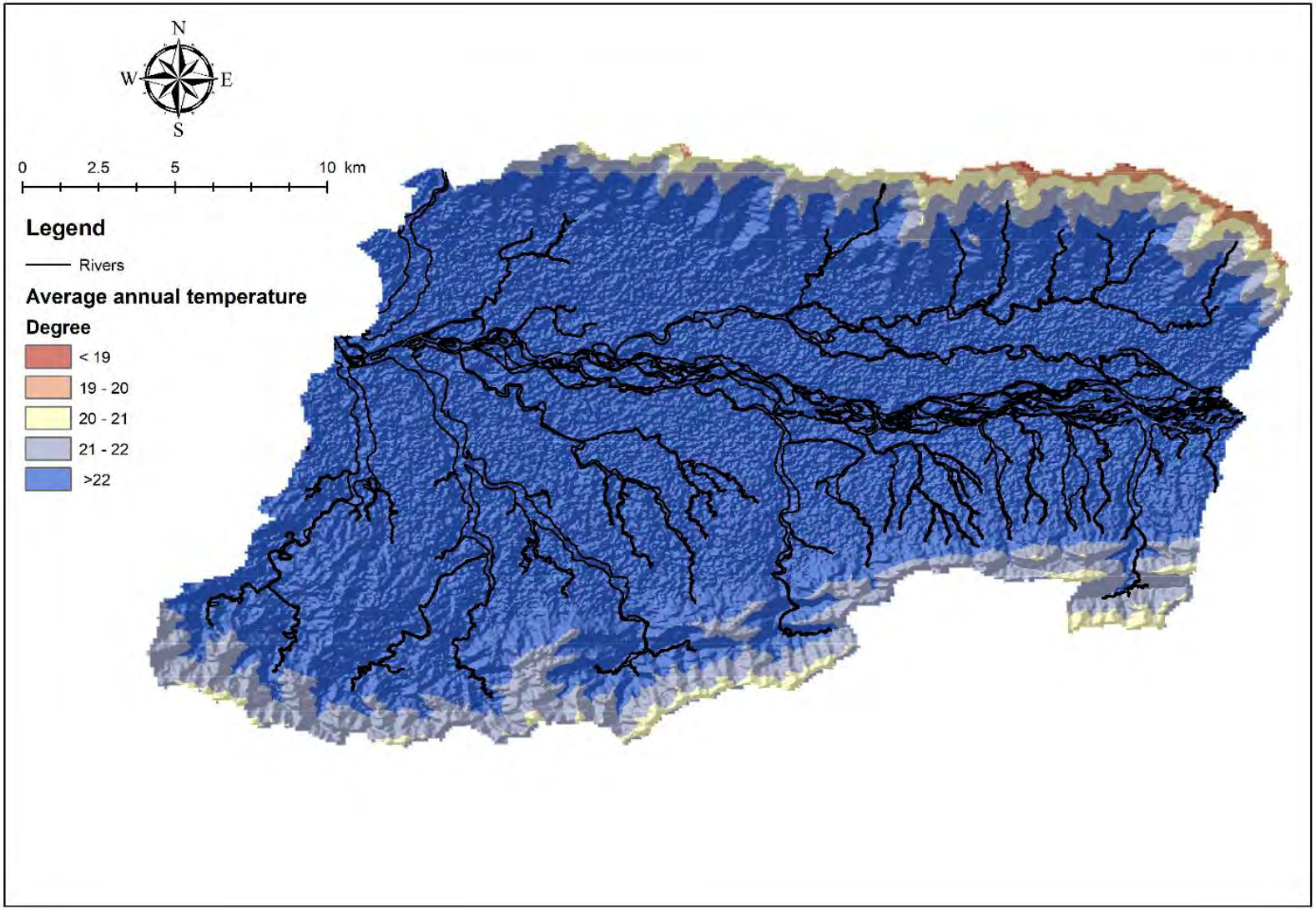


Figure 8: Mean annual temperature distribution (ºC) in the Middle Rapti watershed

Climate change is the trend of change observed in climatic variables over long period of time. Temperature and precipitation are most important variables which strongly affects the bio-physical and socio-economic setting of a location. Temperature and precipitation change can be observed in both temporal and spatial dimensions. Analysis of temperature and precipitation recorded at all stations in Nepal between 1976-2005, by Marahatta et al. (2009), shows an overall increasing trend of temperature and precipitation in the country. The average annual temperature in the Middle Rapti watershed is observed to be increasing at the rate of 0.02ºC/ year.

Related annexes
Annex 4: Temperature and precipitation

2.6 CLIMATE RESILIENCE AND DISASTER RISK REDUCTION

Increased human activity combined with climate change impacts are escalating environmental degradation in many parts of the Middle Rapti watershed, and in some cases, increasing the likelihood and intensifying the effects of natural hazards such as floods and landslides.

These effects are not going unnoticed by local residents. Survey results find that communities have noted increased temperatures (76%), decreased rain (66%), decreasing water sources (61%), prolonged dry seasons (60%), and increased flooding (36%) over the past decade.

Focus group discussions throughout the watershed compiled numerous anecdotes detailing the increasing hazard risk due to climate change impacts, such as the 2018 flooding in Kanchi Gaun, Jharbaira, Motipur, and Simri that claimed many houses and livestock.

In the event of future flooding, there is one early warning system at Bagasota, in the northern part of the watershed. High waters and heavy rain can trigger the system, which sends alerts to the communities downstream in Banke district. A red warning light station has been installed at Kanchi Gaun.

In response to these changes, communities have been collaborating with the District Disaster Risk Reduction Committee on assessments to determine their level of vulnerability to particular hazards on a 1-3 scale, one being the most acute (Table 5). For more immediate concerns, households have begun adopting low-cost technologies to conserve water sources and top soil, such as recharge ponds, river bank plantation, Gabion boxes, vegetable farming, solar pumps, and alternative energy promotion (e.g., biogas).

Table 5: Vulnerability ratings for selected GPs and NPs in the Middle Rapti watershed

SN	GP or NP	VDC	Flood risk	Epidemic risk	Landslide risk
1	Lamahi NP	Chaulahi	1	2	2
2	Lamahi NP	Sonpur	1	2	2
3	Gadhawa GP	Gadhawa	1	2	2
4	Gadhawa GP	Gangaparaspur	1	2	2
5	Gadhawa GP	Gobardiya	1	2	2
6	Rajpur GP	Bela	1	1	2
7	Rapti GP	Sisahaniya	1	2	2
8	Rapti GP	Lalmatiya	2	2	3

Related annexes

Annex 7: Climate change impacts in the Middle Rapti watershed

2. WEALTH

The population of the Middle Rapti watershed is 122,313, and increasingly located in the region's growing urban settlements at Lamahi, Sisahaniya, Bhalubang, Gadhawa, and Patthargadhawa. This internal migration to these cities is placing additional stress on the natural resources in these areas and increasing the amount of waste generated. To accommodate this internal migration, more and more agricultural land at these settlements is being converted to residential. Over the past five years, respondents noted that land brokers are buying farm land, breaking up the plots, and then reselling to buyers for house building.
Dang district (which overlays much of the watershed) is ranked 47 out of 75 districts in Nepal in terms of economic growth, posting an annual average of 0.485.

With a large, fertile floodplain, most households in the watershed claim farming as their primary livelihood, (53%) followed by wage labor (18%) and a variety of alternate occupations, detailed in Figure 10.

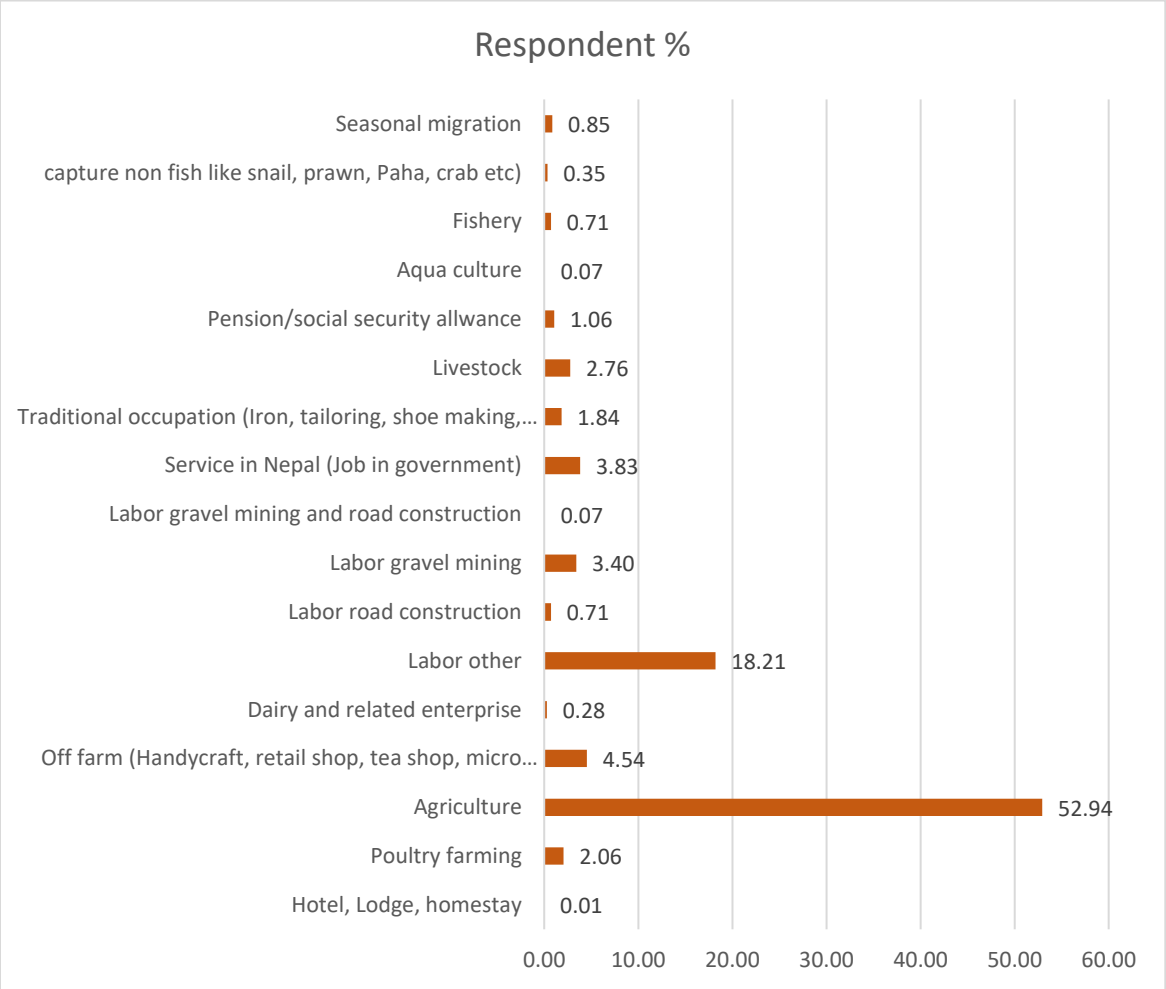


Figure 9: Primary livelihood sources for households in the Middle Rapti watershed

Until the 20th century, the area of the Middle Rapti watershed was primarily occupied by Tharus, an indigenous group that still largely resides in this region. The Tharu were protected from outside invaders by thick jungle cover and a natural immunity to malaria. Following malaria eradiction efforts in the 1960s, massive internal migration to the area began, diversifying the population but also marginalizing the Tharu people, who were forbidden by the government from owning land. As a result, many Tharu are still landless today, working either as fishermen or laborers.

Today, more than 150 social groups live in the Middle Rapti watershed, including Janajati (66%), Brahmin/Chhetri/Thakuri (19%), Madehsis (7%) and Dalit (6%). The watershed is unique for being a southern locale with a majority Janajati population. Tharus are considered Janajati.

Like many areas in Nepal, water and rivers play a central role in many cultural and religious events. Local Janajati groups believe the goddess Kuwarbatti resides in the river and provides blessings of wealth to those who honor her. During times of low rainfall or drought, Tharu women enact the Goru Behrna ritual, during which they steal ploughs from their husbands at night and take them into the field where they simulate farm work. The next day the women put on male dress and sing songs to Vishnu requesting rain. The Maghi Lahan festival is celebrated by the Magar and Tharu communities and calls for a ritual bathing in rivers and ponds for good health.

Banking with formal financial institutions is uncommon in the Middle Rapti watershed. Only 37% of respondents said they have bank accounts. Of that 37%, 30% of account holders are men, 37% are women, and 31% are joint accounts. The higher percentage of female account holders can be attributed to banks and cooperatives that seek to empower women through financial management. Several recognized banks and financial institutions have branches in the watershed, including Rastriya Banijy, Nepal Bank, Agricultural Development Bank, and NIC Asia, among others.

To bolster livelihood security against climate change impacts, we observed several climate-smart technologies in use, including drip irrigation and plastic tunnels for growing offseason vegetables. In spite of these adaptations, many families still struggle with maintaining a stable reserve of cash to support their households: 58% of families surveyed cannot maintain more than 10 months cash reserve to support their families (table 6).

Table 6: Household income reserves in the Middle Rapti watershed

Time period	Households	Percentage
Less than 3 months	85	10
4-6 months	216	26
7-9 months	175	22
10-12 months	338	41
NA	5	1
Total	**819**	**100.00**

3.1 FISHING PRACTICES

Middle Rapti is unique in that traditional fishing communities comprise 55% of the total population in the watershed. Tharu is the largest group (61,151) by far, followed by Kumal (5,973), Bote (158), Majhi (124), and Mallah (11). In focal group discussions, these communities said they harvested fish only for household consumption and not for sale. As fishing communities are traditionally poor, they relied on fish to sustainable family diets and fishing remains the main soure of livelihood. These communities also rely on traditional fishing methods, briefly described here:

Helka (Figure 10): A helka is a small, portable net made with jute fibers. Its light weight makes it ideal for women and children to use. The net is placed in the water to trap fish. This net is sometimes referred to as a diliya.

Figure 100: Photos of a helka diliya fishing net

Taapi (Figure 11): Taapi nets are slung between two bamboo poles crossed in an X formation. A taapi is best used in areas where fish are moving upstream. Fish swim into the net and cannot escape. Like a helka, the taapi is also lightweight and ideal for women and children to use.

Figure 11: Taapi nets being placed into the river in Middle Rapti

Dondiya Thapne (Figure 12): Dondiya are made using small bamboo sticks woven together with jute fiber to form a trap. There are separate types of dondiya used for trap fish moving upstream (sirka) and downstream. These traps can be set at night and pulled in the morning.

Figure 12: Dondiya traps in Middle Rapti

Khongiya (Figure 13): Khongiya traps are made from the middle rib of the thakal leaf. The ribs are woven together with babiyo (Eulaliopsis binate) fiber. The mouth is left open and the tail is tied shut to form the trap. Khongiya are used primarily to fish for charinga or hile.

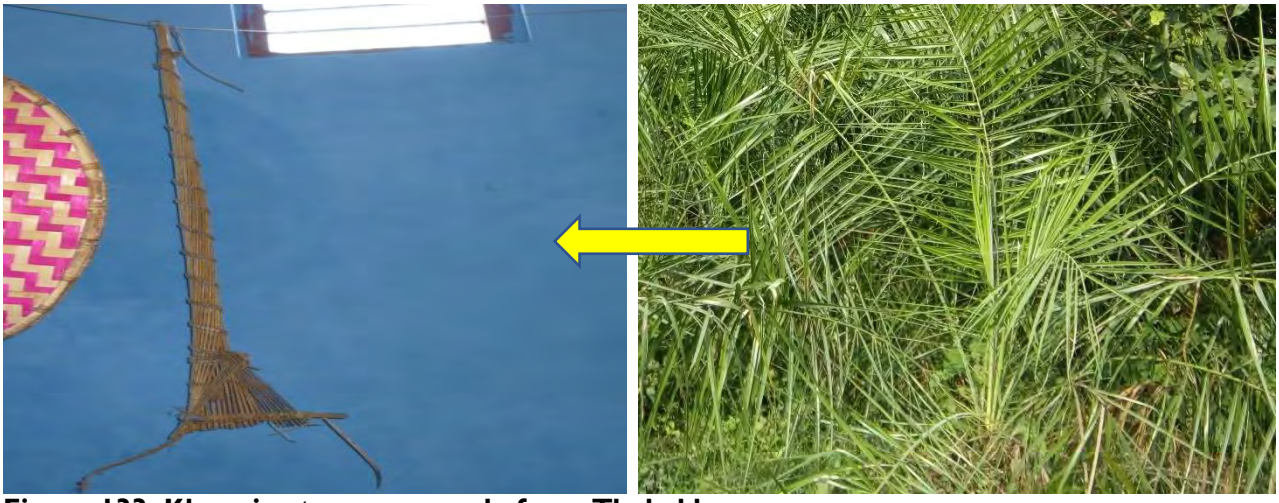


Figure 133: Khongiya traps are made from Thakal leaves

Jaal hanne (Figure 14): Jaal haane are nets made from silicon threads weighted with small iron pieces, which allow it to drag below the water surface to trap fish moving upstream. The typical jaal haane is homemade and takes only small numbers of fish at a time. However, in the eastern part of the watershed, respondents say larger versions of this trap are more common and desctructive.

Figure 14: A fisherman throws a jaal haane into a river in the Middle Rapti watershed

Pahai or Barerwa Tekne (Figure 15): A pahai is a fish trap installed in the river after monsoon. Wooden posts are driven into the river bed, and a net of gaular is strung around the posts. As fish move downstream, they swim into the trap.

Figure 15: A pahai is installed in the river after monsoon to catch fish after spawning

Mahuraune (Figure 16): Mahuraune is an herbal poison harvested from the husk of a garam plant. The husk is ground into powder then dropped into the river where fish are resting. This practice is most common in the Dolai Khola, Riti River, and Kakrahawa Khola.

Figure 16: Women grind and drop maharaune into a river in the Middle Rapti watershed

Tir kochna (Figure 17): Tir kochna, also known as tir hanne, is a bow and arrow method that uses an iron-tipped arrow, bamboo stalk and rubber band. The arrow is fired at close distance into the water. This method is popular among young people.

Figure 17: Young people favor the tir kochna method of fishing in Middle Rapti

As indigenous and largely marginalized people, traditional fishing groups like the Tharu, have a privileged right to fish in Nepal, as well as specially protected access to water and forest products. Given that fishing groups are largely landless communities, having access to these resources is crucial to their existence.

The growing presence of commercial fishing groups in the watershed, however, poses a significant threat to these groups as their harvesting methods are aggressive and unsustainable.

In addition, increasing environmental pressures (e.g., landslides) are endangering aquatic habitats and applying more stress on available fish. Kumal fisherman reported that thedh fish had reduced in number due to increasing sediment loads. All fishing communities surveyed reported that daily catch potentials had declined from 5 kgs to 2-3 kgs over the past decade.

To compete with these pressures, interviews and surveys revealed that more local residents are turning to destructive fishing methods to ensure they meet their daily needs for consumption and income. These methods include electric current and gelatin explosives.

Markets for fish sales are growing in step with the rising population in urban settlements. Markets for fish are now available in Lamahi, Bhalubang, Gadhawa, and Sisanhiya. In times of larger demand, fish can be sold in Darban and Dang Gorahi.

Research also found that many fish imports were arriving via aquaculture farms in India, presenting another competitive force against traditional fishing communities.

3.2 AGRICULTURE PRODUCTIVITY

Agriculture is the primary livelihood (53%) in the Middle Rapti watershed, and 30% of the land is under cultivation, primarily in the fertile floodplains along the Rapti River. Farmers grow paddy, maize, wheat, lentils, and mustard as staple crops, and many are adopting off-season vegetables to generate additional income.

According to DADO, the watershed is the most productive area in the district in terms of production per hectare: paddy (4.1 mt), wheat (2.5 mt), maize (2.02 mt), and lentils (0.9 mt). While these numbers foster hope in terms of food security and livelihoods, climate change impacts in the form of floods, landslides, rising temperatures, and drying water sources are threatening these conditions. Furthermore, unproductive conditions in the Siwaliks in the northern part of the watershed are encouraging migration to the flood plain, adding more pressure on the natural resources through over grazing and degraded forests.

The government of Nepal has promoted irrigation in the watershed as a means to soften these pressures (more details in section 3.3.4) with large-scale schemes (e.g., Praganna Kulo and Badka Path), which cover more than 7,000 ha combined. Total irrigation coverage in the watershed is 10,774 ha.

Farmers can access technical support through the District Agriculture Development Office (DADO), which provides trainings in agriculture, horticulture and water use. Some USAID-funded projects, such as KISAN and SUAAHARA, provide technology demonstrations, such as plastic tunnel farming, water recharge ponds, and drip irrigation. Higher-quality seeds are available through some private vendors and the DADO. A community seed bank in Bagrapur has been established but is not yet open.

Produce is sold in market centers located in Lamahi, Bhalubang, Gadhawa, and Sisanhiya.

3.2.1 SOIL MANAGEMENT AND FERTILITY

As noted above, the flood plains of the Middle Rapti watershed provide fertile soil for agricultural production. The clay and loamy soil have high capacity for holding rain water. But the northern rim of

the watershed, along the Siwaliks, is comprised of fragile substrate prone to erosion, exacerbated by overgrazing and timber harvesting.

Local perceptions on soil fertility over the past decade are mixed: 47% of households said it had declined, 17% said it had not changed, and 35% said it had increased.

Farmers are increasingly turning to synthetic inputs to ensure robust agricultural productivity: 47% said they use chemical fertilizers, which raises concerns about water quality and agricultural run-off into rivers and local water sources.

3.3 INFRASTRUCTURE

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

3.3.1 GRAVEL MINING

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

Gravel mining has been a significant source of revenue in the Middle Rapti watershed since 1991, with the revenue going primarily to the Dang district government. The district government then distributes 35-40% of those funds to Village Development Comittees (VDCs) and municipalities for development projects. According to the (District Development Committee (DDC) in Dang, there are 13 gravel mining sites in the Middle Rapti watershed, extracting approximately 2.04 million cubic meters of sand, stone, and gravel per year.

In the new federal system, *gaunpalikas* (GP) and *nagarpalikas* (NP) will hold authority to draw revenue from mining projects in their respective areas. At the start of each year, the GP/NP will issue contracts to private operators stipulating the maxmimum amount of excavation allowed and the agreed upon price. For example, in Rapti GP, a contract has been awarded for 67,646 m^3, of which USD 143,333 will go to the Rapti NP government. The Rapti NP government has already earmarked USD 33,333 of this revenue for environmental protection and disaster risk reduction projects.

Local interviews and focus group discussions revealed that local opinion holds that gravel mining does not need to be halted in the watershed, but monitoring of the sites to minimize environmental impacts needs to be improved. Many respondents noted that gravel mining has negatively impacted fish habitats in the Rapti River. Around the Balrampur Bridge, local residents suggested that mining was exacerbating floods downstream.

Related annexes
Annex 16: Gravel mining in the Middle Rapti watershed

3.3.2 ROADS

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

There are 136.5 km of roads in the watershed: 64 kms are black-topped while the rest is earthen or gravel. Chailahi, Sonpur, Siseheniya, and Lalmateaya are connected along the East-West highway, which runs through the watershed from the Rapti Bridge (in Bhalubang) to the Arjun Khola (in Chalilahi).

Focus group discussions reveal that some rural road building has been conducted without proper prior environmental assessments in Sishaniya (e.g., an 8 km road from Kalapani to Karnagekot). The contractor reportedly cut a water supply pipe in Pipaldana Tole. Members of local CFUGs attempted to remediate the impact of this road by planting grass along the road sides.

Related annexes
Annex 12: Road networks in the Middle Rapti watershed

3.3.3 IRRIGATION

While irrigation is necessary to improve livelihoods and economic development in the watershed, the amount of water diverted directly affects aquatic life. Keeping minimum flows intact is crucial to maintain watershed health.

Irrigation schemes in the Middle Rapti watershed cover 10,774 ha of land. The Praganna irrigation project in parts of Sonpur, Chailahi, and Sishaniya accounts for more than half of that coverage at 5,800 ha. Most of the schemes range between 50-500 ha.

The irrigation systems are susceptible to environmental impacts. In 1989, the Badaka Path scheme was destroyed by river cutting on the Rapti River. It has not been restored since that time. In focus group discussions, nearly all participants voiced concerns about low water levels and prolonged dry periods that render irrigation systems useless.

The dry periods have also given rise to conflict between irrigation system users. The villages of Kathberuwa and Materiya argued in 2001 over the amount of water diverted to each scheme. Kathberuwa releases water downstream to Materiya, and they proposed creating one main irrigation canal to run between the villages. People in Materiya rejected the proposal and took the matter to the district court. Today, both villages complain of low water levels for irrigation.

Looking at water sources for irrigation, 29% use rain water collection, while 22% extract ground water. Eighteen percent of households use canals to bring water from the river, and 5% draw from nearby ponds. Six percent of the households in Middle Rapti are landless and thus do not have access to benefits from available irrigation.

Focus group discussions reveal that tail end users have encountered the most difficulty obtaining water, due not only to low water levels but also poor canal management that allows sediment to build up and obstruct passage.

Related annexes
Annex 13: Irrigation schemes in the Middle Rapti watershed

3.4 SOLID WASTE AND MANAGEMENT

Solid waste (e.g., garbage, plastics) in the watershed emanates from a number of sources and the lack of sanitation systems, personal and village-wide, threatens water quality and aquatic life.
Major solid waste points are found in urban settlements with markets: Lamahi, Sishaniya, Pathargadhawa, Bhalubang, Kalakate, and Gadhawa. Field observations found large quantities of plastic waste, household sewage, and animal carcasses in these areas.

Waste reuse is comparatively high in the Middle Rapti watershed. Household surveys found that 88% of repondents use solid waste as compost in their gardens and fields. Seven percent use local landfill sites, and 5% take refuse to nearby dumping sites. Household liquid waste is used in family gardens (57%), released into nearby sewers (25%), or disposed in nearby water sources (16%).

Regarding non-point source pollution, agricultural runoff is becoming a larger concern as the use of chemical fertilizer expands in the watershed. To ensure productivity, more farmers are turning away from organic inputs. The slightly elevated levels of ammonia and phosphate in some areas provide evidence to support this concern.

In Lamahi GP, the local government has instituted a waste disposal facility in the Ajammari community forest. However, the facility incinerates the waste, which has reportedly resulted in small forest fires and solid waste running down into the river during times of heavy rain and/or floods.

Related annexes
Annex 15: Major pollution points in the Middle Rapti 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 Middle Rapti watershed. Analysis indicates there is a need to better understand how current institutional arrangements related to, for example, fisheries and gravel mining are positioned (or not) to improve resource sustainability and benefit sharing with local populations.

4.1 ACCESS AND INCLUSION

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

4.1.1 ACCESS TO WATER FOR DOMESTIC AND AGRICULTURAL USE

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

As noted in section 2.2, water availability and access are not acute concerns in the Middle Rapti watershed. More than half the households have access to water in their households, while 35% say they spend less than 15 minutes per day obtaining their daily requirement. Similarly, on the question of access, 95% of households say they have equal access to available water. Notably, of the 5% claiming unequal access to water, 94% were Tharu and/or Kumal, strongly suggesting possible ethnic discrimination.

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

These new governance responsibilities suggest time is appropriate to work closely with local authorities to develop plans to promote improved watershed health. Figure 1 shows the three new gaunpalika and one new nagarpalika that are part of the Middle Rapti watershed. The following seven agencies are the main agencies responsible for water resource management in Middle Rapti:

1. District Coordination Committee (Dang)
2. Drinking Water Supply and Sanitation (Dang)
3. Irrigation Division Office (Dang)
4. District Technical Office (Dang)
5. DivisionForest Office (Dang)
6. Soil and Watershed Management Office (Dang)
7. District Agriculture Knowledge Center (Dang)

While each of the agencies have an important role for water management, DFO, DSCO, and DADO provide the largest offering of support through trainings, administration of resources, and environmental assessment.

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

As noted in section 2.6, there is a siren-based early warning system at Bagasota in the northern part of the Middle Rapti watershed that sends alerts to downstream communities in Banke district. A red warning light station has been installed at Kanchigaun.

When flood and landslide conditions arise, alerts are also disseminated to communities through SMS, radio, and television. However, surveys found that only 68% of households said they had access to such disaster risk reducation-related information. Of that 68%, 80% said they believed their access to this information was equal to that of other social groups.

Local Adapation Plans of Action (LAPA) and Community Adaptation Plans of Action (CAPA) are documents meant to guide government and households alike in term of minimizing the effects of natural hazards and climate change impacts on daily life. By charter, LAPAs and CAPAs are meant to be participatory processes, working up from local levels to NP/GP levels. However, 22% of surveyed households said they were aware of these planning sessions in Middle Rapti.

Related annexes

Annex 20: Areas in Middle Rapti with existing LAPA or CAPA

4.1.3 ACCESS AND INCLUSION IN LOCAL NATURAL RESOURCE MANAGEMENT (NRM) PLANNING

In the Middle Rapti watershed, water availability is a pressing concern, but so are forests and the many NTFPs and ecosystem services they provide. As the need for economic development continues to be addressed, many people living in the watershed have concerns for balancing livelihoods with sustainable livelihoods and biodiversity conservation.

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

There are currently 95 CFUGs active in Middle Rapti comprised of 22,870 households. Collectively, these groups manage 24,482 ha of forest in the region. CFUGs take the lead in monitoring and regulating forestry use for their group. While full caste/ethnic representation data is not available, Paani surveys found that 72% of Tharus claim membership with a CFUG.

By government mandate, female representation in NRM groups is to be at least 33%, including roles on leadership committees. Table 7 provides male and female participation in CFUGs of the Middle Rapti watershed. As the table demonstrates, there is wide varation in proportionate representation, with a few VDCs exceeding the minimum by many points, compared to others that fall well below the stipulated baseline.

Table 7: Members in Middle Rapti CFUGs disaggregated by sex

SN	Municipality	VDC	Number of CFUGs	Male	Female	Total	Percentage female membership
1	Lamahi NP	Chaulahi	11	77	78	155	50.3
2	Lamahi NP	Sonpur	12	108	36	144	25.0
3	Gadhawa GP	Gadhawa	14	60	104	164	63.4
4	Gadhawa GP	Gangaparaspur	9	48	53	101	52.5
5	Gadhawa GP	Gobardiya	20	159	62	221	28.0
6	Rajpur GP	Bela	14	120	50	170	29.4
7	Rapti GP	Sisahaniya	8	80	19	99	19.2
8	Rapti GP	Lalmatiya	7	74	18	92	19.6

The Federation of Drinking Water and Sanitation Users Nepal (FEDWASUN) represents water users in Middle Rapti while the National Federation of Irrigation Water Users Nepal (NFIWUAN) provides leadership on irrigation issues. The Dalit Alliance for Natural Resources (DANAR) explicitly addresses natural resources issues as they affect Dalits and other marginalized groups.

All GPs and NPs in Middle Rapti have a stated policy of cultivating local participation in NRM planning. However, when surveyed, only 24% of respondents said they are involved in an NRM group.

Related annexes

Annex 17: Community forest user groups in the Middle Rapti watershed
Annex 18: Water and sanitation user groups in the Middle Rapti watershed

4.1.4 ACCESS TO BENEFIT SHARING IN THE WATERSHED

According to Nepal's Forest Development Guidelines 2008, a CFUG distributes benefits (and charges for forest products) based on a well-being ranking of its members. In other words, a CFUG leadership committee assesses what each member household can afford to pay for forest products based on their income. In this way, CFUGs attempt to provide proportional access and affordability to all families, particularly those from marginalized communities. It should be noted that this process varies in detail from group to group.

With irrigation and drinking water systems, communities in Middle Rapti employ the Jharali system. At the start of each year, households are assessed based on ability to pay and then are charged a *kalmi* as payment. A *kalmi* is an area of land for which a household is responsible to maintain the irrigation canals. *Kalmi* assessments are typically one or two *bigha* of land – 0.66ha and 1.33ha, respectively. When an assigned family member falls ill and cannot perform the expected work, the leader of the Jharali system approves the exemption from duty. For single women or elderly, a nominal water tax is charged in lieu of labor.

4.2 COMMUNITY ACTION AND RESPONSE

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

4.2.1 CLIMATE CHANGE ADAPTATION AND DISASTER RISK REDUCTION

As a majority of the population in the Middle Rapti watershed is dependent on climate-sensitive agriculture, variations in temperature and precipitation are causing serious livelihood distress to communities in the watershed. To adapt to these changes, many farmers have adopted climate-smart technologies to strengthen their crops and livestock and to promote resilient food systems. Some of these include, off-season vegetable farming, bio-gas harvesting, recharge ponds, no grazing zones, and Gabion boxes.

At the government level, Local Adaptation Plans of Action (LAPAs) and Community Adaptation Plans of Action (CAPAs) are intended to prepare delivery of adaptation services to the most climate vulnerable areas and people of Nepal. Presently there are 52 CAPAs and 7 LAPAs implemented in the Middle Rapti watershed. The plans of action focus specifically on building resilience into hazard-prone areas through projects designed to protect water sources, minimize soil erosion, and reduce flood and landslide risk. Though initially designed with support from the national government, it is expected that local communities gradually assume ownership of LAPAs and CAPAs for the long-term.

A Local Disaster Risk Management Plan (LDRMP) has also been implemented for the district. The plan defined and coordinates disaster response responsibilities for the district, which includes collaboration from government agencies (including military and police) and numerous non-profit organizations such as the Nepal Red Cross.

In spite of these planning efforts, it appears that local knowledge of these resources is low: only 22% said they were aware of LAPAs or CAPAs in their areas.

Related annexes

Annex 20: Areas with prepared LAPAs and CAPAs

4.2.2 COMPLIANCE WITH LAWS AND POLICY PROVISIONS

Focus group discussions and key informant interviews revealed that compliance with conservation-related policies was low in the Middle Rapti watershed, particularly in regard to fishing. The Sahani community in Rautahat was cited for using large nets with small mesh that draw all sizes of fish from the water. In addition, this group was accused of fishing every day and negating the possibility for fish to move upstream and downstream as needed for reproduction and growth. Respondents also noted that the use of destructive fishing practices such as electric current and gelatin explosives were on the rise. Practices such as these noted here violate the country's Aquatic Animals Protection Act of 1961. And, even though this law is now more than 50 years old, many respondents say its provisions are rarely enforced.

4.3 GOVERNANCE

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

Through 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.

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

Regarding upstream/downstream coordination, respondents indicated general satisfaction with the established links. Downstream users, in particular, said that upstream communities were making responsible use of soil, water and forests.

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

Furthermore, while households report satisfaction with upstream-downstream resource use, formal coordination at the government level is lacking, inside Middle Rapti and trans-watershed to Jhimruk upstream.

One note of concern was voiced on the issue of water pollution. Downstream households cited several villages – Bhalubang, Sisahaniya, Lamahi, Gadhawa, and Patthargadhawa – for increasing the amount of improperly disposed solid waste leaching into the Rapti River. As at Sisahaniya, households pointed to the large market place, while in Lamahi, several homes have septic systems that link directly into local waterways. These concerns may be alleviated in the coming years as local governments are allocating more annual resources for water management and sanitation: USD 14,400 in Rapti NP, USD 15,000 in Gadhawa NP, and USD 3,056 in Lamahi GP.

5. RANKING ENVIRONMENTAL ISSUES IN MIDDLE RAPTI

Stakeholders in the Middle Rapti watershed were asked to list environmental concerns, and particularly their anxieties related to sustainability and livelihoods. As many rural Nepalis depend more closely than most on natural resources to support their households, stakeholders cited the advancing degradation of water, forests, and aquatic habitats as major concerns. The full summary of environmental priorities is presented in Table 8 in order of perceived severity.

Table 8: Environmental issues by priority ranking in the Middle Rapti watershed

SN	Issue	Rating
1	Haphazard road construction	High
2	Decreasing water availability	High
3	Flooding and river cutting	High
4	Declining water quality, water pollution	High
5	Declining fish numbers	High
6	Gravel mining, overextraction	Medium
7	Water use conflicts	Medium
8	Landslides	Medium

This table presents issues identified through a community survey, the responses to which were later validated during a multi-stakeholder consultation (MSC) exit workshop. The participants were selected from a wide range of backgrounds representing local residents, civil society groups, and government agencies.

After creating a full list of environmental challenges, including issues related to scope, severity and local interest, participants were asked to vote for issues based on their perceptions of urgency in the need to address. The participants agreed to use voting to prioritize the issues. Men and women voted separately and the results were reported back to the panel to develop a final list.

6. PRIORITIZING MAJOR THREATS AND OPPORTUNITIES

During the MSC exit workshop, participants also listed the major threats, challenges, and opportunities for watershed health in Middle Rapti. Their comments are summarized in Table 9.

Table 9: Threats and opportunities for improved watershed health

Threat	Opportunity
Flooding, river cutting and sedimentation	• Construct embankments • Establish comprehensive early warning system • Promote bio-engineering techniques for soil retention • Incorporate GESI concerns into local NRM planning • Enhance adaptive capapcity of marginalized groups • Regulate road construction to follow environmental guidelines
Drying water sources	• Promote water harvesting and water reuse technologies • Build recharge ponds and water infiltration systems • Promote afforestation • Promote conflict resolution over water use • Prepare long-term vision for water use planning • Raise local awareness on water issues • Promote environment-friendly road construction
Destructive fishing practices	• Control destructive fishing practices • Reduce pesticide use • Regulate capture fisheries • Document indigenous fishing practices and traditional fishing community cultural practices

7. VISION AND MISSION OF MIDDLE RAPTI WATERSHED

This Middle Rapti watershed profile has been prepared through various consultative processes, actively engaging with stakeholders from media, civil society organizations, government agencies, government offices, and environmental research institutions (e.g., universities).

7.1 VISION OF MIDDLE RAPTI WATERSHED

At the exit MSC workshop held in Dang district in 2017, participants were divided into three groups to craft a vision statement for the Middle Rapti watershed as they wished to see it 20 years from now.

The groups were then brought together, and with assistance from a facilitator, they devised a single mission statement to represent the concerns all stakeholders:

"For a Middle Rapti watershed economy that will develop to ensure people's prosperity through biodiversity and natural resource conservation with assurances for social justice, sustainable management, and multiple uses."

7.2 COMMITMENT FOR CONSERVATION OF MIDDLE RAPTI WATERSHED

Using the threats, challenges, and opportunities to watershed health (Table 8), 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). These ideas have been organized by watershed theme in Table 10.

Table 10: Action commitments for addressing environmental issues in the Middle Rapti watershed

Issue	Activity
Soil erosion/landslides	• Install 7 meters of check dams • Plant 10 meters of river bank
Decreasing water levels	• Construct recharge ponds
Drying water sources	• Restore river banks • Improve water source protection
Declining fish numbers	• Coordinate with NEFIN to discuss and promote responsible fishing methods and harvests • Promote awareness of the impact of destructive fishing methods through newly-established federal agencies
Degraded wetlands	• Restore river banks

8. RECOMMENDATIONS

The Middle Rapti watershed profile assesses the status, major challenges and opportunities facing water resources management for the multiple users located within the region. Based on the discussions at the workshops, stakeholders proposed the following final recommendations by theme to improve climate change adaptation and freshwater biodiversity in the Middle Rapti watershed:

Floods, landslides, and river cutting

- Provide training and support for low-cost stabilization techniques for slopes and river banks;
- Provide improved support to control water runoff;
- Raise awareness about forest fires and open grazing, and the relation of these phenomena to landslides and flooding;
- Strengthen the early warning system in Middle Rapti;
- Construct raised water taps and toilets;
- Conserve wetlands to aid flood control;
- Disseminate materials through radio and print promoting watershed management best practices;
- Improve implementation of disaster preparedness and response plans (DPRP) and local disaster risk management plans (LDRMP); and
- Raise and/or relocate infrastructure (e.g., shelter houses, taps) out of flood plains and other vulnerable areas.

Declining fish numbers and unsustainable fishing practices

- Form fishing groups to discuss sustainability and cooperation issues on the river;
- Develop and endorse capture fishery guidelines;
- Initiate dialogue with state government agencies (once established) to discuss fishing issues;
- Conduct survey of capture fishery groups;
- Promote ecotourism as alternative livelihood option for traditional fishing communities;
- Mobilize community-based anti-poaching units (CBAPUs) to combat destructive fishing practices; and
- Build capacity in community forest user groups (CFUG) to monitor aquatic biodiversity and reduce overfishing threats.

Drying water sources

- Restore degraded forest area through plantation and natural regeneration;
- Promote use of rain water harvesting technologies, such as rainwater tanks and water recharge ponds;
- Improve soil erosion control; and
- Conduct awareness programs on water use policies.

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ANNEXES

Annex 1: Profile methodology

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

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

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

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

2. An entry multi-stakeholders consultation [MSC] conducted to

    a) Share preliminary results of watershed conditions;

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

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

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

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

5. KIIs to explore the causes and intensity of the particular environmental issues in the watershed. Different guiding checklists designed around Paani focal interest areas, cross cutting areas, were used while conducting surveys including governance, gender and social inclusion and policy (Figure 8, below).

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

The HH survey data (Table 11) were organized into four broad categories: a) climate change and biodiversity; b) livelihoods and well-being; c) water sources; and d) water quality. The surveys were conducted in locations that were selected during the entry MSC as participants indicated specific issues and challenges appropriate to their respective areas.

Table 11: Household (HH) surveys by topic and number conducted

Subject of HH survey	Number conducted
Biodiversity and climate change	1,240
Livelihoods and well-being	1,031
Water sources	1,411
Water quality	893
Total	**4,575**

To complement the surveys, we conducted 39 FGDs and12 KIIs to investigate the key issues identified by households. Water quality and discharge were measured by Paani staff using the Akvo Flow Mobile App.[4]

Figure 18: Methodological approach illustrated

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

Annex 2: Land use and land cover

Table 12: Land use and land cover

Land use	Area (sq km)	Percentage
Cultivation	134.80	29.71
Forest	278.05	61.28
Grazing	1.42	0.31
Ponds/lakes/reservoirs	0.11	0.02
Rivers/streams	37.44	8.25
Urban	1.89	0.42
Total	**453.71**	**100**

Table 13: Revived springs in the Middle Rapti watershed by location

SN	VDC location	Latitude	Longitude	Altitude	Altitude range (m)	Type
1	Gobardia-1	N27°48'52"	E82°45'42"	304	300-500	fracture/joint
2	Gobardia-2	N27°47'06"	E82°42'59"	330	300-500	river fed
3	Gobardia-8	N27°48'02"	E82°37'28"	233	300-500	river fed
4	Gobardia-9	N27°46'04"	E82°36'41"	425	200-500	contact/river fed
5	Gadhuwa-5	N27°45'34"	E82°32'31"	330	300-500	fracture/joint
6	Bela-2	N27047'38"	E82°25'45"	310	200-600	contact/river fed
7	Chhaulahi-3	N27°54'01"	E82°31'10"	330	300-700	fracture/joint
8	Lalmatia-7	N27°51'21"	E82°53'57"	352	300-700	fracture/joint
9	Shisania-7	N27°52'44"	E82°38'37"	400	300-500	alluvium/fracture
10	Sonpur-8	N27°54'40"	E82°36'43"	700	400-900	fracture/joint

Annex 3: Population

Table 14: Population by VDC, municipality, sex, and caste/ethnicity

Municipality (GP or NP)	VDC	Total population							
		Sex dist.			Population by caste/ethnicity				
		M	F	**Total**	BCT	Dalit	Janajati	Other	Madheshi
Lamahai NP	Chaulahi	9,874	10,822	20,696	5,186	719	13,840	264	687
Lamahai NP	Sonpur	6,571	7,018	13,589	2,794	655	9,972	146	22
Gadhawa GP	Gadhawa	5,393	6,037	11,430	2,287	805	6,411	121	1,806
Gadhawa GP	Gangaparaspur	5,366	5,606	10,972	1,712	536	6,820	196	1,708
Gadhawa GP	Gobardiya	7,331	7,991	15,322	1,752	1,238	11,137	556	639
Rajpur GP	Bela	5,409	5,836	11,245	1,507	2,049	4,655	191	2,843
Rapti GP	Sisahaniya	8,448	9,222	17,670	2,145	651	14,629	117	128
Rapti GP	Lalmatiya	10,236	11,153	21,389	6,089	1,248	12,657	854	541
	TOTALS	**58,628**	**63,685**	**122,313**	**23,472**	**7,901**	**80,121**	**2,445**	**8,374**

Annex 4: Temperature and precipitation

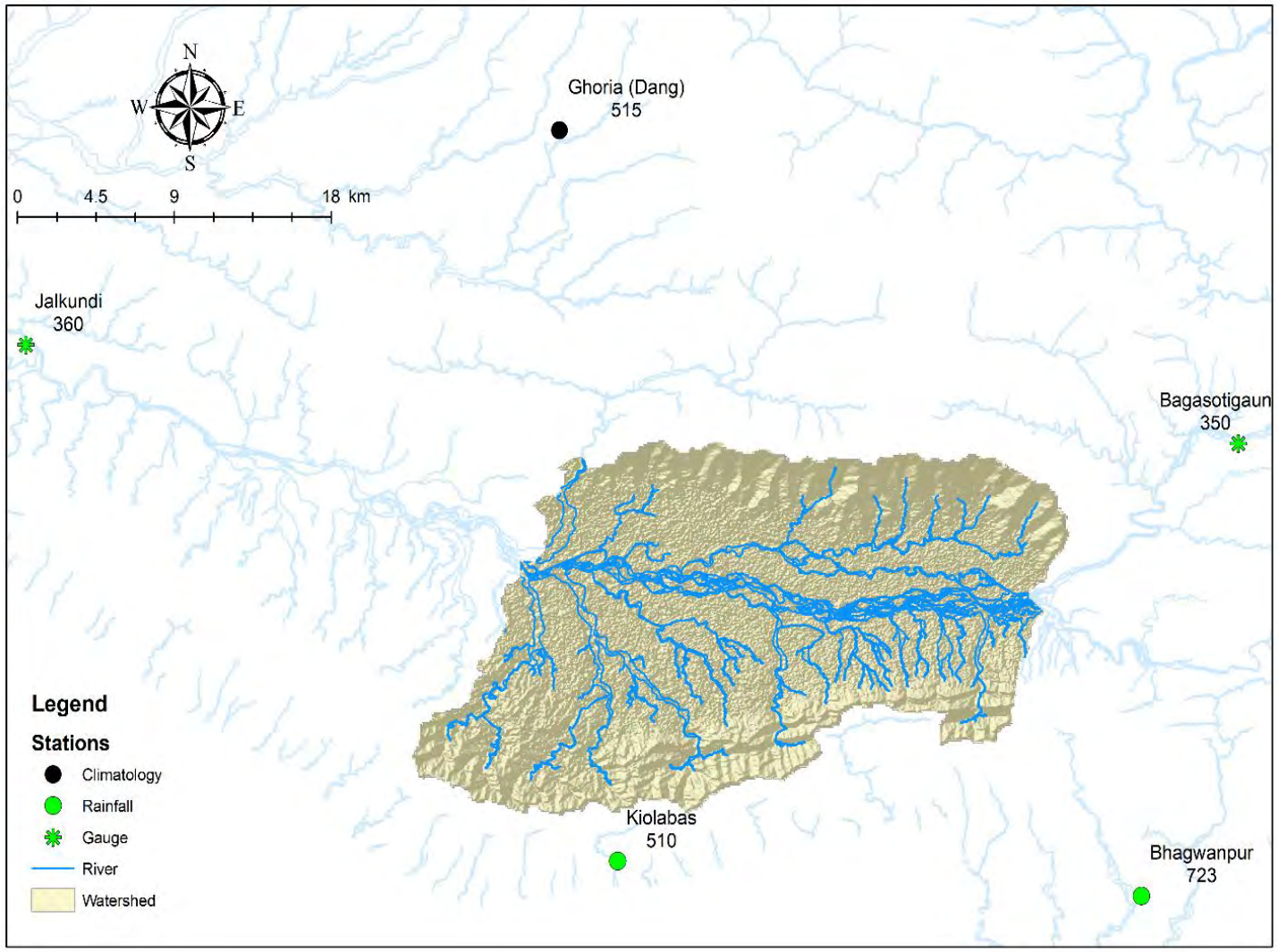

Figure 19: Locations of hydrological and meteorological stations used to determine rainfall and temperature trends in the Middle Rapti watershed

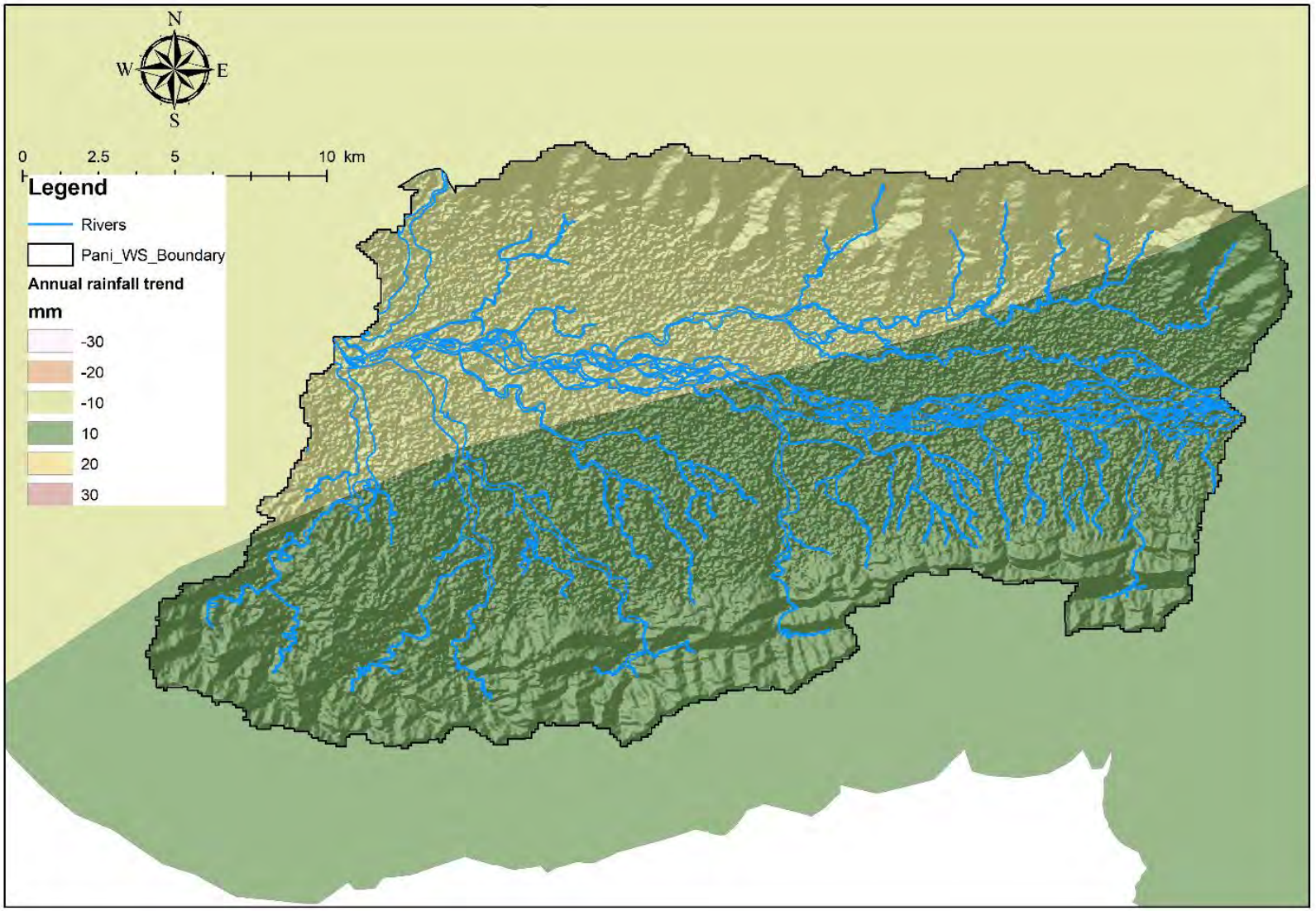

Figure 20: Long-term annual mean rainfall trend (mm/year) observed in the Middle Rapti watershed

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

Table 15: Water Bodies in Middle Rapti watershed

SN	Water Bodies	Status
1	River	The Rapti is the lone river in the watershed, a rainfed waterway that originates in Pyuthan and flows south toward Banke National Park and eventually into the Ganges River in India.
2	Small River	Forty-seven smaller rivers, or tributaries, flow into the Rapti River. Upstream from their confluence, they provide valuable ecosystem services to households, including irrigation and drinking water. In the winter season, however, many of these small rivers maintain extremely low flows or dry up altogether.
4	Wetland	The watershed contains only one wetland (as defined by the DADO) at Jakhera Tal. Jakhera Tal functions as a nesting ground for birds and other important ecosystem services such as water recharge and water filtration.

Table 16: List of rivers and tributaries in the Middle Rapti watershed (and length)

SN	Name	Length (m)
1	Ambas Khola	2,277.76
2	Arnahawa Khola	9,506.37
3	Bagai Khola	4,194.39
4	Bage Khola	8,753.48
5	Baghai Khola	4,809.60
6	Bauharwa Khola	8,749.53
7	Bhulke Khola	7,651.71
8	Bhulkiya Khola	2,155.04
9	Budhi Khola	3,045.53
10	Buke Sota	292.98
11	Chainpur Sota	9,605.22
12	Chaniyaha Khola	3,408.93
13	Dhamile Khola	2,944.21
14	Dharamdoriya Khola	2,341.31

15	Dolai Khola	18,689.79
16	Gangre Sota	6,463.87
17	Ghangrawal Khola	105.31
18	Gidrahawa Khola	6,294.19
19	Goimaha Khola	4,388.70
20	Gurung Khola	18,318.79
21	Hattipaila Khola	10,045.11
22	Jhadi Khola	6,014.39
23	Kakraha Khola	13,433.48
24	Karaudi Khola	3,933.29
25	Kataghari Khola	10,482.10
26	Kaudiya Khola	5,825.19
27	Khabri Khola	24,637.53
28	Khairahawa Khola	9,262.13
29	Mainhawa Khola	4,121.46
30	Mandriniya Sota	5,084.75
31	Narti Khola	11,803.89
32	Padmini Khola	483.02
33	Paneswa Khola	7,309.04
34	Pipari Khola	8,117.13
35	Rangsing Khola	1,653.51
36	Rapti Nadi	32,678.09
37	Rihar Khola	6,130.37
38	Sikrahawa Khola	17,203.02
39	Simari Khola	6,010.68
40	Sokraha Khola	7,683.84
41	Sunai Khola	4,881.32
42	Supaila Khola	12,177.60

43	Syano Khola	8,224.52
44	Talpani Khola	2,163.77
45	Thado Khola	4,103.50
46	Uti Sota	8,995.70
47	Unnamed rivers and streams	229,307.96
	Total Length	585763.09

Table 17: Lakes and ponds in the Middle Rapti watershed

SN	Name	VDC	Remarks
Natural lakes and ponds			
1	Jakhera	Sonpur	Functional, used for ecotourism
2	Dhaireni Jakhera	Gobardiha	Dry
3	Jethangaun Jakhera	Gobardiha	Dry
4	Banki Jakhera	Gangaparaspur	Functional, fishery
5	Paraspur Jakhera	Gangaparaspur	Functional, fishery
6	Gadhawako Jakhera	Gadhawa	Dry
7	Chandanpurko Jakhera	Chandanpur	Dry
8	Khardariyako Jakhera	Khardariya	Dry
9	Patringa Jakhera	Patringa/Jethangaun	Dry
Man-made lakes and ponds			
10	Tikuligadh Pond	Chailahi	Functional
11	Sano Jakhera	Sonpur	Functional
12	Deuki Pond	Sisahaniya	Functional
13	Kalapani Pond	Sisahaniya	Functional
14	Ramjahadi Pond	Lalmatia	Functional
15	Banghusari Pond	Gobardiha	Functional
16	Gobardiha Pond	Gobardiha	Functional

17	Devisthan	Bela	Functional
18	Ganga Community Forest Pond	Gangaparaspur	Functional
19	Shanti Community Forest Pond	Lalmatia	Functional
20	Bangaun Pond	Chailahi	Functional
21	Kalika	Lalmatia	Functional
22	Kulpani	Gobardiha	Functional
23	Saljhundi	Gangaparaspur	Functional

Table 18: Sub-watersheds in the Middle Rapti watershed, including location and area

Name	Locations (VDCs)	Area (ha)
Ahaliya Kholsi Khabai Khola	Bela – 3 Gadhawa – 5 Koilabas – 1, 2, 9	4,704.84
Patthar Khola – Gangrawa Khola	Gangaparaspur – 1 Gobardiha – 5, 9 Koilabas – 1	3,994.16
Chimchime Khola	Gobardiha – 3, 4, 5, 6, 7, 9	3,963.76
Ransin Khola – Baruharwa Khola	Gobardiha – 1, 2, 3	4,339.77
Simari Khola – Gengre Sota	Gobardiha – 2, 3, 4, 5 Sishaniya - 3	2,150.39
Mandriniya Sota – Goimaha Khola	Gobadiha – 5, 6, 7, 8, 9 Sishaniya – 2, 9	2,095.56
Supalia Khola	Gangaparaspur – 1 Gobardiha – 6, 7, 8, 9 Sishaniya – 9	2,282.65
Chainpur Sota	Gangaparaspur – 1, 2, 3, 4, 5, 6, 7, 9 Gobardiha – 9	2,072.71
Sikrahawa Khola	Gadhawa – 1, 2, 3, 6, 7 Gangaparaspur – 1, 6, 7, 8, 9	2,218.21
East Khabri Khola	Gadhawa – 3, 4, 5, 6, 7, 8 Gangaparaspur – 1, 6 Koilabas - 1	4,446.13

West Khabri Khola	Bela – 3 Gadhawa – 5, 6, 8, 9 Koilabas – 9	4,051.27
Gurun Khola	Bela – 1, 2, 3 Chulahi – 5 Gadhawa – 5, 9	4, 630.25
East Lomarahi Khola	Bela – 1, 2, 3, 4, 5, 6 Chaulahi – 5 Satabariya – 1, 2, 3	3,431.94
Lower Arjun Khola	Chaulahi – 1, 2, 3, 4, 5 Laksimpur – 1 Rampur – 2 Satabariya – 1, 2	3,318.79
Arnahawa Khola	Chaulahi – 1, 2, 3, 4, 5, 6, 7, 8, 9 Gadhaw – 6, 8	4,011.73
Koudiya Khola	Sonpur – 1, 5, 6, 8	1,456.45
Praganna Khola	Chaulahi – 7 Gangaparaspur – 2, 4, 7, 9 Gobardiha – 2, 3 Lalmatiya – 1, 2, 4, 5, 6, 7, 8 Sishaniya – 1, 2, 3, 4, 5 Sonpur – 1, 2, 3, 4, 5, 6, 7, 9	4,082.03
Tallo Dolai Khola	Hansipur – 2 Sishaniya – 4, 5, 6, 7, 8 Sonpur – 1, 8	3,976.88
Matahhilo Dolai Khola	Kansipur – 1, 2 Lalmatiya – 3, 4, 5, 6, 7, 8, 9 Sishaniya – 6, 7	3,358.67
Mathilo Rapti Nadi	Gobardiha – 1, 2 Lalmatiya – 2, 3, 4, 7	2,894.04

Source: Soil and Watershed Management Office Dang

Annex 6: Forest types and composition

Table 19: Common tree species found in the Middle Rapti watershed

Scientific name	Common name	Scientific name	Common name
Shorea robusta	Sal or shala	Bombax ceiba	Cotton tree
Terminalia tomentosa	Indian laurel	Careya arborea	Khumbi or slow match tree
Adina cardifolia	Haldina cordifolia	Syzygium cumini	Jambola or Java plum
Anogeissus latifolia	Axelwood or dhawa	Semecarpus anacardium	Bhilwa or cashew tree
Lagerstromia parviflora	Queen crepe myrtle	Buchananiya axilaris	Chironji
Woodfordia fruticosa	Flower of Woodfordia	Madhuka indica	Mahuwa
Cassia fistula	Golden rain tree	Acacia catechue	Khair
Dalbargia sissoo	North Indian rosewood	Pinus roxburghii	Chir pine
Augenia tugenensis	N/A	Terminalia myriocarpa	East Indian almond
Terminalia arjuna	Arjuna	Dalbergia latifolia	Indian rosewood
Pterocarpus marsupium	Indian kino	Schleichera oleosa	N/A
Garuga pinnata	Garuga	Bassia butyracea	Indian butter tree
Grewia optiva	Bihul	Grewia tiliifolia	Dhaman
Cedrela toona	Toon or red cedar	Ficus racemosa	Indian fig tree
Terminalia chebula	Black myrobalan	Termialia belerica	Bahera myrobalan
Emblica officinalis	Indian gooseberry	Diospyros exsculpta	N/A
Solanum xanthocarpum	Yellow-fruit nightshade	Diospyros spp	Persimmons
Cinnamomum glaucescens	N/A	Cinnamomum zeylanicum	Cinnamon tree
Brassaiopsis hainla	Chuletro	Ficus iacor	N/A
Albizia procera	N/A	Orixylum indicum	Indian trumpet flower

Table 20: Common non-timber forest species found in the Middle Rapti watershed

Scientific name	Common name
Ziziphus jujuba	Red dates
Jujuba	Chinese dates
Emblica officinalis	Indian gooseberry
Terminalia chebula	Black myrobalan
Barberis aristata	Indian barberry
Asparagus	Asparagus
Rauolfia serpentina	Indian snakeroot
Acacia concinna	Shikakai

Annex 7: Climate change impacts biodiversity and vulnerabilities

Table 21: Climate change impacts in the Middle Rapti watershed by type and location[5]

Threat	VDC(s)	Location
Forest area encroachment	Chailahi	Arnawa Lamahi Naryaynapur
	Sonpur	Sundabari Narti
	Gobardiha	Dhairrehni Madhawpur Supaila Khola
	Gangaparaspur	Sunpurwa Banki Khajrauta Saljhundi
	Gadhawa	Jhali
Drought	Chalahi	Kulmohar Sitalapur
	Sonpur	Rune
	Sishaniya	Karangekot
	Gobardiha	Kalakate Badahara Jethan Gaun Kothari Madhawpur
Over grazing livestock	Bela	Bela Gahira Materia
	Gadhawa	Chandanpur Balapur Manpur
	Gangaparaspur	Khajrauta
	Gobardiha	Madhawpur Badahara

[5] As noted by residents and government officials in the watershed.

	Chailahi	Chailahi Narayanpur Deupur
Wetland pollution	Sonpur	Jakhera Taal
	Bela	Gurung Khola
	Lalmatiya	Bhalubang
Water pollution	Sisahaniya	Sisahaniya Bazaar Sano Sishaniya
	Chailahi	Lamahi (Bagai Sato) Karmadaiya Khola Arjun Khola
	Gadhawa	Semir
Water conflict	Bela	Katberuwa and Materiya
Drying water sources	Chailahi	Arjun Khola
	Sonpur	Jakhera Taal
	Sisahaniya	Kalapani Bhulke
	Lalmatiya	Pakhanepani Barakhuti
	Gobadiha	Malmala Jethan Gaun Pachaha Mahadewa Dhairehni Madhawpur Ratanpur Jungle Kutti
	Gangaparaspur	Haraiya
	Gadhawa	Banki Thankdeukhar Balapur Rampur Madhawpur Makanahuwa Lachhinpur Khabari Khuri

		Chandanpur Bhojpur
	Bela	Katberuwa Materiya
	Lalmatiya	Majhnigadh Nayagaun Piparkhuti
	Gangaparaspur	Sonpurwa Saljhundi Sondiya
Flood / indundation	Gangaparaspur	Manghar Bodhipur Parsiya Katiyangaun
	Sisahaniya	Bagrapur Bhagwanpur Paharwa Latthahawa
	Sonpur	Raniyapur Sonpur Keruniya
	Bela	Materia Kathberuwa
River cutting	Gobardiha	Khaira Ratanpur Mahadewa Pachaha
	Gangparaspur	Khadgapur Parsiya Katiyangaun Kakrahawa Sunpurwa
	Gadhawa	Dharmapur Jharbaira Semri Bodhipur

	Bela	Materia Kathberuwa Gurung Khola
	Sisahaniya	Bagrapur Paharwa Latthahawa
	Sonpur	Raniyapur Keruniya Sonpur
	Gobardiha	Banbhusri
	Chailahi	Madhyanagar Balrampur Langadi
Landslide	Gobardiha	Dumrai Supaila Khola Chimchime
	Bela	Kathberuwa Gurung Khola
	Sonpur	Sundabari Rupakot
	Gadhawa	Kakrahawa Jabnibas
	Sisahaniya	Rune Bhulke
	Lalmatiya	Devikot
Mining	Gobardiha	Ransing Khola Supaila Khola
	Sonpur	Duali Khola
	Bela	Materia
	Gadhawa	Sikrahawa
River cutting	Gobardiha	Banbhusri Jethan Gaun Pachaha Kothari Mahadewa

		Ratanpur Khaira
	Chailahi	Madhyanagar Balrampur Langadi Ghumna Balrampur Madyanagar
	Lalmatiya	Bhalubang
	Gangaparaspur	Khadgapur
	Gadhawa	Banki Ghoraha Jharbaira Lachhinpur Bhojpur
	Bela	Pratapur
	Sisahaniya	Bagrapur Chikoti Arnahanpur Bhagwanpur
	Sonpur	Raniyapur Keruniya Rajpur
Declining fish population	Gobardiha	Jethan Gaun Pachah Kothari Mahadewa Ratanpur Gobardiha Khaira
	Gangaparaspur	Khadgapur Banki
	Gadhawa	Ghoraha Jharbaira Lachhinpur Bhojpur
	Sisanhiya	Bagrapur Chikoti

		Arnahanpur Bhagwanpur
	Sonpur	Raniyapur Keruniya Rajpur
	Chilahi	Ghumna Balrampur Madhyanagar Langadi
	Bela	Paratpur

Annex 8: Fish and aquatic life

Table 22: Fish species commonly found in the Middle Rapti watershed

SN	Nepali name	Common name	Scientific name
1	Baikha	Shark catfish	Pangassius spp.
2	Tengna	Bagridae	Mystus spp.
3	Thedh	Carp	Labeo spp.
4	Sahar	Mahseer	Tor spp.
5	Padhni	Freshwater catfish	Wallago spp.
6	Katari (Garhan machha)		
7	Chilke (a.k.a., Kalo Katla, Rawa,Garhan, Kalmudwa)	Carp and minnow (Cyprinidae)	Labeo spp.
8	Tilori		
9	Bodana (or Budana)	Carp and minnow ("log suckers")	Garra spp.
10	Manara		
11	Jhinga	Giant tiger prawn	Penaeus monodon
12	Girai and Charinga	Snakehead	Channa spp.
13	Sidhra	None	Puntius spp.
14	Lutti		
15	Chewar		
16	Chipi/Pichi		
17	Mardehani		
18	Mardehni or Bam	Spiny eel	Mastacembelus/Macrognathus spp
19	Gherta species (a.k.a., Baghwa Gherra, Jilbulwa Gherra, Dhikrahawa Gherra)	Indian loach	Botia spp.
20	Murla red		
21	Kukurjhinga		
22	Sujaha	Long-whiskered catfish	Aorichthyes spp.

23	Gugwari		
24	Kheksi		
25	Dira		
26	Dhong		
27	Andhai	Swamp eel	Monopterus cuchia
28	Paharu tilori		
29	Chhuriya katari		
30	Pathar chhepti	Nepalese minnow or stone carp	Pseudoecheineis spp.
31	Roini Machariya	African-mottled eel	Anguilla bengalensis

Source: Paani FGD/KII

Annex 9: Mammals in the Middle Rapti watershed

Table 23: Mammals commonly found in the Middle Rapti watershed

SN	Nepali name	Common name	Scientific name
1	Bagh	Tiger (IUCN Red List mammal)	Panthera tigris
2	Barha Singa	Swamp deer or Barasingha	Cervus duvaucelii
3	Chital	Cheetal	Axis axis
4	Ratuwa	Indian muntjac	Munticaus muntjak
5	Chauka	Four-horned antelope	Tetracerus quadricornis
6	Bandel	Wild boar	Sus scrofa
7	Hundar	Hyena	Hyeena hyeena
8	Bwanso	Wolf	Canis lupus
9	Syal	Golden jackal	Canis aureus
10	Rato bandar	Rhesus macaque	Macaca mulatta
11	Ban biralo	Jungle cat or Reed cat	Felis chaus
12	Nilgai	Nilgai or Blue bull	Boselaphus tragocamelus
13	Bhalu	Sloth bear	Melursus ursinus
14	Chituwa	Leopard	Panthera pardus
15	Dumsi	Indian crested porcupine	Hystrix indica
16	Langur (Nepal gray Langur)		*Semnopithecus schistaceus*
17	Kharayo	Indian hare	Lepus nigricollis
18	Chari Bagh	Leopard cat (IUCN Red List mammal)	Felis bengalensis
19	Jangali Musa	Rat	Rattuss spp.
20	Malsapro	Yellow-throated marten	Martes flavigula
21	Nyauri Musa	Indian gray mongoose	Herpestes edwardsi
22	Lokharke	Squirrel	Funambulus spp.

Source: District Forest Office (Dang)

Annex 10: Plants and trees in the Middle Rapti watershed

Table 24: Plants and trees commonly found in the Middle Rapti watershed

SN	Nepali name	Common name	Scientific name
1	Sal	Sal or Shala tree	Shorea robusta
2	Asana	Indian laurel	Terminalia tomentosa
3	Karma	Adina cordifolia	Adina cordifolia
4	Dhauthi	Axlelwood	Anogeissus latifolia
5	Ashidha or Botdhairo	Pride of India	Lagerstromia parviflora
6	Dhairo	None	Woodfordia fruticosa
7	Simal	Cotton tree	Bombax ceiba
8	Kumbhi	Slow match tree	Careya arborea
9	Jamuna	Java plum	Syzygium cumini
10	Bhalayo	None	Semecarpus anacardium
11	Piyar	None	Buchananiya auxilaris
12	Mahuwa	None	Madhuca indica
13	Raj briksha	Golden shower tree	Cassia fistula
14	Khayer	None	Acasia catechu
15	Sissoo	Indian rosewood	Dalbargia sissoo
16	Bayer	Indian date	Zizyphus jujuba
17	Sadan		Desmodium Oojeinense
18	Arjun	None	Terminalia arjuna
19	Bijay Sal	Indian kino tree	Pterocarpus marsupium
20	Kusum	Soapberry	Schleichera oleosa
21	Dabdabe	Gray downy balsam	Garuga pinnata
22	Chiuri	Indian butter tree	Bassia butyracea
23	Pharsa	None	Grewia tiliifolia
24	Khanayo, Gullar or Dumreni	Cluster fig	Ficus racemose
25	Harro	Black or chebulic myrobalan	Terminalia chebula

26	Barro	Bastard myrobalan	Terminelia belerica
27	Amala	Indian gooseberry	Emblica officinalis
28	Tendu	None	Diospyros exsculpta
29	Katai	Yellow-fruit nightshade	Solanum xanthocarpum
30	Tiju	None	Diospyros spp
31	Sugandh kokil	None	Cinnamomum glaucescens
32	Dalchini	Cinnamon tree	Cinnamomum zeylanicum
33	Chuletro	None	Brassaiopsis hainla
34	Tilka	None	Wendlandia exserta
35	Kabhro	Noe	Ficus lacor
36	Awp	Mango	Mangifera indica
37	Badahar	Monkey fruit tree	Artocarpus lacucha
38	Neem	Indian lilac	Azaderechta indica
39	Sami	Weeping fig	Ficus benjamina
40	Siris	None	Albizia sp.
41	Tatelo	Indian trumpet flower	Orixylum indicum

Source: District Forest Office (Dang)

Annex 11: Birds in the Middle Rapti watershed

Table 25: Birds commonly found in the Middle Rapti watershed

SN	Nepali name	Common name	Scientific name
1	Mayur	Great hornbill	Buceros bicornis
2	Kalo titra	Indian peafowl or blue peafowl	Pavo cristatus
3	Sim titra	Black francolin	Francolinus frankolinus
4	Luiche	Swamp partridge	Francolinus gularis
5	Khairo dhanesh	Red junglefowl	Gallus gallus
6	Mayur	Indian gray hornbill	Ocyeros birostris
7	Phapre	Hoopoes	Upupa epops
8	Karala suga	Alexandrine parakeet	Psittacaula euptria
9	Kanthe suga	Rose-ringed parakeet	Psittacaula krameri
10	Madan suga/tuiche suga	Slaty-headed parakeet	Psittacaula himalayana
11	Junge suga	Red-breasted parakeet	Psitacaula alexandri
12	Kalo giddha	Brown fish owl	Ketupa zeylonensis
13	Dangar giddha	White-rumped vulture	Gyps bengalensis
14	Lamo thude giddha	Slender-billed vulture	Gyps tenuirostris
15	Silsile	Lesser whistling duck	Dendrocygna javanica
16	Chakhewa	Ruddy shelduck	Todorna ferruginea
17	Pitrung/Katus tauke mauri chari	Chestnut-headed bee-eater	Merops leschenaulti
18	Jangali latokosero	Jungle owlet	Glaocidium radiatum
19	Chhirbire hans	Cotton pygmy goose	Nettapus coromandelianus
20	Hans	Ferruginous duck	Aythya nyroca
21	Sano matokore/Khakhaura	Common kingfisher	Alcedo atthis
22	Bhudrung	Brown fish owl	Ketupa zeylonensis
23	Chil	Steppe eagle	Anquila nepalensis
24	Jinger kande baaj	Crested goshawk	Accipiter trivirgatus

25	Kanthe baaj	Collared falconet	Microhierax caerulescense
26	Ghukuti dhukur	Red turtle dove	Streptopelia tranqueberica
27	Sano baudai	Common kestrel	Falco tinnunculus
28	Thulo lahache	Great slaty woodpecker	Mulleripicus pulverulentus
29	Chirke lahache	Fulvous-breasted woodpecker	Dendrocopos macei
30	Koili	Asian koel	Eudynamys scolopacea
31	Hutityaun	Red-wattled lapwing	Venellus indicus
32	Kalo dhade lahache	Black-rumped flameback	Dinopium benghalense
33	Bhadre	Green-billed malkoha	Phaencophaeus tristis
34	Sano jalewa	Little cormorant	Phalacrocorax niger
35	Chibhe	Black drongo	Dicrurus macrosercus
36	Sano bakulla	Little egret (IUCN Red List bird)	Egretta garzetta
37	Lalsar	Red-naped ibis	Pseudibis papjllosa
38	Kalo bhudiphor	Black stork	Ciconia nigra
39	Top chara/Baulahawa	Baya weaver	Ploceus phillippinus
40	Kokale	Rufous treepie	Dendrocitta vagabunda
41	Jureli/Bulbul	Red-vented bulbul	Pycnonotus cafer
42	Pihawa/Gajale chari	Eurasian golden oriole	Oriolus oriolus
43	Dhobi chara	Oriental magpie-robin	Copsychus saularis
44	Semdranga/Shyama	White-rumped shama	Copsychus malabaricus
45	Rani chari	Orange minivet	Pericrocotus flammeus
46	Chirbire matokore	Pied kingfisher	Ceryle rudis
47	Kalij/Nilkanth/Bater/Kuthruke	Coppersmith barbet	Megalaima haemacephala
48	Thulo chamero	Indian flying fox	Pteropus gigantius
49	Bhangeri baj	Besra	Accepiter vigratus
50	Thople latokosero	Spotted owlet	Athene brama
51	Bakulla	Cattle egret	Babulcus ibis
52	Malewa	Rock dove or rock pigeon	Columba livia

Source: District Forest Office (Dang)

Annex 12: Road networks

Table 26: Road networks in the Middle Rapti watershed

SN	Road	Black topped	Gravel	Earthen	Total
Strategic roads					
1	Bhalubang - Arjun Khola	25.5			
2	Lamahai – Koilabas	1.5	15.5	14	
3	Lamahai – Madhyanagar	5			
Village core road networks					
4	Chailahi – Keruniya – Lalmatiya (Damador Road)		20.9		
5	Kalakante – Gadhawa	25			
6	Gadhawa – Gurung Khola	7			
7	Bhalubang – Rupakot – Karange – Bauraha			21.9	
		64	36.4	35.9	136.3

Annex 13: Irrigation projects

Table 27: Irrigation projects in the Middle Rapti watershed

SN	Name	Location (VDC)	Area covered (ha)
1	Gobardiya	Gobardiya	500
2	Falkapur	Sonpur	300
3	Kaudeyasota	Sonpur	900
4	Ghoraha Manpur	Gadawa	500
5	Bela	Bela	150
6	Gangaparaspur	Gobardiya	50
7	Cheleya Manikpur	Gadawa	100
8	Supaula Paraspur	Gangaparaspur	200
9	Gobardiya Badkapath	Gobardiya	500
10	Dangalichhap	Gangaparaspur, Gadhawa	868
11	Narti	Sonpur	20
12	Chisapani	Gobardiya	20
13	Maijharoya	Sesenehiya	13
14	Lalmatiya	Lalmatiya	193
15	Sisanhiya	Sisanhiya	70
16	Mutubhu	Gobardiya	20
17	Mansureya	Lalmatiya	70
18	Arjun Khola	Chailahi	500
19	Praganna Kulo	Lalmatiya, Sisanhiya, Sonpur, Chailahi	5,800
		Total	**10,774**

Source: Irrigation Development Division (Dang)

Annex 14: Water quality

Table 28: Water quality test results from the Middle Rapti watershed

	Name of the river/stream					Water quality standards		
	Dolai Khola	Gurung Khola	Kakrahawa Khola	Jamunibas	Sikrahawa	* Drinking	** Irrigation	** Aquaculture
Date of test	NA	NA	NA	NA	NA			
Conductivity (µS/cm)	278.1	498.7	266.9	439.0	311.8	1,500		
Temp °C	26.3	33.7	43.8	35.1	33.3			4 to 30
Iron (mg/L)	4.4	0.16	0.0	0.0	5.0	0.3 (3)	5	0.01
pH	7.1	7.6	7.6	7.6	6.4	6.5-8.5	6.5-8.5	6.5-9.0
Nitrate Nitrogen (mg/L)	1.1	1.0	0.7	1.1	1.3	50		<300
Nitrite Nitrogen (mg/L)	0	0.0	0.03	0.0	0.02		<5	
Ammonium (mg/L)	0.0	0.0	0.0	0.0	5.0	1.5		0.025
Phosphate (mg/L)	10.0	3.0	6.5	23.5	1.5			

	Name of the river/stream					Water quality standards		
	Kulmohar	Arjun Khola	Madhayan agar	Kholahi	Balarampur	* Drinking	** Irrigation	** Aquaculture
Date of test	NA	NA	NA	NA	NA			
Conductivity (µS/cm)	364.8	376.4	356.7	383.3	380.7	1,500		
Temp °C	30.8	31.7	30.4	33.2	32.5			4 to 30
Iron (mg/L)	0.0	0.16	2.6	0.0	1.1	0.3 (3)	5	0.01

pH	7.9	7.6	7.5	7.6	7.2	6.5-8.5	6.5-8.5	6.5-9.0
Nitrate Nitrogen (mg/L)	1.4	0.8	1.2	1.9	0.8	50		<300
Nitrite Nitrogen (mg/L)	0	0.0	0.03	0.03	0.0		<5	
Ammonium (mg/L)	0.0	0.0	1.0	2.0	1.0	1.5		0.025
Phosphate (mg/L)	17.5	4.4	9.3	7.2	3.7			

	Name of the river/stream					**Water quality standards**		
	Rajpur	**Jhakera**	**Masanghat**	**Singhe Khola**	**Bhulke**	* **Drinking**	** **Irrigation**	** **Aquaculture**
Date of test	NA	NA	NA	NA	NA			
Conductivity (µS/cm)	365.1	225.5	388.1	377.4	544.7	1,500		
Temp °C	33.1	33.1	29.3	31.0	26.0			4 to 30
Iron (mg/L)	0.0	0.12	0.96	1.5	0.0	0.3 (3)	5	0.01
pH	7.3	7.3	7.6	7.3	7.1	6.5-8.5	6.5-8.5	6.5-9.0
Nitrate Nitrogen (mg/L)	1.1	NA	NA	1.4	NA	50		<300
Nitrite Nitrogen (mg/L)	0	0.0	0.03	0.03	0.0		<5	
Ammonium (mg/L)	2.0	0.0	1.0	2.0	1.0	1.5		0.025
Phosphate (mg/L)	6.5	0.6	9.3	6.5	2.4			

	Name of the river/stream					Water quality standards		
	Bhalubang	**Pathargadhwa**	**Bagrapur**			* **Drinking**	** **Irrigation**	** **Aquaculture**
Date of test	NA	NA	NA					
Conductivity (µS/cm)	257.3	382.0	319.7			1,500		
Temp °C	26.0	29.2	27.7					4 to 30
Iron (mg/L)	4.1	0.42	1.7			0.3 (3)	5	0.01
pH	7.2	7.4	7.3			6.5-8.5	6.5-8.5	6.5-9.0
Nitrate Nitrogen (mg/L)	NA	1.5	1.0			50		<300
Nitrite Nitrogen (mg/L)	0.0	0.0	0.03				<5	
Ammonium (mg/L)	2.0	8.0	1.0			1.5		0.025
Phosphate (mg/L)	11.5	3.7	13.0					

Source: Paani biophysical survey

Annex 15: Major pollution points in the Middle Rapti watershed

Table 29: Major pollution points in the Middle Rapti watershed

SN	Name	VDC	Latitude	Longitude	Elevation (m)
1	Bhalubang	Lalmatiya	27°50'25.86"	82°45'41.30"	313
2	Kalakate Market	Gobardiya	27°48'29.97"	82°45'46.31"	311
3	Sisahaniya Market	Sisahaniya	27°50'45.51"	82°39'1.87"	273
4	Gadhawa Market	Gadhawa	27°48'46.78"	82°32'24.44"	254
5	Lamahi Market	Lamahi	27°52'28.00"	82°31'2.09"	265

Annex 16: Locations of gravel mining operations

Table 30: Locations of gravel mining operations in the Middle Rapti watershed

SN	Location	Stone %	Sand %	Gravel %	Metric tons harvested annually
1	Gobardiha-3, Jethan Gaun	10	40	50	7,500
2	Gobardiha-4, Jethan Gaun, Pachawa	10	30	60	24,000
3	Gobardiha-1, Juraini	15	30	55	7,500
4	Gobardiha-2, Badahara	20	40	40	15,000
5	Rangsing Junction		30	70	11,250
6	Balarampur Ghat, Chailahi		40	60	6,000
7	Gobardiha-1 Malmala	30	20	50	67,500
8	Gobardiha-1, Chisapani	20	30	50	6,000
9	Lalmatiya Chaitegaun	10	40	50	3,000
10	Lalmatiya Shantipur	10	40	50	4,500
11	Bela Materiya Ghat		40	60	17,500
12	Bela Kharderiya		60	40	20,000
13	Junction of Rapti and Arjun Khola		40	60	14,400
				Total	204,150

Annex 17: Community user forest groups

Table 31: Community forest groups in the Middle Rapti watershed, including area, membership, and female membership percentages

SN	Name	Location	Number of HH	Area (ha)	Total members	% female members
1	Debisthan	Bela-2	251	429.12	15	13
2	Sriskati	Bela-1	227	276	11	36
3	Durga	Bela-3,4	336	718	13	31
4	Bukidanda	Bela-3	151	445.48	11	18
5	Rameshwory	Bela-3	100	294.25	11	27
6	Ganesh	Bela-3	295	908	15	27
7	Bhagwati	Bela-2	209	113	11	100
8	Ghumna	Chailahi-6	142	15.5	11	18
9	Sissoobagar (Deupur)	Chailahi-3	254	48	17	100
10	Chapper Khola	Chailahi-1	291	387	21	19
11	Ajammari	Chailahi-2	551	550	17	18
12	Bangaun	Chailahi-6,7,8,9 Rampur-2	335	824	17	0
13	Parijat Mahila	Chailahi-2	27	19.2	13	100
14	Pragatishil Mahila	Chailahi-1,3 Rampur-2	79	114.94	13	100
15	Dum Duma	Chailahi-8	117	40.4	15	53
16	Milan Mahila	Chailahi-2,3	37	3	11	100
17	Manakamana	Chailahi 4	76	18	13	38
18	Narayneswar	Chailahi 5	543	451.95	7	29
19	Karri	Chailahi-3,4,5 Satbariya-1	777	626	11	36
20	Madpur Nashahawa	Gadhawa	536	363.78	15	33

21	Manikapur Bagale Bisauna	Gadhawa-5	180	165	13	38
22	Sarbodey	Gadhawa-1,2,3	343	260	13	46
23	Chetanshil Mahila	Gadhawa-2	31	5.42	11	100
24	Upllow Madapur Bankatti	Gadhawa-3,5	332	214	11	36
25	Chandan Pur	Gadhawa-9	350	440	15	20
26	Mahila Samaj Kalayan	Gadhawa-5	23	7.25	7	100
27	Srijanamahila	Gadhawa-5	502	200	11	100
28	Khabari	Gadhawa-5	112	129	11	36
29	Mahilashakti	Gadhawa-3	61	9.5	11	100
30	Jyoti	Gadhawa-6	313	361.75	11	18
31	Chisapani	Gadhawa-5	187	127	15	100
32	Shikhar	Gadhawa-5	87	61	11	100
33	Kamana	Gadhawa-3	23	3.47	9	100
34	Bhavani	Gangaperspur-8	640	511.6	13	31
35	Chiurighat	Gangaperspur-6	104	156	11	18
36	Ganga	Gangaperspur-3,5,6	298	280	15	47
37	Pragati	Gangaperspur-6	344	312	19	32
38	Saljhundi	Gangaperspur-1,2	559	415	9	44
39	Ranibas	Gangapraspur-6	45	57	5	20
40	Hariyali	Gangapraspur-6	98	63	11	100
41	Jagrity	Gangaperspur-9	86	54	9	100
42	Juntara	Gangapraspur-6	40	55	9	100
43	Kulpani	Goberdiha-2	524	359.46	15	0
44	Bansakati	Goberdiha-2	28	3.8	11	18
45	Madhavpur Khaireni	Goberdiha-9	44	7.6	11	0
46	Soorya	Goberdiha-1	293	409.5	11	0
47	Nepal Kumal Samaj	Goberdiha-9	47	1.5	10	20

48	Baghdula Damar	Goberdiha-1	134	102	13	31
49	Chisapani Bagar	Goberdiha-1	96	16	9	11
50	Madhavpur Women	Goberdiha-9	20	1.5	9	100
51	Durga	Goberdiha-7	315	328.5	13	23
52	Goberdiha	Goberdiha-8	816	386	19	26
53	Mahadeva	Goberdiha-6	398	336	11	27
54	Lakhpati	Goberdiha-4	355	341.28	11	18
55	Shanti	Goberdiha-5	298	315.7	11	27
56	Janshakti	Goberdiha-2	214	358	11	27
57	Laxmi	Goberdiha-3	308	310	11	9
58	Jansewa	Goberdiha-1	122	346.5	13	31
59	Janpriya	Goberdiha-1	137	100	10	40
60	Kalikhola	Gobardiha-1	144	116.74	11	100
61	Jagritymahila	Goberdiha-1	87	15	NA	NA
62	Hariyali	Goberdiha-4	102	117.08	11	45
63	Shanti	Lalmatiya-5,6,9	1007	1,486.00	14	7
64	Rapti	Lalmatiya-3	445	1,141.76	19	16
65	Ghantdev	Lalmatiya-8	504	655	11	27
66	Karamdi	Lalmatiya-7	212	491	13	31
67	Kalika	Lalmatiya-4	264	449	11	9
68	Ram Jahadi	Lalmatiya-3	447	273.8	11	18
69	Chisapani	Lalmatiya-7	66	615.93	13	31
70	Milandanda	Sishaniya-6	218	88.54	13	0
71	Kalapani	Sishaniya-5	275	195.27	15	13
72	Panchakaniya	Sishaniya-1	151	67.75	19	16
73	Shankar	Sishaniya-4	242	488.75	15	27
74	Dewki	Sishaniya-7	1008	1,061.93	11	27
75	Tilkeni	Sishaniya-7	142	197.85	11	27

76	Urim Danda	Sishaniya-7	159	156.84	15	27
77	Sagarapur Bagarapur	Sishaniya-8	376	8.45	NA	NA
78	Bhawani	Sonpur-1	151	19.2	11	27
79	Tikuli Gad	Sonpur-5	196	259.21	23	22
80	Baken	Sonpur-1	556	593.25	11	9
81	Sundabari	Sonpur-8,9	365	264.68	13	15
82	Janta	Sonpur-6,8	315	264.26	12	0
83	Barahkshetra	Sonpur-8,9	225	235	15	27
84	JakheraTal	Sonpur-5	243	256.5	NA	NA
85	Trishakti	Sonpur-5	215	123.26	11	27
86	Devisthan	Sonpur-8	98	94.84	11	45
87	Barah	Sonpur-8	95	94.45	15	47
88	Gabukhola	Sonpur-8	173	195.06	11	27
89	Kunteani	Sonpur-8	148	199.78	11	27
		TOTAL	**22,870**	**24,482.13**	**1,074**	

Source: TAL Program

Annex 18: Irrigation user groups

Table 32: Irrigation user groups in the Middle Rapti watershed

SN	Name	Location (VDC)	Area covered (ha)
1	Gobardiya	Gobardiya	500
2	Falkapur	Sonpur	300
3	Kaudeyasota	Sonpur	900
4	Ghoraha Manpur	Gadawa	500
5	Bela	Bela	150
6	Gangaparaspur	Gobardiya	50
7	Cheleya Manikpur	Gadawa	100
8	Supaula Paraspur	Gangaparaspur	200
9	Gobardiya Badkapath	Gobardiya	500
10	Dangalichhap	Gangaparaspur, Gadhawa	868
11	Narti	Sonpur	20
12	Chisapani	Gobardiya	20
13	Maijharoya	Sesenehiya	13
14	Lalmatiya	Lalmatiya	193
15	Sisanhiya	Sisanhiya	70
16	Mutubhu	Gobardiya	20
17	Mansureya	Lalmatiya	70
18	Arjun Khola	Chailahi	500
19	Praganna Kulo	Lalmatiya, Sisanhiya, Sonpur, Chailahi	5,800
		Total	**10,774**

Annex 19: Water supply and sanitation user groups

Table 33: Water supply and sanitation user groups in the Middle Rapti watershed

SN	Name	Location
1	Chaite Macchi Tal Khanepani Tatha Sarsafai	Lalmatiya-3
2	Badhara Patringa Khanepani Tatha Sarasfai	Goberdaya-2
3	Bhalubhang Khanepani Tatha Sarasfai Upbhokta	Lalmatiya-3
4	Ramnagar Khanepani Aayogana Tatha Shayar Shambar	Lalmatiya-4
5	Singe Khanepani Tatha Sarsafai	Sisahaniya-7
6	Lalmatiya Khanepani Tatha Marmat Shambar	Lalmatiya-4
7	Jahadi Khanepani Aayogana Tatha Shayar Shambar	Lalmatiya-3
8	Majhanegadh Khanepani Aayogana Tatha Shayar Shambar	Lalmatiya-9
9	Judapani Khanepani Tatha Sarsafai	Sisahaniya-6
10	Barakhutti Khanepani Tatha Sarsafai	Lalmatiya-7
11	Jamuibash Khanepani Tatha Sarsafai	Gangaparaspur-6
12	Kalapani Khanepani Tatha Sarsafai	Sisahaniya-5
13	Gange Ghopte Chimchime Khanepani Tatha Sarsafai	Goberdaya-5
14	Pachaheya Khanepani Tatha Sarsafai	Goberdaya-4
15	Dhayreni Ratanpur Khanepani Tatha Sarsafai	Goberdaya-7
16	Badahara Khanepani Tatha Sarsafai	Goberdaya-2
17	Manikapur Khanepani Tatha Sarsafai	Gadawa-5
18	Kulhomor Khanepani Tatha Sarsafai	Chailahi-3
19	Gadawa Khanepani Tatha Sarsafai	Gadawa-3
20	Aanp Khola Khanepani Tatha Sarsafai	Lalmatiya-3
21	Chisapani Khanepani Tatha Sarsafai	Goberdaya-1
22	South Baharakhutti Khanepani Tatha Sarsafai	Lalmatiya-7
23	Rasahri Khanepani Tatha Sarsafai	Bela-3
24	Shreechaur Khanepani Tatha Sarsafai	Lalmatiya-8
25	Gurung Khola (scheme 2) Khanepani Tatha Sarsafai	Bela-3

26	Gurung Khola (scheme 1) Khanepani Tatha Sarsafai	Bela-3
27	Narti Khanepani Tatha Sarsafai	Sonpur-5
28	Purbe Khola Betani Supaila Khanepani Tatha Sarsafai	Goberdaya-9
29	Goberdaya 2-4 Khanepani (scheme 1)	Goberdaya-2
30	Goberdaya 2-4 Khanepani (scheme 2)	Goberdaya-2
31	Goberdaya 2-4 Khanepani (scheme 3)	Goberdaya-2
32	Hatti Motor Baba Ranshing Chisapani Khanepani Tatha Sarsafai	Goberdaya-1

Annex 20: Areas with prepared LAPAs and CAPAs

Table 34: VDCs with prepared LAPAs and CAPAs

SN	VDC	LAPA	CAPA
1	Bela	Yes	3
2	Chailahi	Yes	13
3	Sonpur	No	1
4	Gadhawa	Yes	6
5	Gangaparaspur	Yes	8
6	Gobardiha	Yes	11
7	Lalmatiya	Yes	8
8	Sisahaniya	Yes	2
	Total		**52**

Annex 21: Key stakeholders – organizations and offices

Table 35: Key organizations and offices relevant to watershed health in Middle Rapti

SN	Name	Contact number
1	Jilla Prashasan Karyalaya	082560133
2	Jilla Bikash Samiti	082560144
3	Jilla Prahari Karyalaya	082560199
4	Redcross society	082520022
5	Jilla Swasthya Karlaya	
6	Division Forest Office ,	9847845663
7	Khane Pani Tatha Sarsafai Division Karyalaya	
8	Irrigation Division Office	
9	District Livestock Service Office	082560021
10	District Soil and Water Conservation Office	082520061
11	Shakha Tathyank Karyalaya	
12	Jal Utpanna Prakop Sub Division Karyalaya, Dang	
13	Forest and Environment Conservation Coordination Committee	082410017
14	Narti Community Forest Coordination Committee	082540206
15	FEDWASUN District Chapter	
16	NFIWUAN District Chapter	
17	FECOFUN District Chapter	9847823753
18	NEFIN	9857830474
19	Praganna Kulo Sinchai Aayojana	
20	Janatako Tatbandhan Karyakaram	
21	Terai Arc Landscape Program/WWF Nepal	0821541753
22	Percident Chure, Terai, Madhesh Conservation Committee	
23	HWEPC	082560240

Annex 22: Vision building framework employed for compiling the Middle Rapti watershed profile