LOWER MAHAKALI WATERSHED PROFILE

STATUS, CHALLANGES AND OPPORTUNITIES FOR IMPROVED WATERSHED MANAGEMENT

USAID
FROM THE AMERICAN PEOPLE

USAID PAANI PROGRAM
युएसएड पानी परियोजना

Cover photo: For nearly 80 years, Nepal and India have applied engineering practices to solve cross border issues related to water management issues such as flooding. Some of the most successful have been those implemented by local communities on both sides of the border such as the riverbank stabilization shown here. Nonetheless, communities on the Nepal side feel that India is capturing a larger share of the benefits of the Lower Mahakali Watershed.

Photo credit: USAID/PAANI

LOWER MAHAKALI WATERSHED PROFILE:

STATUS, CHALLENGES AND OPPORTUNITIES FOR IMPROVED WATER RESOURCE MANAGEMENT

Program Title:	**USAID/Nepal's Program for Aquatic Natural Resources Improvement Project (PANI)**
DAI Project Number:	**1002810**
Sponsoring USAID Office:	**USAID/Nepal**
IDIQ Number:	**AID-OAA-I-14-00014**
Task Order Number:	**AID-367-TO-16-00001**
Contractor:	**DAI Global LLC**
Date of Publication:	**August 7, 2017**

CONTENTS

LIST OF TABLES III

LIST OF FIGURES IV

LIST OF A V

EXECUTIVE SUMMARY I

LOWER MAHAKALI WATERSHED: NATURE, WEALTH, AND POWER 9

NATURE 10

WEATHER AND CLIMATE CHANGE 10

Temperature 10

Rainfall 12

Climate Change 12

HYDROLOGY 14

Streams and Tributaries 15

Lakes 16

STREAM WATER QUALITY 17

LAND COVER AND USE 19

BIODIVERSITY 20

WEALTH 24

SOCIAL CONSTITUTION 25

FISHING COMMUNITIES 25

TRANSPORTATION 26

LIVELIHOODS OF PEOPLE IN THE WATERSHED AREA: 26

Agriculture 27

Capture fisheries 29

RIVERBED MINING 30

Flooding and Inundation 32

HOUSEHOLD WATER RESOURCE AVAILABILITY AND USE: 36

POWER/GOVERNANCE 38

RIVER BASIN MANAGEMENT 38

Transboundary Water Management 38

Shuklaphanta NP and Pancheswor Dam 39

NEPAL POLICY PROVISIONS AND AUTHORITY TO GOVERN 40

IMPLEMENTATION AND ENFORCEMENT OF ENVIRONMENTAL MANAGEMENT PLANS 47

NATURE, WEALTH AND POWER INTERLINKAGES 48

KEY THREATS TO MANAGEMENT OF WATER RESOURCES FOR MULTIPLE USERS 51

FLOODING 55

RIVERBED MINING 57

DECREASING FISH STOCKS AND UNSUSTAINABLE FISHERIES PRACTICES 58
TRANSBOUNDARY WATER MANAGEMENT 59
RESOURCE USE REGIMES: FISHERIES, SAND MINING 60
CLIMATE CHANGE 60
VISION STATEMENT FOR LOWER MAHAKALI WATERSHED 63
VISION 63
MISSION 63
PRIORIZIED ISSUES IN MAHALAKI WATERSHED 63
REFERENCES 66
ANNEX 1: METHODOLOGY FOR DEVELOPING WATERSHED PROFILE 67
ANNEX 2: LOCATON MAP OF LOWER MAHAKALI WATERSHED 69
ANNEX 3: MAP OF WHOLE MAHAKALI RIVER BASIN 71
ANNEX4: TOPOGRAPHIC MAP OF LOWER MAHAKALI WATERSHED 73
ANNEX 5: RIVER NETWORK IN LOWER MAHAKALI WATERSHED 75
ANNEX 6: ROAD NETWORK IN LOWER MAHAKALI WATERSHED 77
ANNEX 7: BIOPHYSICAL MAP OF LOWER MAHAKALI WATERSHED 79
ANNEX 8: SECONDARY SOURCES OF LIVELIHOODS IN WATERSHED 81
ANNEX 9: VISION AND MISSION OF LOWER MAHAKALI WATERSHED 83

LIST OF TABLES

Table 1: Stream Discharge of Some Waterbodies in Lower Mahakali Watershed 16
Table 2: Water Bodies in Lower Mahakali Watershed 16
Table 3: Water Quality Standard of Different Streams in the Watershed 18
Table 4: Status of Fisheries in Lower Mahakali Watershed 22
Table 5: List of Irrigation Projects in Lower Mahakali Watershed 28
Table 6: Access to Climatic Information in the Watershed 36
Table 7: Policy Provision and Status of Enforcement 41
Table 8: Representation of Women and Marginalized Community in Decision-making Body 43
Table 9: Water User Groups in the Watershed 44
Table 10: Micro catchment identified by DSCO Kanchanpur within the area of the Watershed 47
Table 11: Priority Issues, Linkages and Recommendations 52
Table 12: Summary of Prioritized Issues by Municipality 63

LIST OF FIGURES

Figure 1: Satellite Image of the Lower Mahakali Watershed 1
Figure 2: Location map of Lower Mahakali Watershed 3
Figure 3: Location of Priority Issues Collected from Multi-stakeholder Consultation Workshops 6
Figure 4: Maximum, Minimum and Average Long-term Monthly Temperature (ºC) in the Watershed..... 11
Figure 5: Annual Mean Temperature in the Watershed..... 11
Figure 6: Long-term Average Monthly Rainfall (mm) Estimated in Watershed 12
Figure 7: Annual Mean Temperature Change Trend in Lower-Mahakali Watershed..... 13
Figure 8: Annual Mean Temperature Change Trend in Lower-Mahakali Watershed..... 13
Figure 9: Long-term Annual Mean Rainfall Trend (mm/year) Observed in Lower Mahakali Watershed.... 14
Figure 10: Satellite Image of the Mahakali River 15
Figure 11: Land Use Cover in Lower Mahakali Watershed 19
Figure 12: Population of Lower Mahakali Watershed by Caste/Ethnicity (n=143852) 25
Figure 13: Population of Fisher Communities in Watershed Area..... 26
Figure 14: Primary Source of Livelihoods of Surveyed Households in percent (n=369) 27
Figure 15: Sources of Irrigation among the Households Surveyed (n=165) 29
Figure 16: Community Perceptions of Climate Change Impacts over the Last Five Years..... 33
Figure 17: Sources of Drinking Water in the Lower Mahakali Watershed (N=165)..... 37
Figure 18: Flood Inundation Scenario in Shuklaphanta NP..... 40
Figure 19: Local Authorities With in the Lower Mahakali Watershed 47
Figure 20: Nature, Wealth and Power: Outcomes and Cross-Cutting Themes..... 50
Figure 21: Flood hazard map of Lower Mahakali Watershed..... 56
Figure 22: Numbers of HH Adopting Different Adaptation Practices by Caste/Ethnicity (n=43) 62
Figure 23: Best Practices in the Lower Mahakali Watershed 65
Figure 24: Methodological Approach Employed in Primary Data Collection for Profiling..... 68
Figure 25: Numbers of HH Surveyed in the Lower Mahakali Watershed for Each Thematic Issue 68
Figure 26: Secondary Sources of Livelihoods of Households by Caste/Ethnicity (Total HH 369) 81
Figure 27: Vision Building Framework Used During Watershed Profiling Process 83

LIST OF ABBREVIATIONS

BCN	Bird Conservation Network
BCTS	Brahmin, Chhetri, Thakuri and Sannyasi
BZCF	Buffer Zone Community Forestry
BZMC	Buffer Zone Management Committee
CAPA	Community Adaptation Plan of Action
CBAPU	Community Based Anti-Poaching Unit
CBS	Central Bureau of Statistics
CFUG	Community Forest Users Group
CIP	Community Irrigation Project
CITES	Convention on International Trade in Endangered Species of Wild Fauna & Flora
CSO	Civil Society Organization
DADO	District Agriculture Development Office
DCC	District Coordination Committee
DDC	District Development Committee
DDRC	District Disaster Relief Committee
DFO	District Forest Office
DIO	District Irrigation Office
DPRP	Disaster Preparedness and Response Plan
DRCN	District Road Core Network
DRR	Disaster Risk Reduction
DSCO	District Soil Conservation Office
DWSS	Drinking Water and Sanitation Supply
EDP	External Development Partners
FECOFUN	Federation Of Community Forest Users Nepal
FEDWASUN	Federation of Water and Sanitation Users Nepal
FGD	Focal Group Discussion
GIS	Geographic Information System
GoN	Government of Nepal
HDI	Human Development Index

HH	House Hold
KII	Key Informant Interview
L/S	Liter per Second
LAPA	Local Adaptation Plan for Action
LDO	Local Development Officer
LDRMP	Local Disaster Risk Management Plan
LSGA	Local Self-Governance Act 1999
MSC	Multi Stakeholder Consultation
MSC	Multi-stakeholders Consultation Workshop
NAPA	National Adaptation Programme of Action
NEFIN	Nepal Federation of Indigenous Nationalities
NFIWUAN	National Federation of Irrigation Water Users Association Nepal
NGO	Non-Governmental Organization
NNSWA	Nepal National Social Welfare Association
PANI	Program for Aquatic Natural Resource Improvement
RRT	Rapid Response Team
SWR	Shuklaphanta Wildlife Reserve
UC	User Committee
UG	User Group
USAID	United States Agency for International Development
VDC	Village Development Committee
WS	Watershed

ACKNOWLEDGEMENTS

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

This discussion draft watershed profile is the result of many people working together. Most significant were the generous contributions of time, thoughtful attention, and ideas of members of many community forest user groups (CFUGs), cooperatives, water user groups, and especially, the communities dependent on aquatic biodiversity and local water management. Leaders of Lamkichuha, Tikapur, Rajapur, Madhuban, Thakurbaba and Panchapuri Municipalities (nagarpalika) and Mohanyal, Janaki, Geruwa and Barahatal Rural Municipalities (gaunpalika), and the newly elected local government representatives engaged deeply in the assessment and prioritization and committed themselves to collaborate and integrate the priority agenda into local planning processes.

The USAID Paani Program—युएसएड पानी परियोजना—is grateful for the privilege of having been invited to support the above efforts. The Paani Program (Paani) is a consortium of DAI, WWF, SILT, and NESS that works closely with Nepal's Water and Energy Commission Secretariat (WECS) and draws on the support of WECS' member agencies. Paani enriched the watershed profile by compiling and reviewing secondary data and by collaborating with the Federation of Drinking Waters Supply and Sanitations Users Nepal (FEDWASUN), who carried out surveys to assess community perceptions and biophysical conditions. Thanks are also due to several other collaborating government agencies, civil society organizations, and federations for their consistent cooperation and contributions to prepare this watershed profile. These groups include civil society groups

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

EXECUTIVE SUMMARY

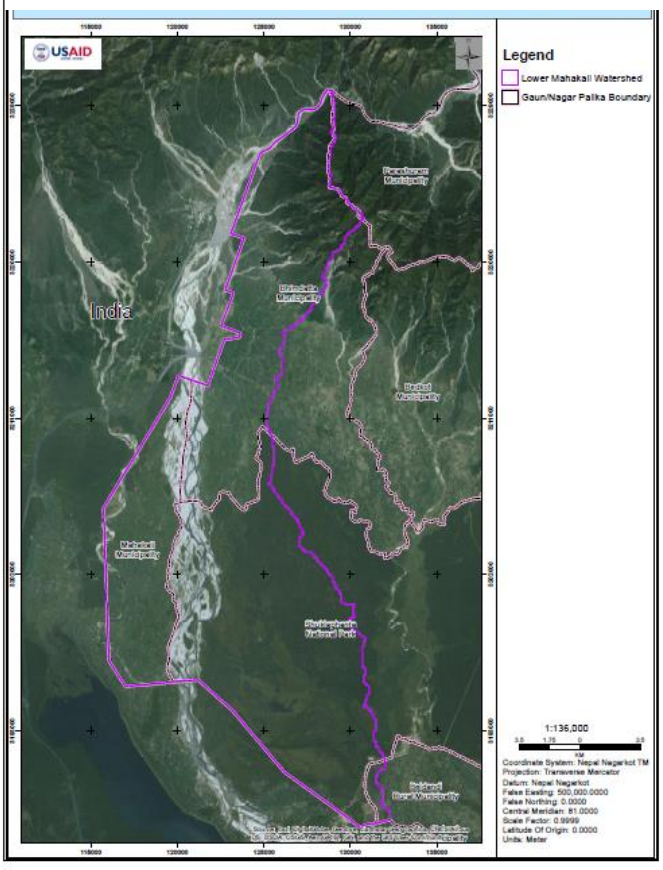
The Lower Mahakali Watershed Profile assesses the status, major challenges and opportunities facing water resources management for the multiple users located within the Lower Mahakali Watershed of the Far Western Development Region of Nepal.

The profile was prepared as part of the Program for Aquatic Natural Resources Improvement (PANI) Project — also known as *Paani*, the USAID-funded Water Program पानी परियोजना— in close coordination with the Government of Nepal and local stakeholders with support from the United States Agency for International Development (USAID). The PANI program aims to increase the knowledge, engagement, and benefits of local water users in target river basins to build local freshwater management capacity.

The Watershed Profile provides critical baseline information for local government, community, civil society, and private sector stakeholders within the Lower Mahakali Watershed to strengthen water resource management in a way that benefits human development and protects the natural resource base upon which well-being depends. The Watershed Profile also supports the design of interventions to improve climate change adaptation and freshwater biodiversity by local stakeholders as part of the Paani program.

The Lower Mahakali Watershed is located within Kanchanpur District of southwestern Nepal and borders India to the west and south. Administratively, the Lower Mahakali Watershed is divided into three zones. The Bhim Datt municipality occupies the northern portion of the watershed, the Mahakali Municipality lies to the west, and Shuklaphanta National Park occupies the southern portion of the watershed (Figure 1). The vast majority of the watershed area is characterized as Terai plain, which is predominately flat, alluvial plain topography with a small portion in the Churia/Sivalik hills to the north. The elevation ranges from 180 to 250 meters (m) in the low elevation Terai to the highest point in the watershed extending to 1,000 m in the Churia/Siwalik hills. The Mahakali River, Tilkeni Khola and Jogbuda Nadi are the major water bodies of this particular watershed.

Figure 1: Satellite Image of the Lower Mahakali Watershed



The Lower Mahakali River is a braided stream that consists of networks of channels within the main channel that runs north-south through the middle of the watershed. As is typical of rivers in the Terai, there are constant changes in the pattern of networks and the extent of the floodplains, which have historically

delivered rich sediment that has supported high biodiversity and agricultural development while also contributing to high flood risk for adjacent human settlements[1].

The Mahakali River, or Sharda River as it is known in India, is a snow-melt fed river system that starts in the Api-Himal and then descends from 3,600 m elevation in Kalapani down to the Lower Mahakali Watershed, where it flows into the Terai Plains. Eighty percent of the rainfall takes place during the summer monsoon in the June to September timeframe, with the river dry much of the year.

The total population within the Lower Mahakali Watershed is estimated at more than 140,000 people, the majority of whose livelihoods are dependent upon agriculture and wage labor. Increasing numbers of people are engaged in seasonal and foreign migration, as well as gravel mining. The Lower Mahakali was traditionally inhabited by the Tharus, who were fishfolk. Today, the areas have become more diversified with waves of in-migration beginning in the 1960s. Census data shows that the majority of the population is Chhetri, followed by Dalit, Brahmin, and Janajati (primarily Tharus and Sonaha). At present, the vast majority of fisherfolk are concentrated in Bhim Datt Municipality with only a small percent (2 percent) in Mahakali municipality. Culturally, the Mahakali River is place of special importance for these communities. The water is considered Pabitra Jal (pure water), and the source is believed to be the religiously significant pond of the Kali temple at Kalapani. The name of the river itself is the name of the famous deity or powerful Devi of the Hindu religion.

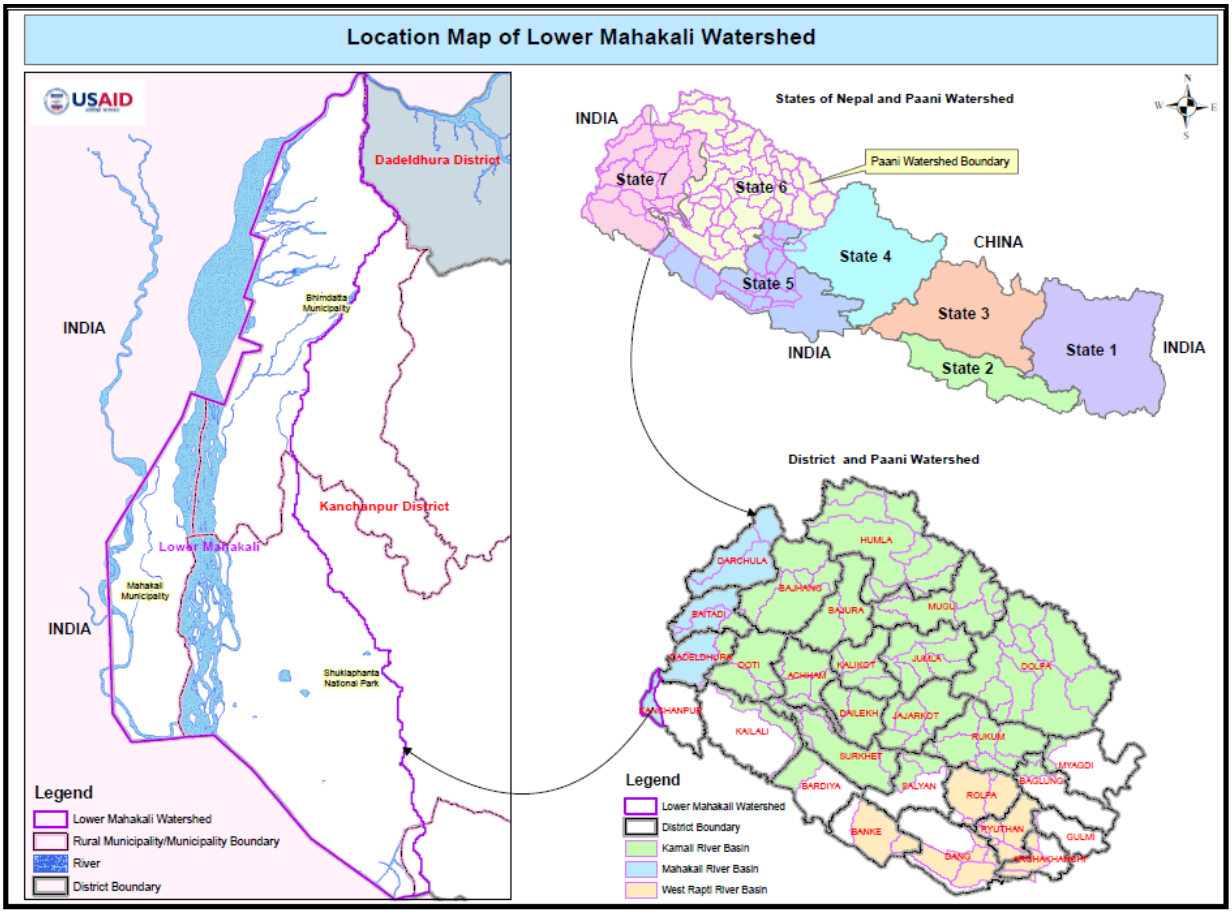
At the watershed level, the Lower Mahakali has been identified as a biodiversity hotspot because it supports a number of endemic bird and fish species, such as a species of catfish found only in Western Nepal (*Pseudecheneis serracula),* and the endangered Sahar fish. Sizable populations of commercially valuable species such as Mahseer, Katle and Buhari fish also occur within the watershed according to the Fisheries Development Center, although local fisherfolk report that fish populations have declined significantly over the last 20 years due to poor fisheries management and habitat modification.

Altogether, there are an estimated 21 lakes and 16 tributaries, including the Mahakali, within the Lower Mahakali Watershed that support a diversity of freshwater and aquatic diversity. One of the most significant wetlands is the Rani Tal in Shuklaphanta National Park (NP), which supports floating aquatic vegetation, such as *Pistia stratiotes*, and provides important habitat for fish species and associated fish-eating birds, such as the Lesser Fish Eagle and Tawny Fish Owl - which contributes to the park's reputation as one of four most important bird areas in Nepal.

Although it is a rapidly developing region with continued economic growth, urbanization, and improving Human Development Index (HDI) levels in parts of the watershed – particularly Bhim Datt municipality – the watershed is facing significant environmental transformation that threatens water resources and biodiversity. In addition, if plans for future hydropower dams along Mahakali River, such as Pancheswor, are implemented, there is a strong potential for additional threats to water resources management downstream within Nepal.

[1] For a variety of more detailed maps of the watershed, see Annexes 2 - 7.

Figure 2: Location map of Lower Mahakali Watershed



PRIORITY ISSUES AND RECOMMENDATIONS FOR THE LOWER MAHAKALI WATERSHED

The Lower Mahakali River has been significantly affected by major transformations in hydrological flows in its upper reaches, climate change, deforestation in the Churia belt, and changes in the fisheries regulatory regime among other stressors. Based on a series of community consultations, stakeholder fora and literature reviews in late 2016 and early 2017, the following priority issues and recommendations have been identified:

Transboundary water management: Upstream barrages in India, namely the Sharda and Tanakpur barrages, have fundamentally transformed the hydrological flows within the Lower Mahakali Watershed in Nepal. The current operational regime of the barrages has led to increased flow in the summer when water flows are already high due to monsoon rains, and significantly reduced flow in the dry, winter months. As a result, the ecological life cycles of most aquatic species have been disturbed. The timing and quantity of water available for agricultural production has also posed problems to farmers, particularly during the dry season when little water is available for irrigation. Furthermore, the barrages hamper the upstream movement of migratory fish, as there are no fish passages and ladders. Additionally, there is no maintenance of minimum environmental flow (e-flow) in the winter season that is directly affecting aquatic biodiversity of the Lower Mahakali, particularly in Shuklaphanta NP. Finally, attempts by the Nepal government to construct an embankment in Mahakali municipality for flood protection have been opposed by the Indian government, because the structure would create flooding on the Indian side of the border.

- Recommendations:

- Strengthen cross-border coordination committee
- Establish communication system with barrage management

Floods creating inundation, river cutting, and landslides: The Lower Mahakali Watershed is highly vulnerable to flood activity, river cutting, and landslides linked to unsustainable land use activities upstream, climate impacts, and natural processes due to the steep terrain in the upper reaches of the Mahakali River. Historical weather data shows that the frequency of high intensity rainfall events is increasing, particularly during the mid-monsoon period, while the yearly average of precipitation is decreasing at a rate of rate of 10 mm/year. Frequent flood events in the Lower Mahakali area have caused losses to human life and physical assets, including the loss of livestock and agricultural land through erosion. The loss of these assets leads to a reduced adaptive capacity to adapt to a changing climate. Increased flood activity has also changed the composition of aquatic species because flood events affect water level, temperature variation, and changes in sediment and turbidity. It also disturbs a wide range of habitats for aquatic life, destroying fish populations and leading to overall declines in fish stocks. The Lower Mahakali experiences high levels of sedimentation and deposition connected to flooding and landslides. Rising riverbeds from sedimentation and mud deposition alters water flow regimes, which affect freshwater biodiversity by increasing water flow rates and temperature and shrinking wetlands. Local communities report that sediment deposits clog irrigation systems and reduce the productivity of agriculture lands, thereby negatively impacting livelihoods and adaptive capacity.

- Recommendations:
  - Provide training and support for low cost stabilization techniques for slopes and river banks, such as bioengineering and river bank planting
  - Support better control of runoff water to reduce soil erosion and protect agriculture land in upstream areas
  - Raise awareness on ways to better manage forest fires and open grazing, such as training to community forest user groups and Khoto Sankalan Samuh
  - Strengthen the Early Warning System
  - Construct raised taps and toilet
  - Conserve wetlands through controlling flooding and its shrinking trend
  - Produce and disseminate behavior change and communication (BCC) materials and radio programs on watershed management best practices
  - Improve implementation of DPRP, LDRMP and related local plans concerned with this issue
  - Relocate or raise infrastructure (e.g., shelter house, Machan, taps, etc.) out of the floodplain and other vulnerable areas

Riverbed mining: Natural and human activities within the ecologically fragile Churia Hills has led to greater gully formation, increased deposition of mud into the river system, and the addition of sand, gravel and boulder materials into downstream areas. While there are large negative impacts in terms of both the wellbeing of aquatic ecosystems as well as livelihoods, the increased opportunity for riverbed mining has become a key revenue source for local government units as well as local communities through wage labor. Unregulated and uncontrolled mining creates disturbances to the riverine habitats, lowers the riverbed, and makes water diversion difficult. Riverbed mining can alter the hydrology of the stream channel, increasing surface flow to dangerous levels during flood events, and negatively impacting the health and safety of laborers.

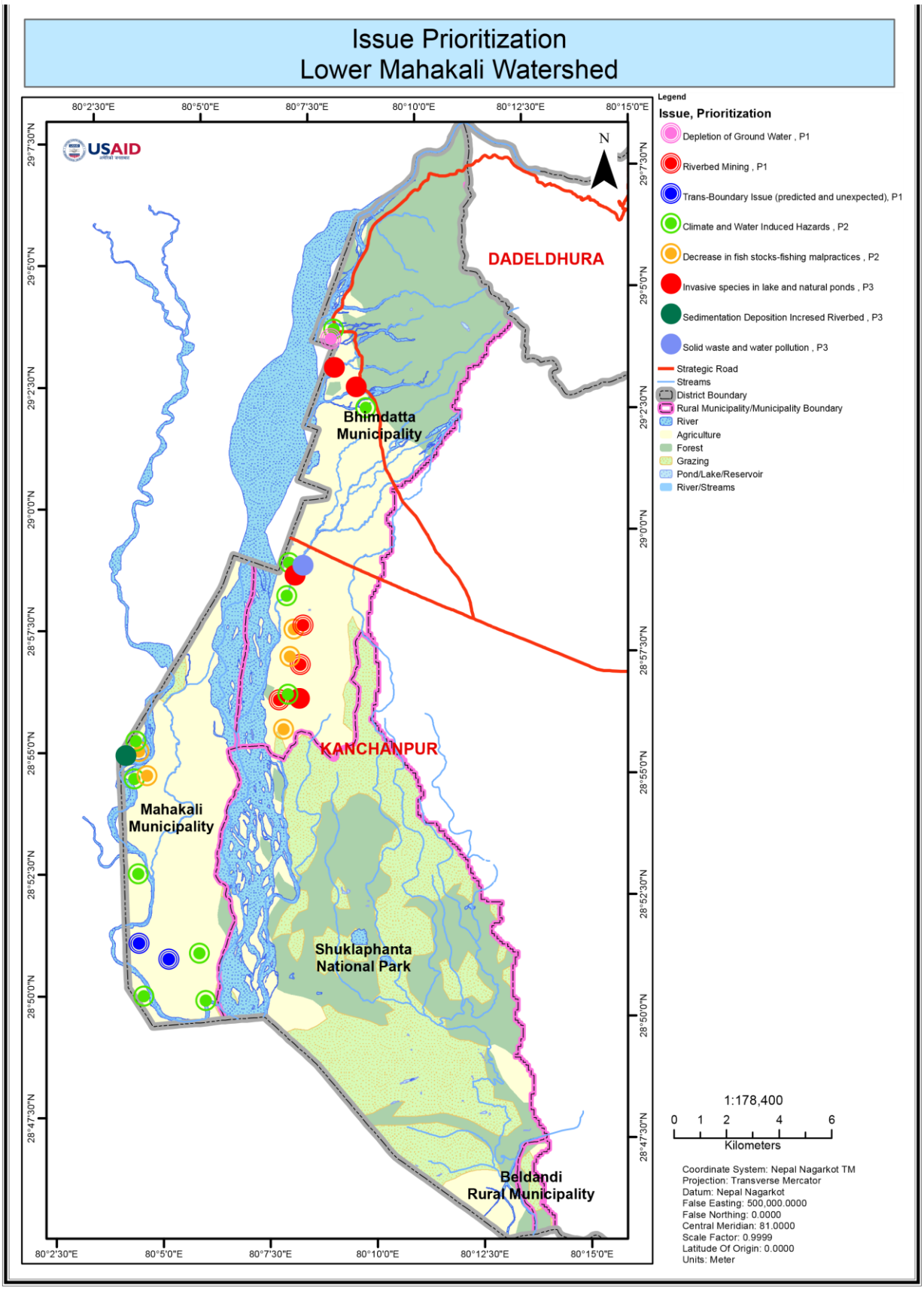
- Recommendations:
  - Promote regulated gravel mining and excavation
  - Engage with local bodies, construct companies and contractors

- Facilitate to apply IEE and EIA provisions
- Facilitate to integrate the issues of riverbed mining in regular and periodic plan of local bodies
- Encourage enforcement of existing laws and regulations related to watershed issues

Decline in fish stocks and unsustainable fishing practices: There is over-fishing in the Lower Mahakali Watershed primarily because of the fishing contract system introduced about 25 years ago. Traditional fisher communities that fish for subsistence, such as the Tharu and indigenous Sonaha, have been marginalized. In their place, a number of non-traditional fishing communities, often-commercial firms, have taken up fishing in the Lower Mahakali Watershed as contract fishermen. In addition to a changing demographic in the fishing population, destructive fishing methods have become increasingly more common. The traditional fishing communities had developed sustainable fishing technique systems over time, which had a lower impact on aquatic biodiversity. However, commercial firms are not concerned about sustainable fishing equipment or practices. Since new fishing communities lack the traditional, more sustainable skills, they often resort to destructive fishing methods as well.

- Recommendations:
  - Fisher Group formation
  - Capacity building of Fisher Groups
  - Develop and endorse capture fisheries guideline
  - Initiate dialogues with State Government (once it is established), DCC/local bodies, contractor and fisher communities
  - Conduct capture fisheries survey
  - Promote ecotourism (sport fishing, catch and release program)
  - Mobilize Community Based Antipoaching Unit (CBAPU) to combat destructive fishing
  - Capacity building of BZMC, BZCF, CFUG at local level
  - Advocacy and leadership training of CSO, CBO, Fisher Group, CFUGs, etc.
  - Promote fisheries culture through fisher groups/communities for commercial purpose

Figure 3: Location of Priority Issues Collected from Multi-stakeholder Consultation Workshops



EXPANDING THE KNOWLEDGE BASE FOR THE LOWER MAHAKALI WATERSHED

During preparation of the Lower Mahakali Watershed profile, several important gaps in information were discovered. These include the lack of downscaled climate change projections for the Mahakali River Basin, need for better information on stream discharge within the watershed and the ecological status of freshwater biodiversity, wetlands and fishery hotspots. In addition, there are knowledge gaps in terms of the impact of irrigation systems (current and planned) on freshwater biodiversity as well as the impact of increased sedimentation on the functioning of the irrigation systems.

- Recommendations:
  - Develop downscaled weather reports and climate change projections for the Mahakali River Basin, including the Lower Mahakali Watershed, and distribute to local communities through local platforms;
  - Conduct freshwater biodiversity inventory and the ecological status of freshwater biodiversity, wetlands and fishery hotspots
  - Develop georeferenced information on aquatic biodiversity and fishery hotspots to guide management of river and fishery resources
  - Develop the capacity of stakeholders in Bhim Datt municipality, Mahakali Municipality, and Shuklaphanta NP to conduct on-going water quality and stream gauge monitoring
  - Collaborate with GoN and irrigation project developers to determine impacts on aquatic biodiversity and the impact of sedimentation on current and proposed irrigation systems

LOWER MAHAKALI WATERSHED: NATURE, WEALTH, AND POWER

The Lower Mahakali 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 power (governance and institutions) [2]. The analysis draws on multiple data sets associated with these three themes in order to identify the critical issues and opportunities facing communities within the Lower Mahakali Watershed.

In late 2016 and early 2017, the PANI program conducted a series of literature reviews, household surveys, focus-group discussions, and key informant interviews (See Annex I for further detail). Once the data was collected and analyzed, the PANI team conducted Multi-stakeholder Consultation Workshops (MSCs) to share the preliminary results of the analysis and identify priority threats, vulnerabilities, and environmental assets by location and stakeholder groups. An exit MSC workshop was conducted in the District headquarter of Kanchanpur on April 9, 2017 in the Lower Mahakali Watershed to share the consolidated results with Lower Mahakali stakeholders, as well as to identify solutions, champions and stakeholders for leveraging funds and expertise to address the challenges in water resources. Representatives of Municipalities, District Coordination Committee (DCC), District Soil Conservation Office (DSCO), District Forest Office (DFO), District Agriculture Development Office (DADO), Buffer Zone Management Committee (BZMC) and numbers of other stakeholders and district level NGOs participated in the MSCs. The participants of the workshop worked on defining the current reality (strengths, weakness, challenges and opportunities) and setting a concrete vision for the watershed.

[2] https://rmportal.net/library/content/nwp-2.0

NATURE

This section examines the environmental and natural resource dimensions of the watershed, including climate and weather, hydrology, biodiversity, fisheries, and land use within the Lower Mahakali Watershed. The main channel of the Mahakali River that flows through the center of the watershed, and its associated tributaries and wetlands, support rich aquatic biodiversity, including a number of commercially important fish species. The Mahakali's water resources also play an essential function in providing irrigation water for agriculture and water for drinking and sanitation that contribute to the subsistence and income generation of the area's population of over 140,000 people.

The Mahakali River is a snowmelt fed river system that starts in the Api-Himal[3] and then descends from 3,600 m elevation at Kalapani down to the Lower Mahakali Watershed where, at around 200 m it starts to flow into the Terai plains. Within the Lower Mahakali watershed, the hydrological dynamics of the upstream barrages, together with local rainfall, primarily determines the water flow patterns. The Lower Mahakali Watershed covers an area of 310 $km^{2,}$ about half of which is made up of Shuklaphanta NP (156 km^2) on its eastern side. The Churia occupies about 47 km^2 to the north. The Mahakali River within the watershed is a braided river system, which means that it is a single channel composed of networks of small channels. The Mahakali River system holds some ecologically diverse remnant patches of rare Terai riverine and wetland ecosystems.

WEATHER AND CLIMATE CHANGE

TEMPERATURE

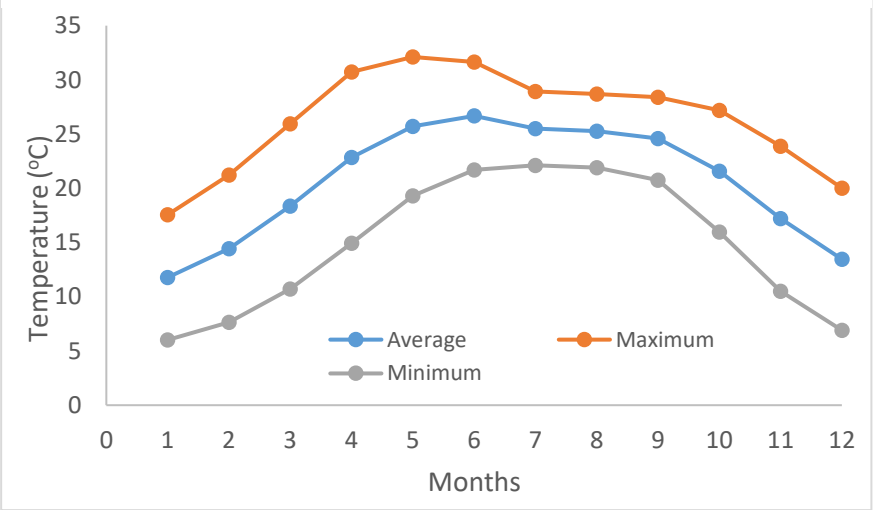
Temperature variation in the Lower Mahakali Watershed is analyzed according to four prominent climatic seasons observed in the watershed: winter (December to February), spring/pre-monsoon (March to May), summer/monsoon (June to September) and autumn/post-monsoon (October to November). There are no long-term temperature recording stations in the Lower Mahakali Watershed. Mahendranagar (station 105), which is located 2 km from the western boundary of the watershed, is the closest climatological station. For the period when the temperature data at Mahendranagar are missing, the temperature data recorded at Dhangadi (station 209) were used to estimate the temperature in the watershed. Dhangadi is located at a distance of about 35 km from the western boundary of the watershed at a similar elevation to that of Mahendranagar.

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

[3] Api is the highest peak in the Yoka Pahar Section of Gurans Himal that is located within the extreme northwest corner of Nepal's Himalayas. It is known for its dramatic rise over the low surrounding terrain.

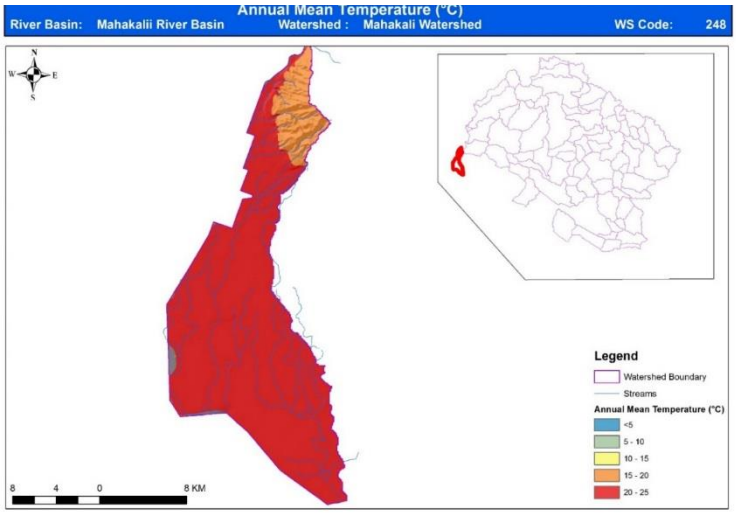
The long-term average monthly temperature variation (daily average) in Lower Mahakali Watershed is shown in Figure 4. The average monthly temperature of the watershed varies from 12 ◦C in winter to about 27 ◦C in summer. Similarly, the minimum and maximum monthly temperature varies from 6 ◦C and 18 ◦C respectively in winter to 19 ◦C and 32 ◦C respectively in summer. Maximum temperature in the Lower Mahakali Watershed is typically observed in May, and the minimum temperature is typically observed in January.

Figure 4: Maximum, Minimum and Average Long-term Monthly Temperature (ºC) in the Watershed



The long-term average annual temperature variation in Lower Mahakali Watershed is shown in Figure 5. The average annual temperature varies from 15 ◦C in the north, corresponding to the higher altitudes of the Churia Hills, to 21 ◦C in the south, which constitutes most of the Lower Mahakali Watershed in the warmer and drier Terai Plains.

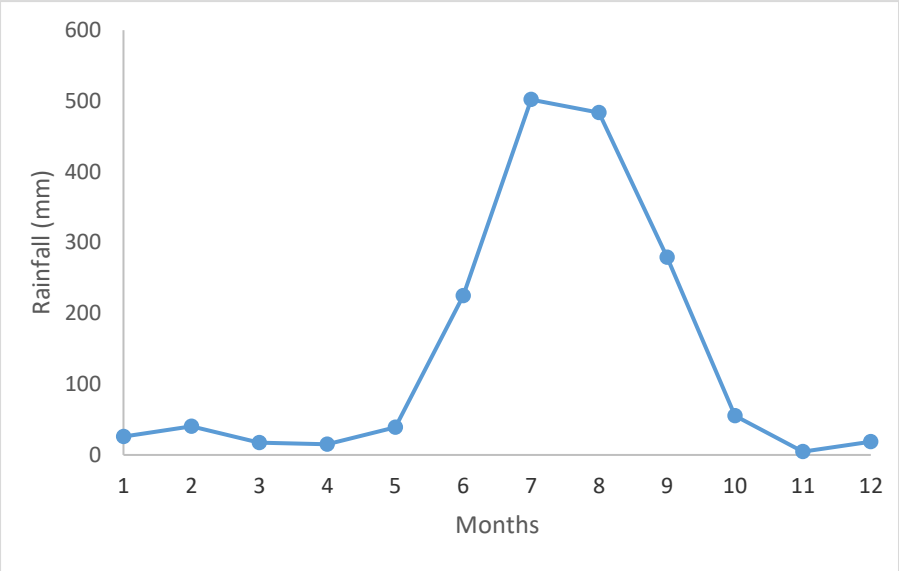
Figure 5: Annual Mean Temperature in the Watershed



RAINFALL

There are no long-term rainfall data records in the lower-Mahakali watershed. Thus, Mahendranagar (105) and Belauri Santipur (106), the nearest stations to the watershed, were used to estimate the average rainfall in the watershed based on Theissen polygon method. Average monthly rainfall estimated in the Lower Mahakali Watershed is shown in Figure 6. The average dry season rainfall (Nov. – April), the average monsoon rainfall (June – September), and the average annual rainfall were estimated as 20 mm, 372 mm, and 1706 mm respectively. Highest and lowest monthly rainfall in the Lower Mahakali Watershed are observed in the months of July and November respectively.

Figure 6: Long-term Average Monthly Rainfall (mm) Estimated in Watershed



Source: Department of Hydrology and Metrology (DHM)

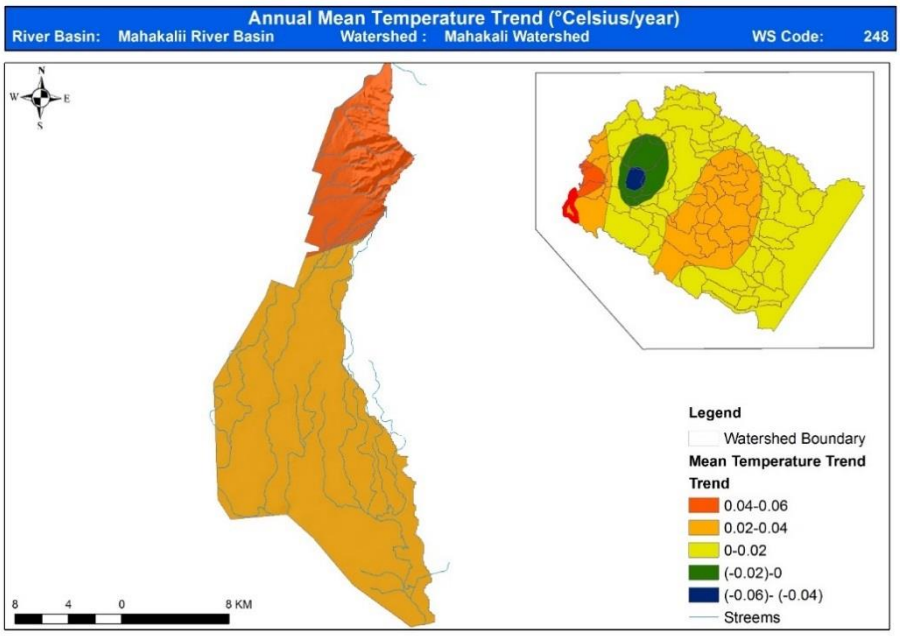
CLIMATE CHANGE

Nepal is ranked as the fourth most vulnerable country to climate change, thirtieth with respect to water-induced disasters, and twentieth with respect to multiple hazards (NPC, 2010). Although no systematic vulnerability assessment of the entire country has been conducted in relation to climate induced-disasters, a few flood and landslide vulnerability assessments of some places have been done. The Nepal Country Vulnerability Study Team (NCVST) in 2009 projected that the frequency of hydro-meteorological extreme events such as droughts, storms, floods, inundation, landslides, debris flow, soil erosion and avalanche would increase due to projected climate change (MOE, 2009). Extreme precipitation events are also likely to increase. One-day precipitation amount has shown an increasing trend, and there have been increasing trends in consecutive dry days (maximum number of consecutive days with rainfall less than 1 mm) and decreasing trends in consecutive wet days (maximum number of consecutive days with rainfall equal or more than 1 mm).

From a historical perspective, an 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. However, the changes vary spatially and seasonally. In the Lower Mahakali Watershed region, an increasing trend of temperature is observed. The winter, summer/monsoon, and autumn temperatures are observed to increase at a rate of 0.04 oC/year. The spring temperature rising rate is observed to vary from 0.04 oC/year to 0.02 oC/year, moving from the southern to northern part of the watershed. The average annual temperature rising rate is observed to vary from 0.02 oC/year to 0.06 oC/year, moving from southern to northern part of the watershed (Figure 7).

The Himalayan glaciers are receding faster than any other glaciers in the world (IPCC, 2007). The Mahakali River has 167 glaciers. With glaciers receding, the function of glaciers in regulating water flow throughout the year, particularly in the dry months, will be lowered. Also, glacier melt in the Himalaya is projected to increase flooding and rock avalanche from destabilized slopes and to affect water resources (IPCC, 2007).

Figure 7: Annual Mean Temperature Change Trend in Lower-Mahakali Watershed



Source: Marahatta et al, 2009

Spatial as well as seasonal variation in rainfall change trend is observed in Lower Mahakali Watershed, which is summarized in Figure 7. The annual rainfall is observed to decrease at the rate of 10 mm/year (Figure 8). Similarly, mean monsoon (Jun. – Sep.) rainfall is also observed to decrease at the rate of 10 mm/ year. Mean pre-monsoon (Mar. – May) and mean post-monsoon (Oct.- Nov.) rainfall are also observed to decrease at the rate of 3 mm/year and 1 mm/year respectively. However, only the mean winter rainfall (Dec. – Feb) is only observed to increase at the rate of 1.2 mm/year respectively (Figure 8).

Figure 8: Annual Mean Temperature Change Trend in Lower-Mahakali Watershed

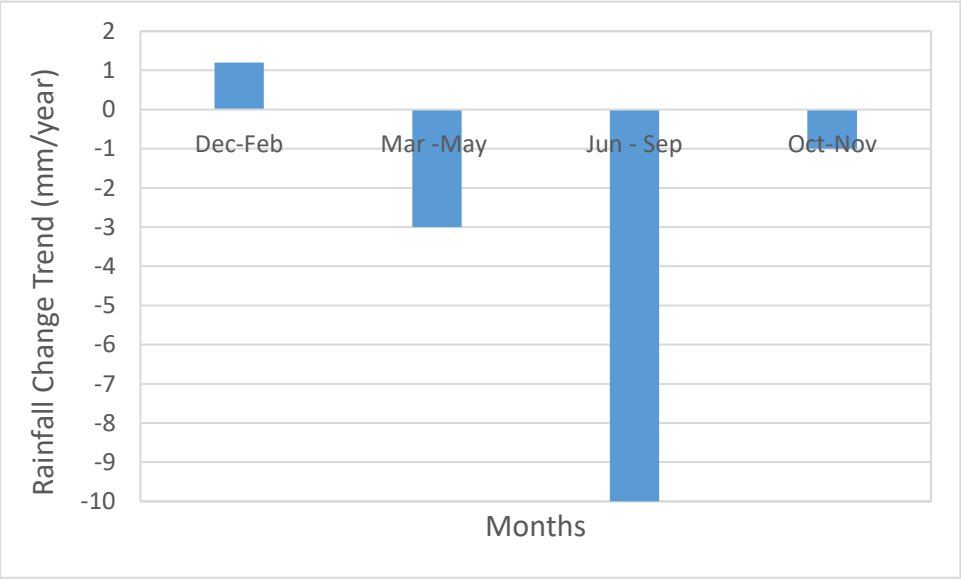
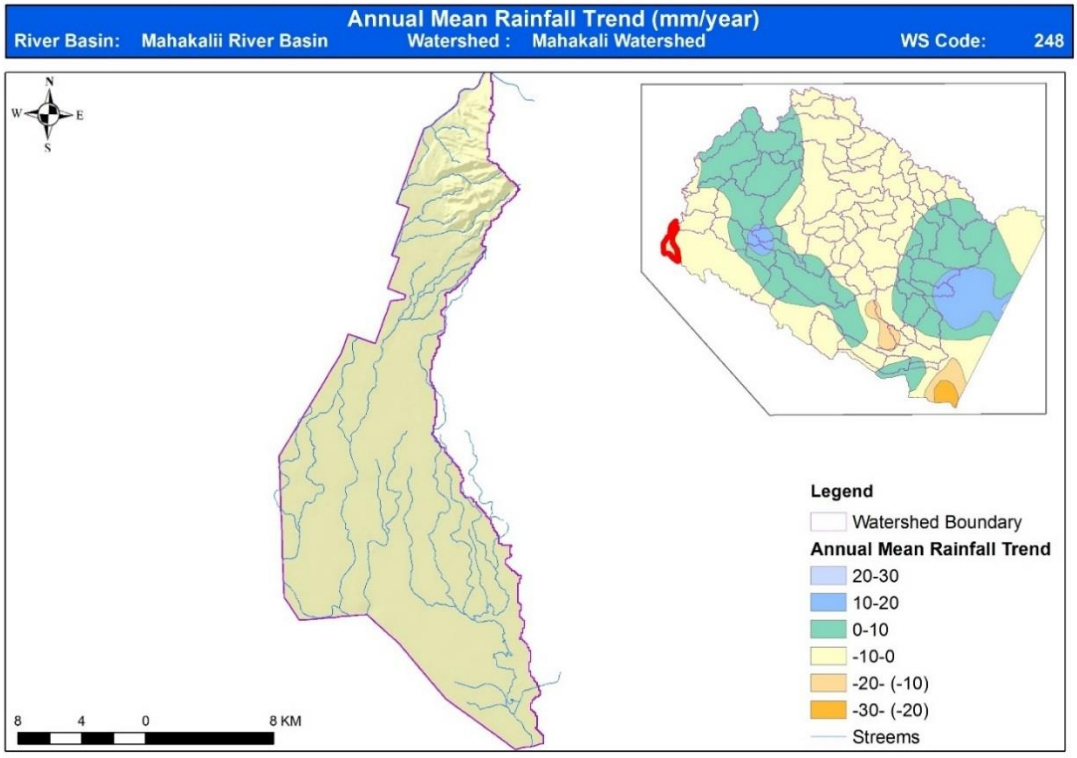


Figure 9: Long-term Annual Mean Rainfall Trend (mm/year) Observed in Lower Mahakali Watershed



Source: DHM

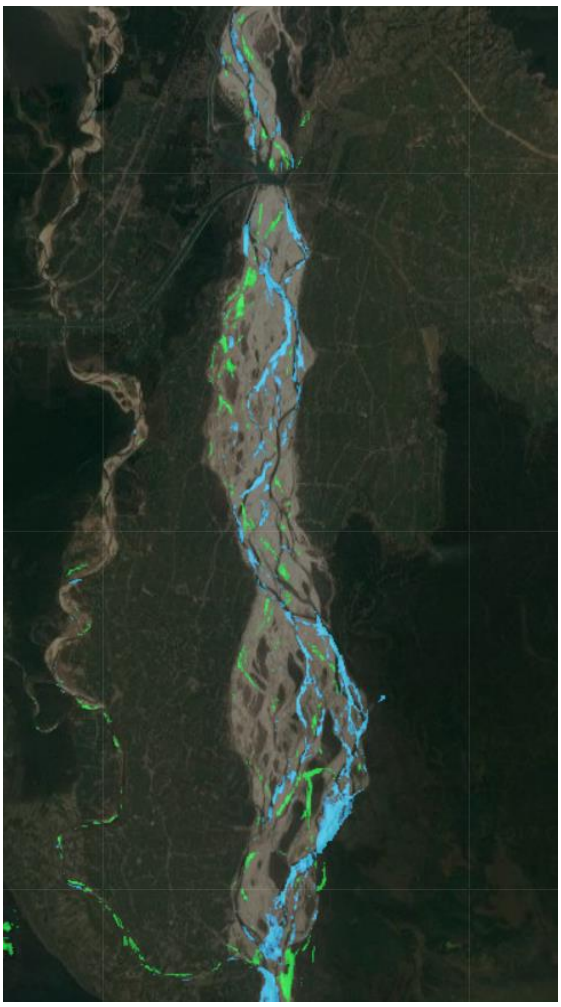
HYDROLOGY

The main channel of the Mahakali River runs north to south through the middle of the Lower Mahakali Watershed and is a braided river consisting of an overlapping network of streams, tributaries and wetlands (Figure 10).

The total drain density of this watershed is 769 m/km^2. Although there are hydrological stations measuring water level and discharge located further up in the Mahakali river basin (e.g., Baitadi station no. 170 is the nearest one, and a few others such as no. 120 and 169), there are none within the Lower Mahakali[4]. As such, there is little information on hydrological flow and its seasonal or annual variation.

Information from a global study of surface water change over period 1985-2016 (based on imagery with 90 m pixel resolution) suggests that there has been greater conversion of land area to water area compared to conversion of water areas to land. [5] While it is common to observe erosion and deposition zones within the corridors of braided river, in this case the eroded part lies within Shuklaphanta NP. A closer analysis may help to decipher what the causes of this surface water change are within the Lower Mahakali Watershed.

Figure 10: Satellite Image of the Mahakali River



STREAMS AND TRIBUTARIES

In total, there are 16 named tributaries within the watershed, including Bhuni Khola, Bangau Khola, Bange Khola, Bhingri Gaad, Bhumethala Khola, Chaudhar Nadi, Gadha Khola, Gatadi Khola, Jogbuda Nadi, Kamikate Khola, Machhetri Khola, Malariya Khola, Sukha Khola, Tilachaur Khola and Tilkeni Khola. Out of these 16 tributaries, most of the streams originate from Churia and are almost without water during dry season. These include Bhuni Khola, Bangaun Khola, Bange Khola, Bhingri Gaad, Bhumithala Khola, Gatadi Khola, Kamikate Khola, Machhetti Khola, Sukha Khola, Tilachaur Khola and Tilkeni Khola. These streams cause serious loss to human, livestock, houses, and agricultural lands due to DRR related issues such as landslides from the Churia hills upstream, river cutting, sedimentation, deposition, flooding and inundation during the monsoon period.

The Gandha Khola flows down through the Bhim Datt Municipality. Some drainage systems from this area mix with this this stream, along with water from irrigation canals. In spite of having water year round in Bhujela Khola, Malariya Khola and Jogbuda Nadi, the river communities are not using it for irrigation or for drinking water. The Jogbuda Nadi brings flooding and inundation during winter, and excessive water is released by hydropower and irrigation from the head of Naglascape/Lohia in India (PANI FGD, 2017).

Water discharge in a couple of tributaries was estimated (by floating method/area velocity) during Mar. - May 2017, which provided an idea on dry season flow (Table 1). A number of tributaries in the northern side of the watershed were completely dry at the time of the PANI Survey in May 2017. A significant

[4] Information is collected by gauging stations in the Indian part of the Mahakali but this is not publically available due to national security laws of India (see Midha & Mathur, 2013).
[5] See: http://www.nature.com/nclimate/journal/v6/n9/full/nclimate3111.html, and the website: http://aqua-monitor.appspot.com/

area towards the southern side of the watershed is the Shuklaphanta Wildlife Reserve, which is a protected. This is a onetime measurement and further measurements during other seasons would provide important information on water resources availability and variability.

Table 1: Stream Discharge of Some Waterbodies in Lower Mahakali Watershed

Name of Rivers/Streams	Date of Measurement	Estimated Discharge (L/S)
Jogbudha River	05-Apr-2017	3006.89
Malaria Khola	05-Apr-2017	59.00
Bhujela Khola at Lamsar	05-May-2017	257.07
Gandha Nala	18-Mar-2017	200.00
Nayagaon, Gandha Nala	05-Apr-2017	490.90
Bhujela Khola Near Mahakali Confluence	05-Apr-2017	342.82

LAKES

Of the 27 natural lakes found in Kanchanpur, there are 13 in Shuklaphanta municipality (two in the national park), four in Beldandi Rural municipality, three in Mahakali municipality, and one in Bhim Datt municipality[6]. One of the largest wetlands in Shuklaphanta NP, named "Rani Tal," covers 10 hectares. Most of these lakes are shrinking due to deposition of silt and mud by floodwaters during the rainy season[7] as well as increasing encroachment by new settlers. There is a knowledge gap regarding the changes in wetland areas and conditions within the Lower Mahakali, as these wetlands are not among the national priority programs on wetland and lake conservation. Birdlife Nepal reports that several wetlands within the Lower Mahakali, including Rani Tal, have the potential to be designated as Ramsar sites. Several lakes fall under the authority of consumer groups or community forestry groups who then lease out fishing rights to locals, though not for commercial purposes.

Table 2: Water Bodies in Lower Mahakali Watershed

SN	Water Bodies	Status in Lower Mahakali Watershed
1	Larger River	Mahakali in itself is a larger, snowmelt fed river system that starts in the Api-Himal. However, because of the Sharda and Tanakpur barrages in the Indian upstream area, the river is almost completely dewatered in the winter season in the Lower Mahakali Watershed area, and releases high discharge during summer months.
2	Small River	Jogbuda Nadi, a small river entering from the Indian side is part of this watershed area. The discharge of the river is 3007 l/sec. The confluence of this river with Mahakali occurs at Kutiyakabhar. This is a highly flood-affected area. Sometimes the people of that area suffer from excessive water that comes from both Sharda barrage (at Naglaescape), and through Jogbuda Nadi.

[6] https://thehimalayantimes.com/nepal/47-natural-lakes-kanchanpur-far-west-nepal/

[7] There is conflicting information about this as an earlier report for Shuklaphanta National Park indicates that the area of water bodies over the period 1978-1996 increased by 0.88percent percent and 1.94percent percent in Shuklaphanta National Park and its buffer zone respectively (ref, 17).

SN	Water Bodies	Status in Lower Mahakali Watershed
3	Head Water Streams	There are a number of headwater streams i.e. Bahuni Khola, Bhujela, Tilkeni, Malaria Khola, Gandha Nala.
4	Wetland	Kanchanpur is one of the richer districts in terms of natural ponds and wetlands. Rani Tal and others located within Shuklaphanta NP have the potential to be Ramsar sites.

STREAM WATER QUALITY

Water quality measurement was conducted at the time of PANI Survey 2017 during the dry season to identify the basic status of river water quality and flow in the watershed using the Akvo Caddisfly kit and Akvo Flow mobile app. This data provides important information about the sources of pollution and the basis for maintaining and improving the water quality and watershed health.

Table 3 presents the water quality parameters and data of several streams within the Lower Mahakali Watershed. Based on the first results on water quality data, and relating those to different standards, it was found that most of the parameters are within the range for drinking, aquaculture, and irrigation purposes. However, ammonium and phosphate appeared to be at somewhat elevated levels as seen in Table 3. Additional water quality measurements during other seasons would provide very important information on water quality and its variation.

Table 3: Water Quality Standard of Different Streams in the Watershed

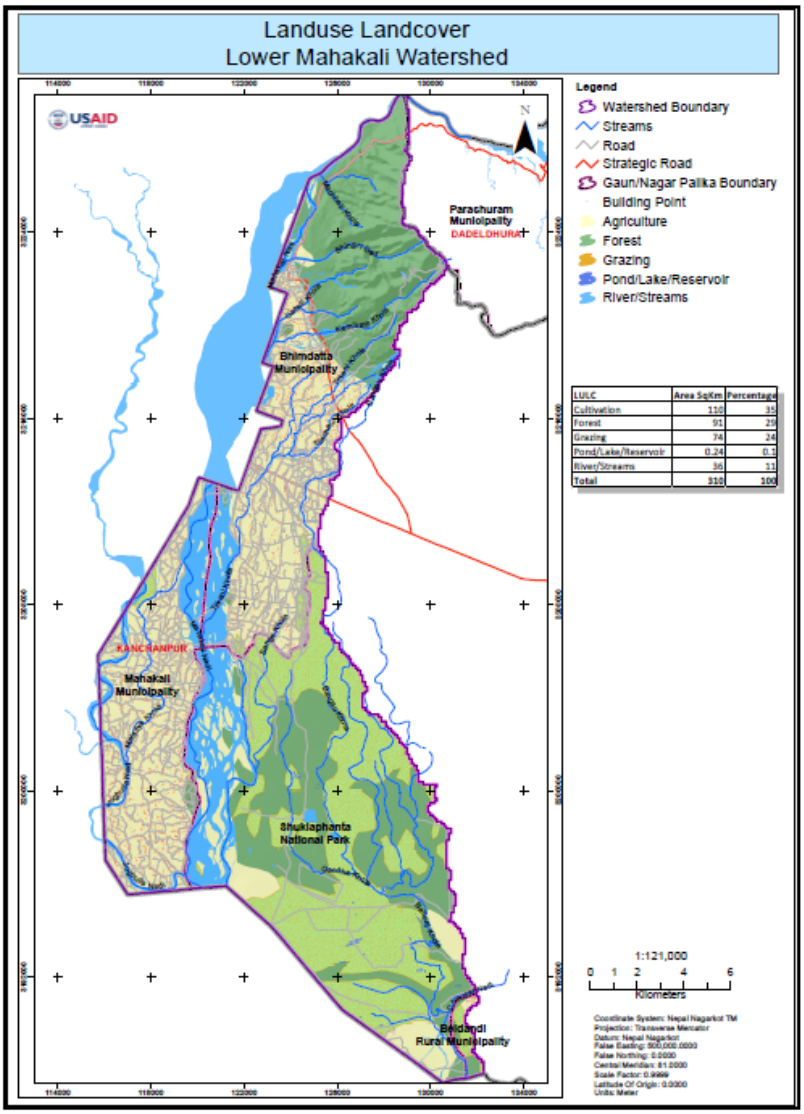
Water Quality Indicator	Name of the River/stream						Water Quality Standards		
	Jogbudha river	Malaria Khola	Bhujela Khola at Lamsar	Gandha Nala	Gandha Nala at Nayagaun	Bhujela Khola near Mahakali confluence	* Drinking	** Irrigation	** Aquaculture
Date of test	5/4/2017	5/4/2017	5/5/2017	5/4/2017	5/4/2017	5/4/2017			
Conductivity (µS/cm)	299.2	285.9	591.2	329.7	413.9	433.3	1500		
Temp.(°C)	32.9	29.3	26.4	28.1	31.7	31.4			4 to 30
Iron (mg/L)	0.2	0.3	0	0	0	0	0.3 (3)	5	0.01
pH	7.6	7.6	7.4	7.3	7.4	7.5	6.5-8.5	6.5-8.5	6.5-9.0
Nitrate Nitrogen (mg/L)	0	1	0	0	0	0	50		<300
Nitrite Nitrogen (mg/L)	0	0.1	0	0	0	0		<5	
DO (mg/L)									5.0-10.0
Turbidity (NTU)							5 (10)		
Ammonium (mg/L)	0	1	1	0	2	2	1.5		0.025
Phosphate (mg/L)	16	22	13	4.4	0	3.7			

Notes: .*Nepal's Drinking Water quality standards,
** Nepal Water Quality Guidelines, Volume 1 (Irrigation) and Volume 2 (Aquaculture), Irrigation, Ground Water Resource Development Board, Ministry Of Irrigation

LAND COVER AND USE

The majority of the land area within the Lower Mahakali is agricultural land (109.81 km^2 or 35 percent of land area.) and forestland (90.75 km^2 or 29 percent of land area). Forestland is primarily broadleaved forest. The remaining area consists of grazing land, which consists of grass, shrub and bushes in patches, and may have few trees scattered here and there (74.06 km^2 or 24 percent of land area). About 12 percent of the land area (35.6 km^2) is covered by rivers and streams with a very small portion (0.24 km^2) consisting of ponds, lakes and reservoirs. Given the low population density and rural nature of the Lower Mahakali Watershed, it is not surprising that only 0.01 km^2 of land is coved by urban settlement.

Figure 11: Land Use Cover in Lower Mahakali Watershed



BIODIVERSITY

Since the area covers both tropical and sub-tropical conditions, the Lower Mahakali is rich in biodiversity possessing patches of rare Terai wetland ecosystems. The Lower Mahakali Watershed consists of a number of different ecological zones covering forest areas, grasslands, and wetland ecosystems. Therefore, the Lower Mahakali is known as one of the important watersheds in Nepal in terms of being a biodiversity hotspot.

While there is a limited amount of knowledge about the terrestrial biodiversity in the area, there is practically no information on the condition of aquatic biodiversity in the watershed. In a terrestrial sense, Shuklaphanta NP, a major grasslands ecosystem in the eastern part of the Lower Mahakali Watershed, is of critical importance. Tree species such as Simal (*Bombax ceiba*) and Palash (*Butea monosperma)* are found on the edges of Shuklaphanta NP. Dhaddi *(Saccharam sp*), narkat *(Phragmites karka*), Siru *(Imperata cylindrica*), kans *(Heteropogon contortum*), Beldande are the major grass species found in the Shuklaphanta NP (Joshi, 2002). This grassland ecosystem includes several lakes and ponds that support aquatic biodiversity. Even though there is insufficient precise information on biodiversity, anecdotal information suggests that the park supports a wide range of nationally and globally important biodiversity including 46 mammal species, 423 bird species of migratory and resident birds (including Nepal's largest population of Bengal florican), and 16 species of reptiles. The protected area hosts the world's largest herd of swamp deer as well as tigers, leopards, chital, hog deer, sambar, rhinos and hispid hares.

Outside of Shuklaphanta, there are a range of different forest types throughout the watershed, ranging from khair (*Acacia chundra)*-Sissoo (*Dalberghia sissoo*) forests in riverine areas, gureland pithura (*Trewia nudiflora*) riverine forest, sal (*Shorea robusta)* in both Bhabhar (densely forested area between Churia/Sivalik hills and Terai) and Terai areas, pseudo steppe with Graminae, tropical elephant grasses, and predominately cultivated areas in in lowland Dun (GoN/MFoSC, 2013).

According to local communities within the watershed, the protected *Bijaya Sal* (*Pterocarpus marsupium*) tree holds important medicinal value. Over the period 2001-2010, the rate of forest cover change in Kanchanpur District was high at -0.25 percent (DFRS, 2014). It has a high rate of conversion of forest land to agricultural uses (70 percent of all conversions) when compared with other Terai districts. In particular, the forestlands near riverine areas, near roads and on edges of government forest lands are targeted for such conversion by new settlers. In upland forest areas, tiger, bear, rhinoceros, elephants, jackals, monkeys, common kite, vulture, cuckoo, hawk, dove have been sited within the Lower Mahakali Watershed.

In terms of aquatic habitat and fish species, there are several lakes, rivers and oxbow lakes in the watershed area. Prominent wetlands are Rani Taal (10 ha), Sikari Taal, Kalikitch Taal, Tarapunal and many others. None are presently declared Ramsar sites, although the wetlands of Shuklaphanta have the potential to be designated Ramsar sites[8]. The aquatic vegetation includes floating species like *Pistia stratiotes, Nelumbo nucifera, Nymphoides indica, Nymphoides hydrophyllum*, chara, red and green algae and blue-green algae, *Persicaria barbata, Persicaria capitata, Persicaria glabra*, P*olygonum plebeium, Polygonum pulcherum* and water's edge species like *Equisetum diffusum, Dryopteris cochleata*, and tall grass like *Phragmites karka*.

National and Terai assessments of the status of wetlands in Nepal provide a broad-brush review of the ecological conditions of wetlands in different eco-zones but no specific information on the wetlands in

[8] Baral, H. S. 2012. Status of wetlands and wetland birds in Nepal. *Daphne, Bird Conservation Nepal,* 21,3/4 15.

Lower Mahakali is provided[9]. According to Kanchanpur's District Forest Office, Kanchanpur ranks 9th when it comes to importance for wetlands nationally. Lakes such as Betkot and Jhilmila are well-known within Kanchanpur's Churia area for high levels of aquatic biodiversity. Although there has been little investigation of the ecological status of these wetlands, anecdotal evidence indicates there are significant problems. For example, Rani Taal is covered with water hyacinths and is awaiting conservation efforts to bring back its original ecology[10]. A recent phyto-ecological assessment of the Mahakali River[11], while providing very interesting findings, only covers Baitadi, Darchula, and Dadeldhura districts.

One of the four most important bird areas in Nepal is Shuklaphanta NP. 423 bird species have been recorded in Suklaphanta NP alone. The park supports the highest population of Bengal floricans in Nepal. It is the western limit of swamp francolin, Jerdon's bushchat, rufous-rumped grassbird, chestnut-capped babbler and Jerdon's babbler; the north-western limit of yellow-eyed babbler; the eastern limit of Finn's weaver and the most important regular wintering site of Hodgson's bush-chat. Forest birds include spot-bellied eagle owl, dusky eagle owl, rufous-bellied eagle and Oriental pied hornbill. The forests are also important for great slaty woodpecker and white-naped woodpecker. The white-rumped vulture, slender-billed vulture, lesser adjutant, grey-headed fish eagle, darter and rufous-rumped grass bird are breeding residents. Sarus crane, painted stork and bristled grass bird are summer visitors. Greater racquet-tailed drongo, white-capped water redstart, rusty-tailed flycatcher and rufous-gorgeted flycatcher are uncommon winter visitors.[12]

Wetland birds face a wide range of threats in the watershed area, and these have significantly increased since 2004. Widespread threats include drainage for agriculture, unsustainable harvesting of resources, diversion and abstraction of water for farmland irrigation, overgrazing of shorelines and marshes, widespread mining of gravel from riverbeds and the possibility of new dams. Many species are suffering from water pollution, hunting, trapping, disturbance and destruction of feeding and nesting sites. Water pollution from agricultural chemicals has been identified as a particularly serious threat to lowland wetlands (BCN 2010).

Over-fishing and fish poisoning have significantly reduced the food supply of fish eating birds. Almost all these species have declined in Nepal's wetlands, and many of them are now included in this nationally threatened list, for instance Lesser Fish Eagle (*Ichthyaetus humilis),* Tawny Fish Owl *(Ketupa flavipes)* and four tern species. As a result of this barrage of threats, a large percentage of wetland birds (75 percent) are considered Critically Endangered or Endangered. Some wetland species have shown precipitous declines over recent years, for example, Brahminy Kite (*Haliastur indus),* Caspian Tern (*Sterna caspia)*, Black-bellied Tern (S. *acuticauda)* and River Tern (S. *aurantia)*[13] which is found true in the Lower Mahakali Watershed.

The Mahakali once supported many river-dependent aquatic species such as the Ganges river dolphin. There were several studies conducted on Ganges River Dolphin in Nepal. The results showed that the dolphins have become extinct from the Mahakali river system due to insufficient water near the Nepal-India border[14]. Dolphins are mainly under threat due to habitat loss and fragmentation from damming of rivers for hydropower and irrigation, coupled with a lack of local awareness and stewardship and transboundary issues[15]. New studies have examined in detail how irrigation demands and intensified

[9] IUCN. 2004. A review of the status and threats to wetlands in Nepal. Kathmandu: IUCN; Bhandari, B. 1996. An inventory of Nepal's Terai wetlands. Kathmandu; IUCN.
[10] https://thehimalayantimes.com/multimedia/photo-gallery/rani-taal-shuklaphanta-wildlife-reserve/
[11] Kunwar, R. et al. 2015. Phyto-ecological assessment of Mahakali river, Far-Western Nepal. *J of Natural History Museum*, 29: 32-48.
[12] https://en.wikipedia.org/wiki/Shuklaphanta_National_Park
[13] The State of Nepal's Birds 2010, Inicators for our changing world, published by BCN
[14] IUCN Nepal 2017; Janawali & Bhuju 2000; Shrestha 1989; Smith et.al. 1994 Status, Distribution and Conservation Threats of Ganges river dolphin in Nepal"; !UCN Nepal, January 2017
[15] WWF Nepal, 2006, Paudel et.al. 2015

fishing intensity have created threats to river dolphins in the Karnali basin[16]; it is likely that the same threats have led to the disappearance of the river dolphin in the Mahakali. Other species such as freshwater otter, mugger/crocodiles, turtle and aquatic macro invertebrates, such as insect larvae, snails/mussels (food for many people), and planktons have also been reported to be on a decreasing trend. Two to three species of tortoises can still be found in the Mahakali.

In terms of fisheries, there is a strong relationship between fish stocks and fish-dependent livelihoods. Of the 20 million Nepalese currently living in rural areas, over 2.8 million depend on aquatic and fisheries resources to support their livelihoods, (CBS, 2006, IUCN Nepal 2004). There are about 69 fish species found in the Mahakali (Shrestha, 1990). A recent study indicates that the Lower Mahakali is one of the important watersheds in Nepal in terms of biodiversity hotspot since they support endemic fish species such the catfish, *Pseudoecheineis serracula* (Rajabanshi, 2013; Ng, HH, Edds, 2005). The status of fisheries in Nepal is summarized in Table 4.

Commercially valuable species such as mahseer (*Tor*), katle (*Neolissocheilus*) and buhari (*Wallago,* known as lachiya locally) are available in good numbers according to the Fisheries Development Center, Kailali. Populations of asla (*Schizothorax*), buduna (*Garra*), bhoti (*Channa*), tengar(*Mystus spp*) and eel have decreased mainly due to habitat loss. Sahar (*Tor spp*), an endangered fish species, is also found in the watershed area.

Table 4: Status of Fisheries in Lower Mahakali Watershed

Fisheries Dimension	Status in Lower Mahakali
Rare and endemic fish	• 96 percent of respondents of HH surveys reported that the number of native fish species has decreased compared to the last 5 or 10 years • They felt that some indigenous fishes are moving towards extinction i.e. mudhakhiya, chitauri, kunda, ota and the freshwater shrimp jhinge; • An endemic fish species named Pseudoecheineis serracula sp is found in this watershed. • Lachiya, dudhiya, singri and mungro are rare but found within the Shuklaphanta NP in Bahuni Khola. • Filausiya and tengar are also rare fish in this area.
Commercially useful native fish	• Karsa, rohu, singhi, lachiya, karangawa, philausiya, goch, bhedal, dedawa, bhuriya, dadhawa, bam, dhungri, bani, gadari, galara, bhudawa, rawa, kursa, rohi, bajariya Mahseer, guduna, bhoti, shahar katle, asla, buhari

Source: FGD with Sonaha Community

Based on an initial database search, there are no fish species that are officially listed or protected by the Nepal Government or other international lists such as CITES or IUCN within the Lower Mahakali, but many are reported to be threatened with extinction in the scientific literature. Rare migratory fishes like sahar (mahseer *Tor spp*), Asla, snow trout (*schizothorax spp*), rajabam (*Anguilla Spp*), gonch (*Bagarius spp*) are affected by changes in water velocity, fluctuating water levels, habitat change, development and encroachment.

The Sonaha community traditionally fished in the Mahakali River from the Banbassa Bridge to the Dhaknaghat. From their perspective, mahaseer, ghoch, kadhangwa, dhungri, bani, gadari, galara, bhudawa, rawa, kursa, rohi, and bajariya are common varieties of fish. Lachiya, dudhiya, singri and mungro are extremely rare but found within the Shuklaphanta NP area in *Bahuni* khola.

[16] Khanal, G. et al. 2016. Irrigation demands aggravate fishing threats to river dolphins in Nepal. Biological Conservation,

The Sonaha have a detailed understanding of the specific habitats within which particular fish species are found. On the main river, where giant boulders are found surrounded by water and fish holes, fish with scales are found such as mahseer, ganchh, kadhanwa, ghiuri, ghuriya, dadhuwa and bam. Under the stones, chitauri fish can be found. If stones are not present, singi fish are found in groups (50-100 in number), making a *bhakari*-like nest. Species such as rohu and naini are not found in areas with stones but in large water bodies. Among deep ponds in riverbeds, large-mouthed kharsa and gadheri fish are present. Within the canals and small tributaries, the finger-sized baliya, bhuriya, and dedhuwa can be found. Larger fish such as kauwa, which is like a gharial crocodile in shape, can still be found while the brown-colored katchchuhcho/kauwa are almost extinct. A rare species, the large-bellied mudhakhiya is now extinct as is the jhinge. Among these fish species, the very small sized fish (50-100 mm) called chitauri are used to cure various diseases, and the fat of these fish is known for its pleasing taste.

The importance of the watershed has also been recognized by conservationists for endemic fish species such as *Pseudoecheineis serracula*. Filausiya and tengar are almost extinct. All the major fish micro-habitats are drying out, and the quality of the water is also worsening. Open defecation, the presence of nearby urban settlements, hospitals, and excessive use of chemical fertilizers are the major sources of water quality degradation in the watershed. A recent study shows that 58% of samples (62.8% of hand pumps and 28.6% piped water) detect the presence of coliform bacteria. The study shows that 16% of the samples of hand pumps were found to be contaminated (Bohara, 2015). Likewise, 14% of the piped water supply samples were found to be contaminated. The water supplied from hand pumps for drinking purpose were more contaminated with bacteria than the water supplied from pipes. Statistical analysis showed that there was a significant difference of total coliform count in the samples of tap water and hand pump. According to the report, the quality of drinking water in the watershed is critical for controlling infectious diseases and other health problems. As a result, numerous fish species are facing extinction. Community perception of the disappearance of fish indicates that 95.7 percent of respondents believe that the number of native fish has decreased when compared to the last 5 or 10 years.

In terms of non-native, invasive species, there have been relatively few reports of invasive fish. Approximately 1.3 percent of respondents noted that the number of exotic fish had increased when compared to the last 5 or 10 years. For exotic plants, about 6 percent of respondents indicated that they have seen plants which are new or never seen before in recent years. Water hyacinth and other species have started to spread in recent years. The District Forest Office in Kanchanpur has done some work to remove invasive species such as the exotic plant *Lantana camara*.

WEALTH

The Lower Mahakali area is undergoing transformation as a result of economic growth, increases in agricultural and fisheries production, as well as urbanization. Outside of the Shuklaphanta National Park in the eastern part of the watershed, there are two main municipalities: Bhim Datt in the north and Mahakali in the south. A small part of Beldandi Rural municipality also falls within the watershed. According to the rapid assessment report of USAID's *Sajhedari Bikas Program* (2013), of the two major municipalities, Bhim Datt is an urbanizing area with good economic growth and high levels of Human Development Index (HDI) of 0.80. In Mahakali municipality, the ex-Dodhara VDC HDI is higher (0.54) when compared with ex-Chandani VDC, which is very low at 0.20.

Due to the combination of economic growth and relatively higher density of population compared to other PANI watersheds, there is a greater demand on natural resources such as forests and water. The total population of this watershed is 143,852 of which 48 percent are male and 52 percent are female.

As described under the Nature section above, the watershed consists of four broad types of land uses with land under agricultural production and forests covering 35 and 29 percent, respectively, and land consisting of grasslands/shrubs and rivers and streams occupying the remaining area (map presented in Figure 11 above). The Lower Mahakali Watershed can be broadly divided into three main zones: Churia belt to the north, the agricultural production area on the western side of the watershed in Mahakali municipality, and Shuklaphanta NP to the south and east.

The watershed provides a range of important ecosystem services. The well-forested, Churia range protects the Terai portion of the watershed below even as it also supplies a large part of the sand, gravel and boulders that forms the centerpiece of the local economic revenue system. Historically, the sediments and deposits brought down by the river system have supplied nutrients for the agricultural production activities in the Terai. However, habitat modification upstream and flood events increased sedimentation to the point where it has created significant disturbances for irrigation management and riverine edge agricultural fields. Flooding made worse by climatic factors creates considerable havoc, particularly in Mahakali municipality. The situation has been aggravated by the construction and management of the of the Sharda and Tanakpur barrages, which have fundamentally altered the ecological cycle within the watershed leading to habitat loss – while at the same time permitted greater ability for communities to mine the riverbed for sand, gravel and boulders.

Findings from the PANI FGD, KIIs and HH interviews, as well as biophysical analysis, indicates that problems of water accessibility for irrigation and drinking are not substantial problems in this watershed. In many cases, communities are able to access ample groundwater resources during periods when surface water resources are not available. Similarly, the analysis has shown that water quality is not a substantial problem in this watershed, largely because of the low population density and limited amount of urbanization leading to less point source and non-point source water pollution factors.

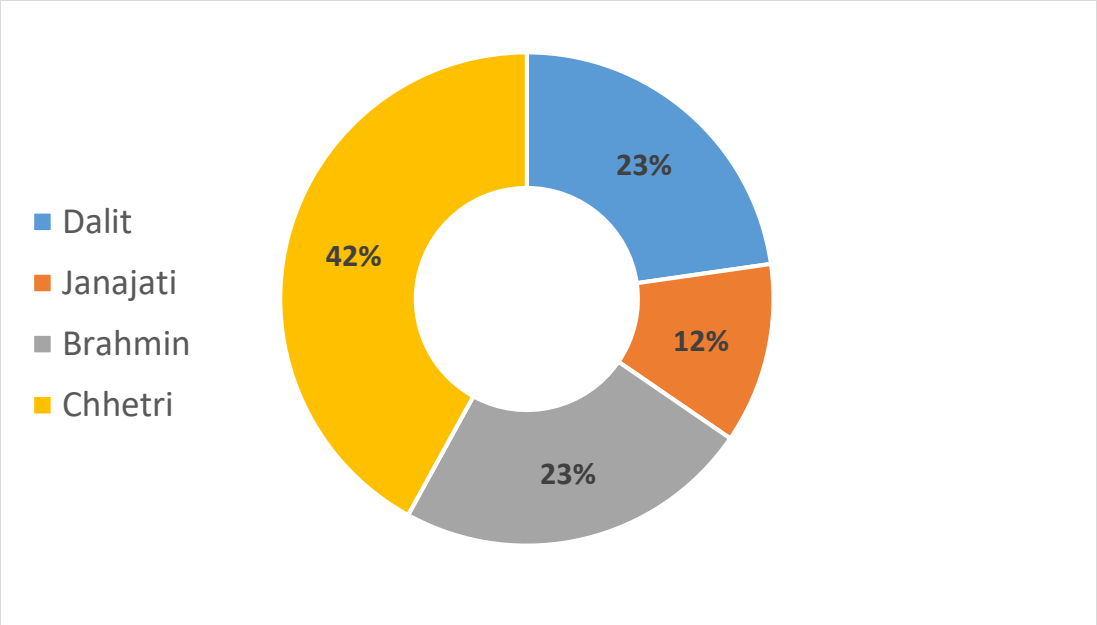
In a cultural sense, the river holds special importance for the local residents of the watershed. There is an oral history that the source of the Mahakali River is the pond of the Kali temple at Kalapani. The local people of this watershed consider the water of Mahakali River as *Pabitra Jal* (pure water). The name of this river itself is the name of a famous deity or powerful devi of the Hindu religion. The local people, by making Mahakali devi temples in different places in the watershed, worship her. The fish are also taken to be a form of god Vishnu according to the value system of Hindu religion. Fish also hold ritual value among the cultural practices of certain ethnic groups in this watershed. Cultural values are connected with water everywhere and are an indispensable part of life in the Lower Mahakali.

SOCIAL CONSTITUTION

The Lower Mahakali Watershed is an area that was traditionally inhabited by Tharus of different kinds who were fisher folk. Today, it has become much more socially diversified because of waves of in-migration starting from 1960s. Historically, most settlement of the Terai took place in the eastern and central parts of Terai. Once malaria was eradicated from the Terai in the 1960s, considerable in-migration from the nearby districts in Mid-Hills occurred even with Far Western and Mid-Western districts in the 1960s and 1970s. This in-migration continues today of both those who are marginalized and poor in the Mid-Hills searching for income opportunities, as well as those with middle-income levels who are seeking to further improve their economic status by engaging in cash cropping and purchasing land in the Terai. Lastly, there is a continuing movement of Tharus from further east into Kanchanpur, searching for land that can be privately owned. Beyond this permanent form of migration, there is a somewhat high level of seasonal migration, mainly of men going to India to work in the tourism industry (as security guards and hotel staff). There is relatively little long-term outmigration. As a result, during the summer months, once rice has been transplanted, men undertake their seasonal migration to India. During this time, there is a considerable level of feminization of agriculture, and natural resources management.

The census data shows that there are more than 150 diverse social groups living in the watershed. The majority of the population in the watershed is Chhetri (42 percent), followed by Dalit (23 percent), Brahmin (23 percent) and Janajati (12 percent) (as seen in Figure 12). In general, Far Western Nepal has a lower level of Janajati populations compared to central or eastern parts of Nepal because of long-term migratory patterns of Hindus from the areas to the west. The main Janajati groups in the watershed are "Tharu" communities that are also known traditionally as fisher communities.

Figure 12: Population of Lower Mahakali Watershed by Caste/Ethnicity (n=143852)



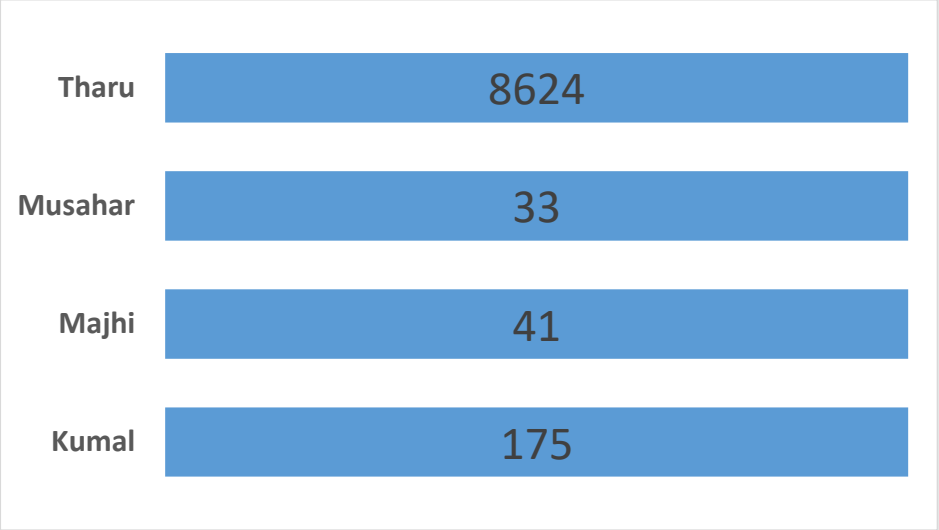
Source: Population Census 2011

FISHING COMMUNITIES

Census data shows that fisher groups cover about 6 percent of the total population in the watershed area. The population of fisher group represents the population of Kumal, Musahar, Majhi and Tharu (Rana, Dagaura, Chaudhary) communities in the watershed. The majority of the fisher groups (98 percent) are concentrated in Bhim Datt Municipality whereas only 2 percent of their population is found in Mahakali Municipality (Figure 13). The PANI HH survey shows that only two households reported

they engaged in capture fisheries as primary source of their livelihood in spite of a reasonably significant fisher folk population. Of the fisherfolk surveyed, the majority do fishing for home consumption but not for commercial purposes. The likelihood is that traditional fishing communities have to seek alternative livelihood options with reduced fish stocks as well as new forms of fishing regulatory structures.

Figure 13: Population of Fisher Communities in Watershed Area



Source: CBS 2011

TRANSPORTATION

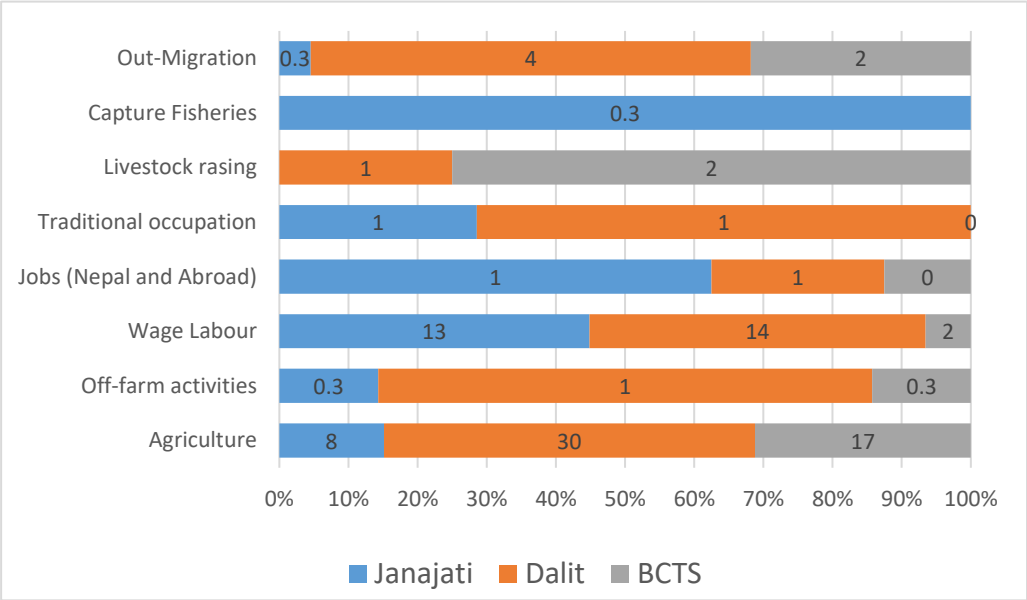
Bhim Datt is well connected with other parts of the Terai as a result of the East-West Highway, which extends about 44 km from Mohana Bridge to Gadda Chauki. Considered a strategic road within the District Transport Master Plan, the Department of Roads has already blacktopped the road although some gravel and earthen portions remain. In total, the Lower Mahakali Watershed has about 51 km district roads and 20 km strategic roads. One of the longer multispan pedestrian bridges in Nepal is located within the watershed. As the Chandani and Dodhara areas are cut off by the Mahakali river from the urbanizing Mahendranagar area (about 12 km north-east from bridge), this bridge (located 8 km below Sharda Dam) is the only connection to these VDCs. Down river, the Indian border is only 11.4 km away. This lack of motorized transport options for Mahakali municipality explain some of its weaker economic growth. In response, the government has initiated plans in 2017 to build a four-lane bridge that will lead to stronger economic ties between India and Nepal[17].

LIVELIHOODS OF PEOPLE IN THE WATERSHED AREA:

With a favorable monsoonal climate, fertile and cultivable soil, and good road infrastructure, the watershed is one of the major agricultural belts for Far-West Nepal. Despite agriculture being the main occupation of the majority in the watershed (56 percent), wage labour (29 percent) also forms a substantive portion of household income in the watershed area (Figure in Annex). Seasonal migration and foreign migration form a small portion of overall livelihood activities. In addition, income from gravel mining is also growing, suggesting that communities secure livelihoods from diversified sources.

[17] http://kathmandupost.ekantipur.com/printedition/news/2017-03-02/govt-to-construct-four-lane-bridge-over-mahakali-river.html

Figure 14: Primary Source of Livelihoods of Surveyed Households in percent (n=369)



Source: PANI Survey 2017

AGRICULTURE

Within this Terai landscape, the fertile agricultural land has been able to support a multiple-cropping regime that includes paddy rice, upland rice, wheat, millet, varied lentils and peas, sugarcane, potato, mustard, chili, onion, garlic and spices. A number of large-scale irrigation projects have been implemented in the area to support agricultural production, and agricultural diversification and commercialization is also promoted by the Government of Nepal (GoN).

There has been significant irrigation development within the Lower Mahakali Watershed supporting agricultural intensification and diversification (Table 5). The Mahakali Irrigation Project has been a project of the Department of Irrigation. It was first commenced in 1971, and subsequently successfully completed its first and second phases in 1987 and 1998, respectively. The first phase of this project covered 3510 ha in then Chandani and Dodhara VDC, ward number 1, 3, and wards 5, 6, 8, 9 and 10 of Bhim Datt Municipality. Now the third phase of this project is being implemented and proposes to operate under the Indo-Nepal Treaty called "Treaty for Integrated Development of Mahakali River including Sharda, Tanakpur, and Pancheswor Multi-purpose Project". Furthermore, an ADB-funded "Community Irrigation Project" (CIP) is presently implemented in Kanchanpur district. According to the DDC of Kanchanpur it covers ward number 8, 9 and 10 of Bhim Dutt Municipality. Besides this, some irrigation projects have been constructed by GoN and the Irrigation Development Division (IDD) in the different areas of this watershed.

Some of these irrigation systems, such as the first phase of the Mahakali Irrigation Project have changed the hydrological regime of the Shuklaphanta Natinoal Park and therefore diminished its biodiversity[18]. No specific assessment, however, of the environmental impact has been carried out. About 56 km of the

[18] SWR (2006): Suklaphanta Wildlife Reserve and Buffer Zone Management Plan, 206-2011

canal falls within the reserve and buffer zones. Some 4 km of natural flow of the Gaudhar River in the NP has been diverted for irrigation. The Mahakali irrigation system isolates part of the NP but there is little understanding of its impact on Shuklaphanta's grassland and wetland ecosystems. If the Pancheswor dam is constructed, then there will be further significant impacts on the ground water level, plant community succession, grazing and migration patterns of terrestrial and aquatic life.

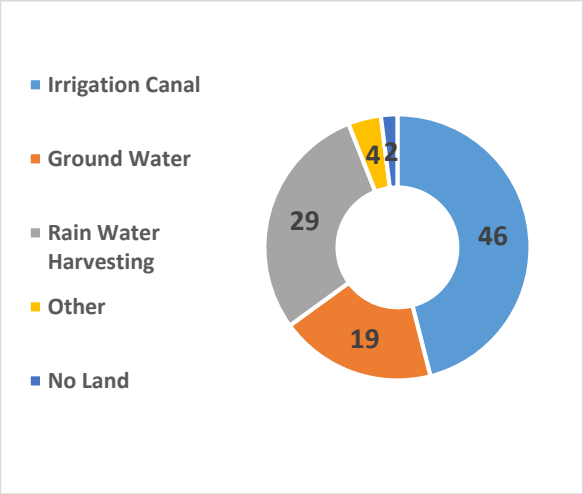
Table 5: List of Irrigation Projects in Lower Mahakali Watershed

SN	Project Name and address	Address	Command Area (ha)	Population
1	Palangi Swari Irrigation Project	Bhim Datt-9	90	728
2	Brahmdev Irrigation Project	Bhim Datt-9	200	1743
3	Nantali Irrigation Project	Bhim Datt-9	18	168
4	Gahatadi Irrigation Project	Bhim Datt-9	35	409
5	Tarulpani Irrigation Project	Bhim Datt-9	35	314
6	Siddhanath Irrigation Project	Bhim Daat-8	75	700
7	Maleriya Nala Irrigation Project	Mahakali	500	2351
8	Khanykhola Irrigation Project	Bhim Datt-9	75	820
9	Siddhanath Irrigation Project	Bhim Datt-9	114	1297
10	Dhungyadi Irrigation Project	Bhim Datt-9	48	511
11	Tumadi Khola Irrigation Project	Bhim Datt-9	50.5	282
	Total		1240.5	9323

Source: Irrigation Development Division, Kanchanpur and DDC Kanchanpur

Sources of Irrigation in the Watershed: Based on the PANI HH survey 2017, 46% of the households were using facility of irrigation canals in which water comes from river; while 19 % of households were using ground water (boring). Some 29% of the interviewees obtain their water from rainwater harvesting. The survey also shows that 4% of households are using the facility from other sources, and 2% of households have no agricultural land. The FGD interviews indicated that tail end users did have problems obtaining sufficient irrigation water due to poor management of the irrigation system as well as due to the deposition of mud in irrigation canals (that needed regular cleaning). How increased sedimentation and deposition from the riverine flows affects the major irrigation systems in the Lower Mahakali merits closer analysis. Wards 11-13 of Bhim Datt Municipality, which are seriously affected by floods, also do not receive much irrigation water despite being part of Mahakali Block A (Tertiary). This canal is 6 km long and comes from Banskheda. Water only reaches up to half of ward no. 12 because of a small hume pipe used there for irrigation purpose, although there are large number of users. This has led to conflicts between upstream and downstream users of the canal. Winter wheat is cultivated here but since irrigation water is unavailable, it is difficult to get decent production levels. Over a period of four or five years, only 2-3 crops are possible in the absence of irrigation.

Figure 15: Sources of Irrigation among the Households Surveyed (n=165)



Source: PANI Survey 2017

CAPTURE FISHERIES

The diversion of Mahakali water for irrigation and hydropower in India has led to decline in fish numbers. Additionally, the opening of the water gates at the Sharda and Tanakpur barrages has damaged the fisheries ecological cycle. Overall, fish habitats have been destroyed and water holes and small lakes have been lost. For traditional fisher folk, this change together with the introduction of a new fisheries regulatory policy introduced by the DDC about twenty five years ago, has meant they are not able to catch much fish any longer from the Lower Mahakali to meet their food needs let alone for income generation. In particular, among the various traditional fisher folk communities, the Sonaha (an indigenous community that is not recognized by the government as *janajati)* have become more marginalized as a result of these processes.

Originally, the traditional occupation of the Sonaha, particularly in Bhim Datt municipality, was gold panning together with fishing. Following the construction of the Sharda and Tanakpur barrages, and the resultant minimal flow in winter and floods from opening barrage gates in summer, riverbank erosion and licensing of riverbed mining by DDC, they are no longer able to practice gold panning. One such community is known as "Gold Sieving" (*Sun Chalne*) and lives near the riverbank at Bhim Datt Municipality-13.

As a result, the Sonaha community has been compelled to engage in wage labor for the riverbed mining activities on the riverbed. Consequently, gold panning skills have almost completely disappeared since they even no longer possess the instruments used for sieving gold. Moreover, there is no longer interest in the younger generation in gold panning, for there is not a single person in the community who can teach them the skill. The severity in loss of this traditional knowledge, skill and practice is also reflected in the fact that all the gold panning equipment has vanished from this 23-household community except for one "Sunauta".

When the DDC began issuing fishing licenses to contractors based on a competitive bidding process, the Sonaha lost out, and moreover, the commercial fishing operations overfished the river. The licenses were issued to the highest bidder irrespective of any consideration as to whether the bidder was from a traditional fisher or non-fisher community. The KII respondents indicated that they were largely unable to compete for the contracts, nor access the open market. Consequently, the Sonaha were denied access to capture fisheries and this prevented the *Sonaha* from utilizing traditional fishing practices. The DDC's licensing system has therefore posed serious threats to the *Sonaha* community's livelihood options. In practice, the contractor has been mobilizing two people from nearby Indian villages to

capture fish in the Mahakali River, who in turn sell them to the contractor at cheap prices in order to retail them in local markets profitably. Outside this regulatory framework, two people coming from nearby Indian villages have been mobilized by the contractor over the last 10 years to fish in the Mahakali River.

For the Sonaha, the fishing license holder issues a *purji* charging NRs 2000 per household per year. The person who has the *purji* from contractor is allowed to catch 2.5 kg fish per day. However, if the catch is over than 2.5 kg, the excess catch requires a payment of Rs.30-35 per kg to the *contractor*. Although many people of the *Sanaha* community wish to engage in traditional fishing, only a few people (4-5) have obtained the *purji* from the license holder. In Sonaha Tole of Bhim Dutt, only five out of the 23 people interviewed have obtained a *purji*; the rest are buying fish from the market. The households not having *purji* are compelled to purchase fish even for home consumption leading to nutritional problems. As a result, the local *Sonaha* community have lodged a request to the Shuklaphanta National Park Administration to give them permission to fish inside the National Park. In recent years, therefore, this community has secured their livelihoods from riverbed mining operations instead.

The Sonaha community's traditional method of fishing is more sustainable because they use nets (*pakhaiya, thati*). Previously they used fishing rods (*balchhi*) but the license for a fishing rod costs NRs 500 per year. According to the interview respondents, some other fisherfolk use destructive fishing methods (e.g. insecticides or blast/dynamite) because of their limited fishing skills. The Sonaha do not have the power or resources to stop the use of insecticides, and in addition, there is a lack of education and awareness about these issues. A few years ago, a local NGO called SWEET attempted to stop the use of insecticides through campaigns and formation of groups but this was not well implemented.

The fishermen from Indian nearby villages who live in the Kutiakabhar area on the other side of the river fish with big dragnets and boats and sell their catch in the local markets. The traditional community strongly disagrees with these destructive fishing methods but they cannot go against those who do it. In general, the Sonaha seek an end to the contractor system as well as restoration and rehabilitation of fish habitats. In their view, most of the problems for fish habitats originate with the Sharda and Tanakpur barrage hydrological controls rather than with riverbed mining. This observation merits closer scientific examination. The plight of the *Sonaha* coupled with declining fisheries stock in the Lower Mahakali indicate there are reasonable grounds for reconsidering how access to fisheries can be enabled for marginalized communities who will at the same time protect the natural resource through sustainable fishing practices.

RIVERBED MINING

Riverbed mining (for sand, gravel and stone) is becoming commonplace in the watershed and is an important source of income for a range of local bodies such as VDCs, DDCs and municipalities. As a result of changes in the hydrology of the river system, more boulders and rocks have become accessible, particularly in the drier winter months, in downstream areas. It has likely become a major source of revenue for Kanchanpur district since the 1991 District Development Committee Act was enacted together with the District Development Committee Regulations opening up opportunities for revenue generation for district governments. According to Kanchanpur Community Development Officer, sand/gravel mining as well as fishing are the primary sources of income for Kanchanpur's DDC. Of this, some 35-40% goes back to VDCs and municipalities (Bhim Datt and Mahakali) for development work. Although the Natural Resources Committee of the Constituent Assembly requires the DDC to carry out an Initial Environmental Examination or Environmental Impact Assessment, it is unclear if this has been carried out for Kanchanpur.

The DDC of Kanchanpur awards contracts for riverbed mining from Mahakali River through a bidding process every year. As reported by the DDC of Kanchanpur, the *Jaya Jaganath Nirman Sewa* has been

contracted up to an amount of NRs. 30,000,000/- (thirty million rupees) for this current fiscal year indicating substantial quantities of sand-gravel-rock are being annually extracted from the riverbed in Lower Mahakali. The DDC delineates the areas for riverbed mining. About 300 cubic meters are extracted per day. The DDC conducts monitoring at sand and gravel extraction sites through its monitoring committee.

Although a general study was carried out by United Nations Development Programme (UNDP) on the current practices of revenue generation from natural resources for local bodies[19], there is no specific analysis of Kanchanpur's practices. This study provided an in-depth analysis of current practices, value chain analysis, environmental effects as well as recommendations. Among its recommendations, it suggests that there is lack of legal clarity between the different Act governing riverbed mining so that there is conflict between the DDC, District Forest Office, District Agriculture Development Office, Buffer Zones and Community Forestry User Groups over resource ownership and sharing. There can also be problems of non-extraction of riverbed materials that are being increasingly deposited downstream leading to increased flooding risks, excessive rise of riverbeds, threatening bridges, fertile farmland and residential areas. In contrast, there are also problems of over-extraction also affecting bridges and riverine habitats. Most importantly, the study noted that although considerable revenue is generation, this is not sufficiently being re-invested in river protection work or Churia protection; instead, it is being used for road construction and other major infrastructural projects.

Riverbed mining has also enabled communities to gain wage labor opportunities in sandstone crushing and sieving. Riverbed mining has become a source of livelihoods for people of the Terai and Hill origins. Men, women and children from those households near the riverbank collect sand and stone in order to sell to the local on-site contractors. As a result, most of the households along the river's edge in the Lower Mahakali watershed work on sandstone crushing and sieving during the dry season. In particular, communities and households near the riverbank from mainly Airi, Odali, Bhujela, Badhaipur (ward number 11, 12 and 13 of Bhim Datt Municipality) often go to riverbed mining. On the one hand, this provides a new and often alternative source of livelihood for these households. On the other hand, those living near the riverbank are poor, disadvantaged and socially excluded vulnerable people who often find temporary settlement in public lands such as riverbanks. Due to working on sand-stone crushing and sieving, they are further exposed to occupational and health hazards.

For the Sonaha, for example, who now increasingly rely on riverbed mining work (given the difficulties in fishing and gold mining), earning about NRs 500-800 per day, they are also exposed to health hazards. In the summer dry season (Baisakh, Jetha and Asar), people suffer from dehydration and must be admitted to hospital. This is the result of undrinkable river water and inability to carry sufficient drinking water. Since the Sonaha do not possess land for agriculture, there are few other income options available to them.

In a broader sense, the potential implications of licensing on the status of aquatic biodiversity is yet to be studied. A study such as one on Tinau River's riverbed extraction and effect on the aquatic environment[20] would be helpful to carry out for the Mahakali River. Such a study would need to cover a number of key components. Firstly, it would need to set out our understanding of how the river morphology has been altered in its degrading (upstream) and aggrading (downstream) stages so that the patterns of deposition of riverine materials in different parts of the river can be identified as well as changes in gradient, flow and velocity. This can include an examination of bank erosion, slope instability, river incision, head cutting and damage to river equilibrium. Secondly, changes in the level of the river

[19] UNDP. 2011. *A review of current practices of revenue generation from natural resources for the local bodies of Nepal*. Kathmandu: Ministry of Local Development's Local Governance and Community Development Programme (LGCDP).
[20] Dahal, K. R., Sharma, S., & Sharma, C. M. 2012. A review of riverbed extraction and its effects on aquatic environment with special reference to Tinau River, Nepal. *Hydro Nepal*, 11: 49-56.

bed in different stages of the river (including whether new rounds of deposition are able to compensate for mining), how it affects diversion into irrigation canals, as well as bridge and embankment conditions can also be assessed. Thirdly, an examination of the location of settlements involved in and affected by riverbed mining can help ascertain the socio-economic implications. Overall, there is a considerable level of cost externalization taking place in riverbed mining. Fourthly, the environmental impact of riverbed extraction on groundwater table levels (which are typically lowered), on the aquatic habitat of the wetlands, and specifically no fish habitat loss are needed.

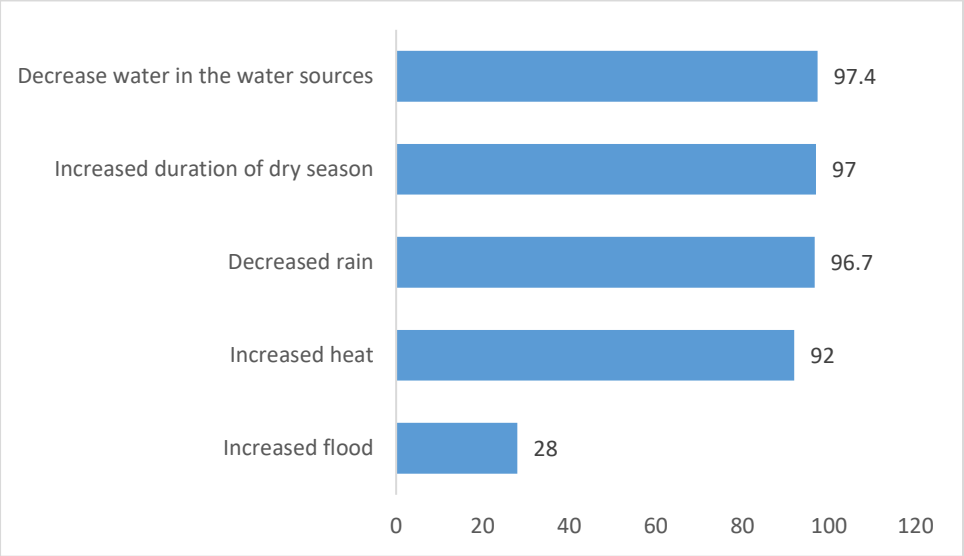
It is not the case that riverbed-mining needs to be halted but rather careful planning of sites and levels of extraction can help to ensure that positive income is generated with minimum environmental and social impacts. Further to that, the revenue generated can be ploughed back into river protection so that both natural and social capital is sustained rather than lost over time. Lack of proper policy and regulation of riverbed mining runs in contradiction of the fundamental right to live in dignity, and a right to clean and healthy environment guaranteed by the Constitution to Nepal's citizens. As local devolution and governance takes place, there is a strong need to address the policy and regulatory concerns behind riverbed mining.

FLOODING AND INUNDATION

The incidence of flooding is related to a combination of changes in rainfall pattern that produce either cloudburst-related intense episodes of rain, or heavy monsoonal rain over a longer period in conjunction with the changes due to rising river bed, riverbed mining, and embankment structure management. Flooding is therefore not simply a natural disaster but a synergistic combination of human and natural factors.

Based on the HH survey by PANI 2017, the community's perceptions of climate change over the last five years in the Lower Mahakali can be seen in Figure 16. It is clear that community members perceive there to be less rainfall, lower water availability and longer dry season as the major phenomena related to climate change. Greater risk of floods is the next most important feature of climate change. 28% of respondents reported that floods have increased over the last 5 or 10 years. River cutting, deposition and inundation are major problems in various areas. 97% of respondents reported that water sources have decreased and increased dry season compared to the last 5 or 10 years. Nonetheless only 14% of households reported having implemented adaptive activities.

Figure 16: Community Perceptions of Climate Change Impacts over the Last Five Years



Source: PANI Survey 2017

According to the Nepal Redcross Society, a rapid assessment report by USAID's *Sajhedari Bikas Program* (2013) shows that Bhim Datt Municipality and Mahakali Municipality of Lower Mahakali watershed have reported 4-6 major flooding and river cutting incidents over the course of the period 2010-2013. The municipalities in Lower Mahakali watershed have been categorized into very high, high, moderate and low vulnerable categories in terms of flooding and river cutting. Bhim Datt Municipality and Mahakali Municipality are in the "very high" category, and therefore vulnerable to frequent floods, inundation and river cutting, particularly in the rainy season. However, even in winter, as a result of the transboundary dimensions of the Lower Mahakali (in this case Nagla Escape in India as part of the Sharda barrage), unwanted water is released and negatively affects communities in ex-Dodhara and ex-Chandani VDCs.

Within the PANI interviews, floods were reported as the key hazards of the watershed. The PANI HH survey shows that major floods occurred in the Lower Mahakali watershed in Nepali B. S. 2037, 2049, 2065, 2071, and 2073. They result in river cutting and inundation mainly in Wards 3, 7, 8, 9, 10 wards of Mahakali Municipality, and 9, 10, 11, 12 and 13 number wards of Bhim Datt Municipality. There was significant displacement as well as loss of lives, livestock, and agricultural lands. The majority of Dalits (90%) said they have flood and landslides in their community compared to 69 % of non-Dalits. In general, floods create the greatest threats for the deprived and poor communities; the elderly, women and children; for those with less than 1-2 katha of land; and those on *ailani* (only housing) land. Women particularly are the frontline of responding to disasters since they have to care for children and elderly, and find places to cook. With many men away doing wage labor work elsewhere, women and children become more vulnerable during disasters having to manage all responsibilities alone.

The Lower Mahakali watershed faces a range of flooding issues. One of the primary issues is flooding in Mahakali municipality as a result of excess water from Tanakpur Hydroelectric Power plant in Naglaescape (or known locally as Nagra) being diverted to the Jogbudha river (See Map in Annex-5). This flooding can take place even in winter months. The high water current of the Mahakali River during the monsoon obstructs the flow of the Jogbudha River for up to 2-3 kilometers upstream from the meeting point of those two rivers. This ultimately creates flooding and serious inundation in the Dodhara and Chandani ex-VDC areas. The areas that are always heavily affected by floods within Mahakali municipality are: Dodhara -- Kutiakhabar, Shanti Tole ward no. 10, Muskure Tappu ward no. 7,

Sundarnagar and Giri Tole; Chandani – Purnagiri Tole ward no. 2, Shrestha Tole, and Jamunaghari (Ganesh Primary School).

In 2039/40, there was a massive flood in which only 41 out of 105 households remained in Kutiakabhar. Among them two households belonged to Brahmin/Chettri, one household belonged to Janajati and the remaining 38 household belonged to the Dalit community. Among the Dalit community, most of them are landless (i.e. they have no agricultural land). According to the Kanchanpur district profile, the Kutiakabhar area has a particularly high density of disadvantaged groups such as *Dalits*. People moved up into the highlands temporarily or on a long-term basis to stay safe. In that flood, some 100 bigha of agricultural land was destroyed in one night. Livestock and other aquatic animals also lost lives during such floods. In the floods of 2064/65 BS, 9 persons died in Shanti Tole (Dodhara VDC-08). For several years after that, the arable land was abandoned due to sedimentation. Therefore, agricultural production is decreasing and they have to resort to wage labor work in India. Even young 12-year old boys work in India. They cannot access grass within the municipality and so are forced to go to India where they have to pay for fodder. Only 15 of the 41 households in this area have registered land. The remaining 26 only have settlement land for housing (*ailani* land). For those with some land, they engage in alcohol production and retailing. They live precarious lives with theft commonplace and constant threats by the security forces on the Indian side.

According to Kutiakhabar residents, the last big flood was in 2071; there were two floods that year. There were floods last year as well affecting the vulnerable elderly and children, and students in terms of being able to reach safe areas. In particular, the four houses, which lie between Sundarnagar to Kutiakhabar, are at high risk of flooding and inundation. The area of Baidiphant is inundated every year. In 2073, eight people died (including *a child).* During that flood, women and children took shelter in a school in ward #7 for three days, while men remained on the rooftops of their houses. Army and police provided security at the school for three days. During floods, women, especially pregnant women, and children are the most vulnerable. Residents are not aware of the term "climate change," but they recognize clearly the stress of climatic hazards in their area (as seen in Figure 8). The residents explained that they have been living there since 2025; wealthier families had migrated long ago.

During the flooding, they cross the river by boat at the village Aambhojh. Before 2065, there was only one boat under a VDC contract. The community now has two households with boats and there are two government-owned boats. Two of these were provided by funds of parliament members when Mr. Harish Thakulia was elected in 2065. There is no general electricity provision in this area, and even though 12 solar powered systems were established in selected households, during floods, people are unable to charge their mobile phones. The community also needs two *machans* (tents) at a cost of 10-12 lakhs each to provide shelter during flooding.

One of the main issues, according to the FGDs in Kutiakabhar, is that the Mahakali River changes course during the rainy season. As a result, an embankment is needed. The community noted that they had heard that a 50 m embankment was being built elsewhere but it had not reached their village. Moreover, the embankments constructed in the areas from ward 7-10 of Mahakali municipality are not high enough to provide protection against these floods. The Indian management system for Tanakpur did not allow an increase in the elevation of the embankment, as it would lead to further flooding within Indian portions of the Sharda/Jogbudha river systems. In particular, the construction of an embankment between Kutiakhabar and Bodhipur in Melaghat area is being opposed by the Indian authorities. In Chandani ex-VDC, the area about 200 m on both sides of the suspension bridge is vulnerable to flood water entry due to lack of maintenance. Although a contractor has been selected for repair work, communities live in fear of the next flood because the work has been delayed. In Chandani ex-VDC, there are two river control committees with 11-12 members each. These were created to solely focus on repairing broken river banks.

Early warning systems have been set up in some places. An early warning system was started in 2065 BS by a local NGO called NNSWA. They formed a network to provide early warning working together with the media on information sharing. However, this system has not proved to be effective. In addition, another early warning system was established from 2068 by the Darchula District Administration Office, which relies on police to inform the lowlands about inundation and flooding by mobile phones. Once these warnings are received, people who are skilled in running a boat or an inflated rubber tube spontaneously start to transport people and goods to safer locations. There is no formal village-level dissemination system but since the village is small, the information is communicated by foot. A flood early warning system is also in place within the watershed area. A siren system has also been established in some parts of the watershed.

The map in Annex 5 provides a close-up map showing Mahakali and Jogbuddha River in the area of Mahakali municipality. A local risk disaster management plan is being developed for Mahakali municipality. There are limited resources for responding to flooding. A suspension bridge is presently being constructed by the Suspension Bridge Division of the Ministry of Local Development. The local residents were not consulted regarding its construction; according to them, the southern side of the bridge is in the correct location but the foundation is not dug deep enough and so is likely to slide down.

In Bhim Datt municipality, wards 11-13 are the most affected by floods. Not only did flooding in 2070 BS cause substantial sedimentation in agricultural fields, but the following year brought new floods adding to the damage. It took two years from 2070 to clear the sediment to recover production in agricultural fields. The DDC and Municipality piled up the sediment in one location but subsequently it became naturally dispersed in the area again. Users of the Shahid Smriti Buffer-Zone Community Forest (1.5 km^2) in Badhaipur indicated that their forest was also destroyed by river bank cutting and flooding. Moreover, the debris was deposited on farmland creating a double loss.

Therefore, although agriculture is the main occupation of residents in Badhaipur (for example), this only provides sufficient food for only 3-4 months. As a result, over half the households have someone involved in employment abroad, whether in India or the Gulf countries. In India, people go to Delhi and Bangalore for work. Additionally, people engage in stone and sand crushing, earning about NRs 1500 per tractor load of stones and Rs 500-600 for a tractor load of sand. Given the fishing contractor system, these communities are unable to engage in fishing. For about 25 years, many families kept a rubber tube in order to collect fuelwood for household use and to sell during the monsoon season. During floods, it doubles as a rescue vehicle. However, as a result of the cost of tubes, fewer people keep such tubes. The community would like financial support to enable the community to obtain more tubes.

In Purnagiri Tole (a Haliya settlement) in Bhim Datt asserted that flooding and landslides occur at the same tie. While women face the largest burden immediately, it is the men who face negative consequences over the long-term. The FGD interviews indicated that they had no knowledge of Disaster Risk Reduction Planning or Climate Change Adaptation Planning. This community has never fished in these waters, and most are engaged in stone-sand crushing and sieving wage labor. They have not had access to any community forests, as the annual fee of NRs 1000 is too high.

In Bhim Datt municipality, there is a fund for women and children to help with disasters such as floods. The DDC has a flood monitoring system; in Badhaipur, for example, there is a flood monitoring committee. Moreover, there is a staff member from the Women and Child Development Office sitting on the disaster committee. Watch groups (*nigarani samuha*) have also been created to provide support in the context of disasters. Police usually come 2-4 hours before a possible flood event to inform residents, and occasionally, radio also broadcasts this information. At times, residents learn about possible flooding from the sand-stone contractors working by the side of the river. In the 2070 BS, the

army and policy personnel helped with rubber tubes for rescue work. After the flood subsided, various organizations arrived with relief supplies but distribution tended to address the needs of elites and influential people while many needy people were left out.

The People's Embankment Program (*Janatako Tatbandh*) program has built embankments along the Mahakali River, but there remains a considerable amount of work still to do, and moreover, those that were built in the past require maintenance. For example, a 200-300 m length of embankment was broken in 2073 BS in ward number 12 at Odali. The People's Embankment Program aims to not only provides protection for flood-prone communities but also empowers them by creating economic opportunities. Reclaimed land can be used for agricultural activities or public spaces such as parks. Although the army and armed police force provide some assistance blocking the water with sand bags when there is an acute situation, this only provides temporary relief. There needs to be a system to provide regular monitoring and repair of the embankment every year. However, funds for the People's Embankment Program are facing shortages in 2017[21] and therefore it is difficult to carry out the activities as stipulated by the Master Plan. Its scope has expanded considerably since its beginning (2009/2010) without an equivalent increase in funding.

According to the Water Induced Disaster Prevention Division (which looks after Kanchanpur and Dadeldhura), their focus is on Chure conservation, river training, establishing environmentally-friendly gabions for embankments at Jogbudha to Zero Point at 12 km, in Dodhara and Chandani ex-VDCs, as well as in Rangun khola (which is still being completed). The People's Embankment (*janatako tatbandhan*) and Embankment Protection User's Committee (*tatbandhan samrakchhan upabhokta samiti*) have a watchman. In terms of access to information about a range of disasters related to rainfall and floods, Table 6 provides a general indication that except for some limited access to data on flood risks, there is no access to any other data that will help households respond to risks that emerge upstream.

Table 6: Access to Climatic Information in the Watershed

Access to information[22]	Bhim Datt	Mahakali
Weather information	2	2
River and stream levels	2	2
Water Quality	3	3
Flood risk	2	2
Landslide risk	3	3

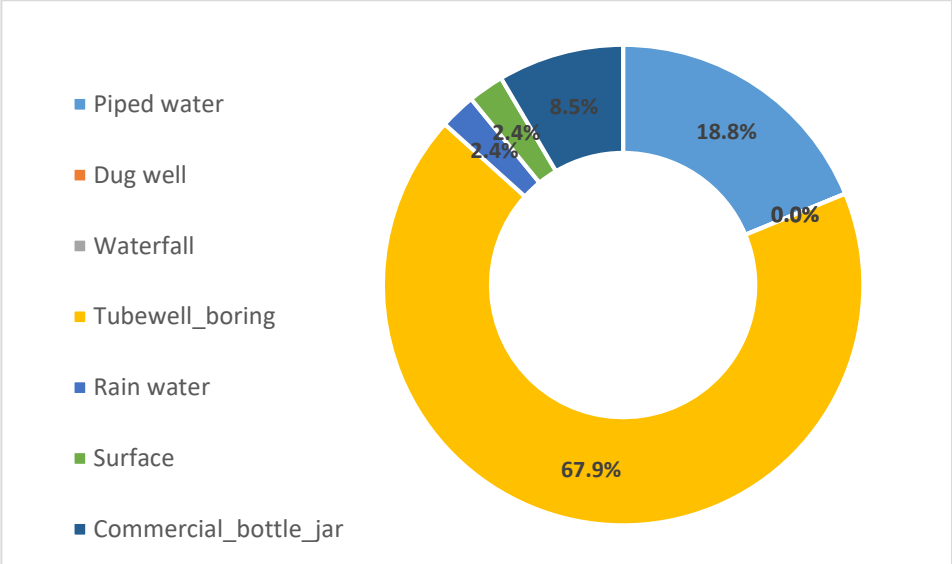
Note: 1-good access; 2-limited access; 3-no access

HOUSEHOLD WATER RESOURCE AVAILABILITY AND USE:

The PANI HH survey shows that the surveyed households are using water mainly for drinking, cleaning, and irrigation and construction. The PANI HH survey shows that out of the total 165 households, 67.9% of the households are using shallow tube well/hand pump as their main source of drinking water (Figure 17). Beyond this, 18.8% of households are using piped water, 8.5% of households are using bottled water/jar water, 2 % households using rainwater harvesting, and 2% households are using river/stream/natural spring.

[21] http://kathmandupost.ekantipur.com/news/2017-07-02/peoples-embankement-programme-faces-funds-crunch.html
[22] Focus Group Discussion and KII

Figure 17: Sources of Drinking Water in the Lower Mahakali Watershed (N=165)



Source: PAANI Household Survey 2017

POWER/GOVERNANCE

In this section of the report, an analysis is provided of the social, institutional and regulatory structures through which water resources management, aquatic biodiversity management, and adaptation to climate change are enabled within the Lower Mahakali Watershed. A primary institutional factor affecting watershed management in the Lower Mahakali Watershed is that of transboundary water management between India and Nepal. Within Nepal, there is a bifurcated administrative arrangement within the Lower Mahakali whereby Shuklaphanta NP is under the central management of the Ministry of Forests and Soil Conservation with its own specific hierarchical structure allowing local participation by buffer zone residents and the two municipalities under local government. Within these two municipalities, there are a range of local-level user groups related to irrigation water, drinking water, forest management, and lake management. At times, groups such as community forest user groups expand their mandate to include biodiversity concerns, lake and pond management, as well as fisheries.

What the analysis indicates is that there is a need for capture fishery management groups to be formed at the local community level that will promote participatory fisheries management and provide a vehicle through which provisions in existing laws on sustainable fisheries can be implemented in practice. In addition, enhancing coordination between the local governments and the various participatory user groups (be they inside or outside Shuklaphanta NP) will facilitate watershed scale management systems. Such a platform can permit an integrated planning perspective to emerge that addresses upstream-downstream linkages as well as protection of ecosystem services at the broader scale.

RIVER BASIN MANAGEMENT

TRANSBOUNDARY WATER MANAGEMENT

One of the primary issues facing the Lower Mahakali Watershed is the significant change in environmental flows following the construction of two barrages on the Indian side of the Mahakali. The first, the Sharda barrage, was constructed in the 1920s for irrigating lands in Uttarakhand. The second, the Tanakpur barrage, was constructed in the 1980s, essentially to replace the aging Sharda barrage. The construction of the Barrage was started in 1988. The Tanakpur Agreement provided for the construction of the left afflux bund (the retaining wall) on Nepalese territory for which the Nepalese provided 2.9 hectares of land to construct the left afflux bund of 577-meter length. The Agreement provided for the installation of a head regulator at the Tanakpur Barrage.

The construction of the dams and their mode of operation creates numerous threats for freshwater and wetland biodiversity by inundating important habitats, transforming downstream water flows, increasing suspended load sediments, oxygen and nutrient dynamics, bed load transport, barriers to migration, and also changing microclimates. It is clear that when floodplains are disturbed, the ecology of fishes is significantly affected. The productivity of migratory species, such as mahaseer (*Tor tor*) in particular is affected to the point of serious decline or even disappearance.

Today, the Mahakali/Sharda River is governed by a bilateral treaty between Nepal and India. The Mahakali Treaty of 1996 subsumes earlier treaties such as the Sharda Treaty of 1920 governing use and management of the Sharda barrage, as well as the agreements over the Tanakpur barrage (which was heavily debated over many years)[23]. This Treaty signaled a change in relations between Nepal and India

[23] Asia Foundation 2015. Status and implementation of transboundary river agreements on the Kosi and Sharda rivers in India. Issue Brief no. 1. New Delhi: Asia Foundation.

in water resource negotiations working towards a more equitable stance for Nepal. In essence, although there was a certain level of consultation by the Indian authorities with the Nepalese authorities, the control over the barrage water flows appears to largely remain with the Indian authorities.

Although the Mahakali Treaty of 1996 provides for the creation of an implementation body called the Mahakali River Commission, in practice, the Commission has not been set up and very little and basic information is publically available on how the treaty is being implemented. Greater effort is needed to create and provide spaces for increased public engagement and participation in transboundary water negotiation as well as effective treaty implementation. The Pancheshwor Multipurpose project (proposed upstream of the Tanakpur barrage) has been a heavily contested project for many years and although there have been some formal moves afoot (such as environmental impact assessments in 2010) to restart discussions about the project, it remains in its early stages.

During the summer monsoon months, the barrages have kept their gates fully open in order to prevent accumulation of mud and sediments in the Indian irrigation canals. The implication of this is that the Lower Mahakali Watershed receives substantial water flows that is rich in mud. This not only serves to increase river cutting but also deposits a considerable amount of mud on agricultural fields and in the rivers and streams as well. This creates ecosystemic disturbance whereby habitats for fish are destroyed, and the overall balance in freshwater biodiversity is undermined.

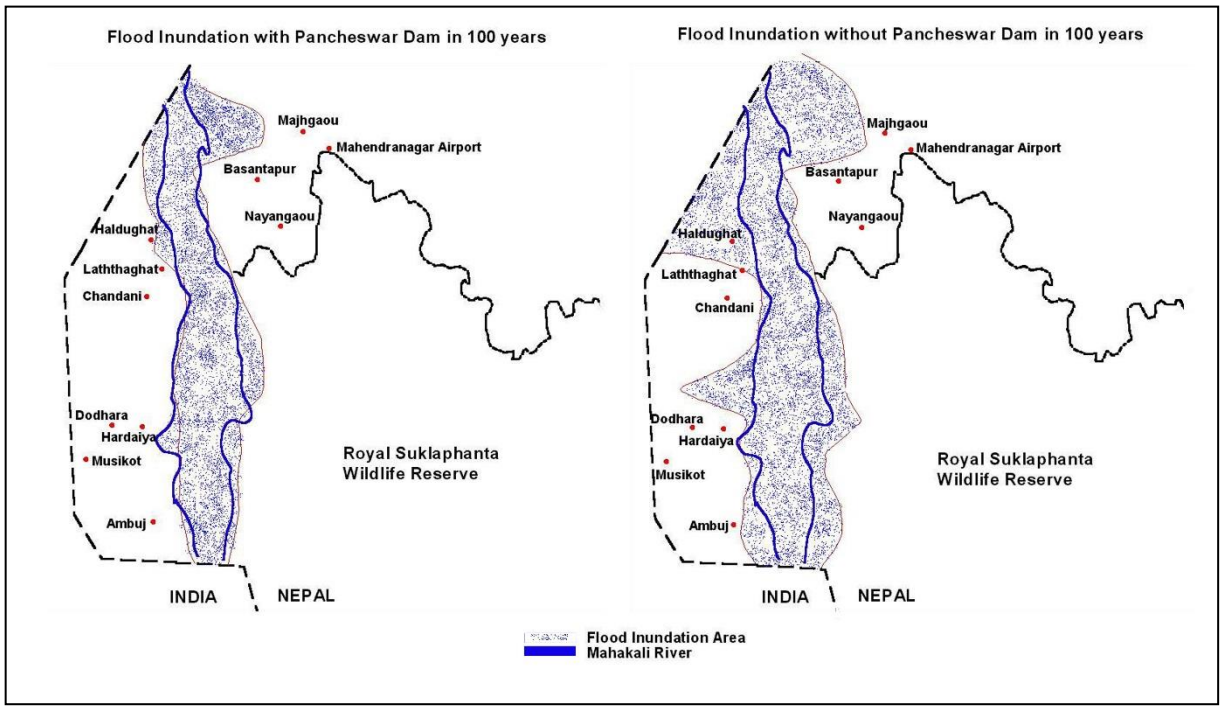
During the winter months, only about 5% of the water flow is allowed through the barrage gates in order to retain maximum water use for irrigation. As such, this almost dewatering of the area below the barrage following the monsoon leaves many riverbeds dry. Whilst this combination of high water flows in summer and dry riverbeds in winter has enabled the gravel mining taking place along riverbanks, it has fundamentally destroyed the river's ecology. In addition, since many of the communities who live near the riverbank are among the more marginalized and poor residents, their increasing involvement in riverbed mining is exposing them to greater health hazards for which they have no public welfare facilities.

SHUKLAPHANTA NP AND PANCHESWOR DAM

The Shuklaphanta NP is a floodplains ecosystem governed by period flooding and associated fluvial processes[24] and is heavily affected by overall hydrological processes of the Lower Mahakali. If the proposed Pancheswor dam is constructed, there will be significant changes in the flood inundation scenarios for the Lower Mahakali (Figure 18).

[24] SWR (2006): Suklaphanta Wildlife Reserve and Buffer Zone Management Plan, 206-2011

Figure 18: Flood Inundation Scenario in Shuklaphanta NP



Source: SWR, Buffer Zone Management Plan 2006

NEPAL POLICY PROVISIONS AND AUTHORITY TO GOVERN

Although there is no separate watershed conservation policy, there are different policies such as Forest Policy 2015, Forest and Soil Conservation Sector of the Fourteenth Plan 2016/17-2018/19 and National Biodiversity Strategy and Action Plan 2014 that apply to watersheds and freshwater biodiversity conservation. The objectives of the Forest and Soil Conservation Sector of the Fourteenth Plan are to conserve and manage watersheds in an integrated manner for increasing soil productivity through conservation of water, water resources, and soil while applying/following measures for mitigating negative effects of climate change and disaster risk reduction, among others. Similarly, one of the strategies of the Forest and Soil Conservation Sector is managing sensitive watershed based on appropriateness of land by designating as protected watershed. The government is yet to identify and designate any watershed as a protected watershed in this region.

Working policies of the Forest Policy are, among others: watersheds will be identified, categorized and prioritized for controlling soil erosion, flood, landslide, desertification and river; participatory soil and watershed conservation programs will be operated by establishing linkage between upstream and downstream through developing operational plan based on priority; technology will be transferred by developing cost effective soil and watershed conservation and agro-forestry system through action research; integrated conservation and management program based on river system will be operated by categorizing the whole area including Chure, Terai, Madhesh in accordance with the National Land Use Policy; and different kind of wetlands will be identified and classified and capacity will be increased by designating the responsible agency for conservation and management of wetlands.

District Soil Conservation Office (DSCO), Kanchanpur has prioritized altogether 27 sub-watersheds have in the district. Most of the rivers of these sub-watersheds originate from Chure range. The DSCO has been giving priority to the sub-watersheds of the Chure area since most of the sub-watersheds of the area are fragile. One of the sub-watersheds is Gatadi Khola Sub-Watershed. Its Sub-Watershed Plan was developed in 2016 after the establishment of DSCO in Kanchanpur. The experts who came from the DSCWM, Kathmandu, prepared it. It is north of Brahmadev. Four out of the 27 sub-watersheds

prioritized in the district are part of the Mahakali River basin.[25] The tendency of Kailali and Kanchanpur is to look downstream/plain area whereas the problems originate from uphill of Chure. This fact needs to be taken into consideration while assessing and planning. Although the DSCO was established in Kanchanpur in the middle of 2016, it has been steadily working for implementation of a few elements of watershed conservation related provisions of the Forest Policy at the Gatadi Khola sub-watershed level.

There are wide ranges of laws that relate to watershed management in terms of improving aquatic biodiversity as well as adapting to climate change (Table 7). As noted above, the management of Shuklaphanta NP comes directly under the purview of the Department of National Parks and Wildlife Conservation. The 1973 National Park and Wildlife Conservation Act provides for a participatory approach to buffer zone management through a three-tiered approach involving the Buffer Zone Management Council, User Committees, and User Groups. The Buffer Zone Management Regulations also allow for the formation of Buffer Zone Community Forestry Groups. To what extent the buffer zone management arrangements are addressing wetlands and floodplains management needs are unclear. Moreover, since the income base for Shuklaphanta NP is low, there is little income to support the Buffer Zone Management Council. Importantly, there is very little coordination between the national park management and the local district-level or municipality-level government units. In this case, since some irrigation systems pass through the national park, it is necessary to coordinate regarding the impacts of water management on park biodiversity and ecosystem integrity. Some articles of the National Park and Wildlife Conservation Act promulgated in 1973 have already become outdated and are not suitable to the demands for development of the protected areas in the changed political and social context of the country.[26]

Table 7: Policy Provision and Status of Enforcement

Role to Conserve Aquatic Natural Resources- Legal Provision	Lower Mahakali Watershed Situation
Right to healthy and clean environment: The Constitution of Nepal 2015 guarantees the right of every person to live in a healthy and clean environment as a fundamental right (Constitution of Nepal, 2015, article 30 (1)). It also guarantees as a fundamental right the right to get compensation for the damage caused by environmental pollution or degradation as prescribed by law (article 30 (2))	Right to live in a healthy and clean environment is likely to prevent and control destruction of environmental resources such as trees, plants, animals, rivers, rivulets and wetlands and watersheds as well as will help to keep such environmental resources healthy. This right imposes duty on the federal, state, and local government to protect and keep these resources healthy. It is expected that the elected representative of local bodies will give due attention to fulfillment of this right.
Municipality (Local Body): Local bodies are empowered to prepare and implement programs with regard to forests, vegetation, biodiversity, soil conservation, and environmental conservation in the village development area (Local Self Governance Act, 1999, section 28(h)). Municipalities are required to assist in environment conservation by controlling air, land and water pollution in the municipality area; conservation of environment, forest, plants and other natural heritage;	Although the LSGA has been in force for the past 18 years, the absence of local elections has made it difficult to implement its provisions. Moreover, local bodies have not given priority to the development of a separate program for conservation of biological diversity. The municipalities in the watershed area are concentrated on only collection and disposal of

[25] As per the notes of the meeting held with Mr. Shyam Prasad Neupane, Soil and Watershed Conservation Officer, and Mr. Bal Dev Bhatta, Assistant Soil and Watershed Conservation Officer, DSCO Kanchanpur on January 8, 2017.
[26] GoN, Ministry of Environment, Science and Technology.2008a. *Nepal-Thematic Assessment Report: Biodiversity*. Ministry of Environment, Science and Technology, Singhadurbar.

Role to Conserve Aquatic Natural Resources- Legal Provision	Lower Mahakali Watershed Situation
collection, transportation and disposal of solid waste of the municipality area (LSGA, section 96 (1) (c)).	solid waste and that too has been very ineffective.
Municipality (Local Body): The National Park Regulations 1974 under the National Parks and Wildlife Conservation Act provides detailed provisions for hunting license (rules 5-13). However, there is no specific provision relating to fish, but the definition of wildlife includes fish as well.	Community Based Anti-Poaching Unit (CBAPU), and Rapid Response Team (RRT) established and functional at watershed area
BZMC: The Buffer Zone Management Regulations also prohibits a number of activities in a buffer zone, unless specific permission has been granted by the warden (rules17 and 19). Such activities include harvesting trees, carrying out cultivation and any other destructive practices inside forests; mining, quarrying stone, soil or sand, or removing any substances in a way that is likely to have significant adverse impact on the environment; using hazardous pesticides or explosives in a river, stream or source of water flowing inside a buffer zone; and hunting wildlife.	Buffer Zone Community Forestry User Groups (BZCF), User Committees (UC), and User Groups (UG) are formed and mobilized from BZMC to carry out conservation related activities

The total area of Mahakali Municipality and some part of Bhim Datt Municipality is within the Buffer Zone of Shuklaphanta NP. There is one Buffer Zone Management Council and a total of nine User Committees under BZMC under Shuklaphanta NP. Out of these, three user committees exist within the Lower Mahakali Watershed, namely the Himalaya User Committee, Sagarmatha User Committee, and Shuklaphanta User Committee. These committees represent large numbers of functional user groups at the community level. 156 user groups exist under these committees. Of the total, 48 percent of the user groups are under Shuklaphanta User Committee, followed by 28 percent user groups under Sagarmatha User Committee, and 24 percent under Himalaya User Committee.

As yet, there is lack of information as to the management orientation of these committees on wetlands and floodplains management issues. For example, it is known that for riverbed mining, the buffer zone management committee collects a royalty per square meter that falls in buffer zone areas, but it is unclear how these funds are utilized.

As we look at the caste/ethnic and men and women representation within the committees, 74 percent of the committee members represent Brahmin, Chhetri and Thakuri (BCT) groups of which 50 percent are male and 25 percent are female. Likewise, Janajati in which 11 percent are female represents 16 percent of the members of the committees and 5 percent are male. Of the total, 11 percent of the committee members are Dalits. A FGD finding shows that a socially excluded group Haliya lived in Bhimdatta Municipality. They are landless people and worked for landlords before they were freed. 15 Freed Haliya households are excluded from the community forest in Purnagiri Tole (Haliya settlement) of Bhimdatta Municipalit. The community forest has the provision to pay Rs 1000 to get membership, which is very high for them and renders them unable to benefit from the community forest. These facts suggests us that there is a significant need to carry out facilitation to create more inclusive committee in order to increase the participation of women, Dalit and Janajatis at the decision-making level.

Table 8: Representation of Women and Marginalized Community in Decision-making Body

User Committee of BZMC	BCT			Dalit			Janajati			Total
	Female	Male	Total	Female	Male	Total	Female	Male	Total	
Himalaya	38 %	46 %	85 %	8 %	8 %	15 %	0 %	0 %	0 %	100 %
Sagarmatha	8 %	42 %	50 %	8 %	8 %	17 %	33 %	0 %	33 %	100 %
Shuklaphanta	23 %	62 %	85 %	0 %	0 %	0 %	0 %	15 %	15 %	100 %
Total	**24 %**	**50 %**	**74 %**	**5 %**	**5 %**	**11 %**	**11 %**	**5 %**	**16 %**	**100 %**

Source: BZMC/Shuklaphanta NP

Within the district and municipalities, the Local Self-Governance Act of 1999 allocates authority to manage a wide range of natural resources and water-related issues including agriculture, rural drinking water, irrigation, river control, and the prevention of soil erosion, tourism and cottage industry (LSGA, section 28). Under the rubric of 'forest and environment', VDCs are empowered to prepare and implement programs with regard to forests, vegetation, biodiversity, soil conservation, and environmental conservation in the village development area (section 28(h)). Although the LSGA has been in force for the past 18 years, there have been no local elections through which the law can be implemented in practice. Moreover, local bodies at the watershed area have not given priority to the development of a separate program for conservation of biodiversity. As such, it can be expected that now that local elections have taken place, the elected representatives will implement the power of the Local Self-Governance Act more sincerely.

The local body has considerable power to manage public works and generate revenues to support infrastructure, management and upkeep. As such, they play an important role in leveraging assets to create new forms of wealth for social welfare and in the social interest. The local body has full title over certain property situated within the village development area, including "public properties" not owned by an individual or by the government, such as public drainage and sewerage; roads and bridges; ponds, water spouts, taps, wells and ghats; temples, and grazing fields (section 68(1) (b)). "Natural heritage" is also included in this list of assets (section 68(1) (d)), as are "forests according to existing forest laws or handed over by the GoN (section 68(1) (c)). The local body may impose a variety of taxes and fees. These include land revenue or land tax, rent and tenancy tax, and a tax on "natural resources utilisation" within the village development area (sections 55, and 215). For instance, as reported by the DDC of Kanchanpur, the *Jaya Jaganath Nirman Sewa* has been contracted up to an amount of NRs. 30,000,000/- (thirty million rupees) for this current fiscal year, indicating substantial quantities of sand-gravel-rock are being annually extracted from the riverbed in Lower Mahakali. Thus, the DDC is utilizing the power given to it by the Local Self Governance - unfortunately, without ploughing back some of the revenues generated from natural resources for the conservation of the riverbank and watersheds.

One of the major responsibilities of DSCO is to implement the Soil and Watershed Conservation Act 1982, which empowers the government to designate any area as protected watershed areas (Section 3). Synergy can be achieved through carrying out activities like (i) construct and maintain dams, embankments, terrace improvements, diversion channels, and retaining walls necessary for erosion and landslide control, (ii) carry out plantation, plant grasses, weeds or other vegetation, and look after, maintain and grow the same, (iii) protect vegetation in landslide-prone and steep slope areas and undertake afforestation programs, and (iv) maintain fertility of soil and balance cleanliness of water and environment (Section 4). Other development funded partners and programs often provide opportunities for collaboration on watershed management and conservation.

As DSCO was recently established in Kanchapur district in the middle of 2016, and it has limited human and financial resources, it has begun to make its presence felt by constructing and maintaining embankments, terrace improvements necessary for erosion and landslide control, and by supporting plantation, plant grasses, weeds or other vegetation, among others.

Beyond the decentralization mandate put into place by the 1999 Local Self-Governance Act, a wide range of laws governing water resource management, soil conservation, forestry, disasters and flood control are currently under the authority of the respective ministries at the central level. Major laws that relate to water management, drinking, irrigation, soil conservation, forests, disasters and flood control, riverbed mining are the Aquatic Animals Protection Act 1061, National Park and Wildlife Conservation Act 1973; Soil and Watershed Conservation Act 1982, Natural Calamity (Relief) Act 1982, Local Self Governance Act 1999, Water Resources Act 1992, Forest Act 1993, Environment Protection Act 1996, Mines and Minerals Act 1985, Electricity Act 1992, However, many of these laws provide for the formation of local government committees or village-level user groups to manage the respective resource. The National Park and Wildlife Conservation Act 1973; Local Self Governance Act 1999, Water Resources Act 1992, and Forest Act 1993, and Drinking Water Regulations 1998, Irrigation Regulations 2000 and Aquatic Animals Protection Regulations 2009 enable user groups.

The "Water Resource Regulations 1993" has a provision for establishment of a "District Water Resource Committee" in the chair of Chief District Officer (section 8(1). The secretariat of the committee is in the DDC since the member secretary of the committee is the Local Development Officer (LDO). In addition, since the water resource is a common property regime, the concept of user group/committee is also applied at the village level for the proper management and utilization of water. These water-related user groups are registered in different government authorities (DDC, VDC, DFO, DADO, DSCO, DIO, DWSSO, etc.). Additionally, the user committees are organized into a federation too. Similarly, for the forest sector, the 1993 Forest Act and 1995 Forest Regulations provide for the creation of community forestry user groups who are able to manage local forests to meet their needs while sustaining forest conservation.

Table 9 sets out the numbers of irrigation water user groups, water supply and sanitation user group are function in the Lower Mahakali Watershed area. 11 irrigation water user groups are affiliated with the district chapter of NFIWUAN. Likewise, in total, eight water supply and sanitation user groups are also present affiliated with FEDWASUN. NEFIN is also working in the watershed area having district coordination council and municipal coordination council in both municipalities.

Table 9: Water User Groups in the Watershed

SN	Name of the User Committee	Address	Command Area (ha)
A	**Irrigation Water User Groups**		**90**
1	Palangi Swari Irrigation	Bhim Datt-9	200
2	Brahmdev Irrigation	Bhim Datt -9	18
3	Nantali Irrigation	Bhim Datt -9	35
4	Gahatadi Irrigation	Bhim Datt -9	35
5	Tarulpani Irrigation	Bhim Datt -9	75
6	Siddhanath Irrigation	Bhim Datt -8	500
7	Maleriya Nala Irrigation	Mahakali-4,7	75
8	Khanykhola Irrigation	Bhim Datt -10	114
9	Siddhanath Irrigation	Bhim Datt -8	48
10	Dhungyadi Irrigation	Bhim Datt -9	50.5
11	Tumadi Khola Irrigation	Bhim Datt -9	1240.5
B	**Water Supply and Sanitation User Group**		

SN	Name of the User Committee	Address	Command Area (ha)
1	Brahmadev Water Supply and Sanitation Users Group	Bhim Datt -9	
2	Mimi Water Supply and Sanitation Users Group	Bhim Datt -7	
3	Tilkeni Mateina Water Supply and Sanitation Users Group	Bhim Datt -10	
4	Bungcha Bol Water Supply and Sanitation Users Group	Bhim Datt -8, 9, 10	
5	Chandani Water Supply and Sanitation Users Group	Mahakali-8	
C	**Nepal Federation of Indigenous Nationalities (NEFIN)**		
1	NEFIN, District Coordination Council	Bhim Datt, Kanchanpur	
2	NEFIN, Municipal Coordination Council	Mahakali Municipality	

Section 3 of the Aquatic Animals Protection Act, 1961 renders punishment to any party introducing electric current, poisonous, noxious, or explosive materials into a water source, or destroying any dam, bridge or water system with the intent to catch or kill aquatic life. The Act has been in effect since 1961, yet both noxious and explosive materials are increasingly used in water bodies throughout Nepal. There is no reported case of person being prosecuted for violating the Act. This is a clear evidence of the government's ineffectiveness in developing a surveillance system for conserving aquatic life and wetland habitats. However, if poison is to be used for catching or killing an aquatic life, only safe poison is allowed to be used (section 5 (a)).[27]

The Aquatic Animals Protection Act 1961 recognizes the rights of the citizens to catch fish, except as proscribed in sections 3, 4 and 5 (section 6). Developers that wish to construct a dam for electricity, drinking water or irrigation or some other purpose are required to construct a fish ladder, to the extent possible, for passage of aquatic life. In case construction of a fish ladder is not possible, arrangements must be made for aquatic hatchery or nursery for artificial breeding of aquatic life (section 5 (b)(1)). This provision, however, is not complied with by the Mahakali Treaty of 1996 that subsumed earlier treaties such as the Sharda Treaty of 1920. Although the Mahakali Treaty mentions that India must maintain a flow of not less than 350 cusecs downstream of the Sharda Barrage in the Mahakali River to maintain and preserve the river ecosystem (article 1 (2)), it is silent about the construction of fish ladder or arrangements to be made for aquatic hatchery or nursery.

Closing the doors of a dam and any other structure or destroying fish ladder by anybody other than the authorized officer is prohibited (section 3 (a)). The GoN may prohibit catching, killing and harming certain kinds of aquatic animals through notification in the *Nepal Gazette* (section 4 (a)). Section 4 (b) further empowers the government to prohibit catching, killing and harming certain kind of aquatic animals in a specified season and condition. The government may publish a notice in the Nepal Gazette to prohibit catching, killing and harming aquatic animals in a specified water bodies without the permission authorized officer and the Government shall have sole right over the aquatic animals in such water body (section 5). This section gives overriding right to the Government over aquatic animals in such water bodies, which is likely to curtail livelihood opportunity and traditional practices of local people. A notification to this effect was published by the Ministry of Agriculture and Cooperatives on 5 August 2002 in Section 52 Number 17 of Nepal Gazette prohibits capturing, killing and or harming

[27] For the purpose of this section, safe poison means chemical or herb recommended by Technical Officer.

different species of turtles, crocildes, dolphin, *Tor*, *Neolissochilus*, and fish and also killing or capturing of aquatic life on certain distance of Koshi and Gandak barrage and Phewa Lake[28].

The Aquatic Animals Protection Regulations provide for establishing users group for fish culture in certain stretch of a river or certain ponds, lakes, at the community level. However, such users group is yet to be established in Kanchanpur district. Bhim Datt Municipality and Mahakli Municipality need to do so by utilizing the provisions of the Aquatic Animals Protection Regulations 2009.

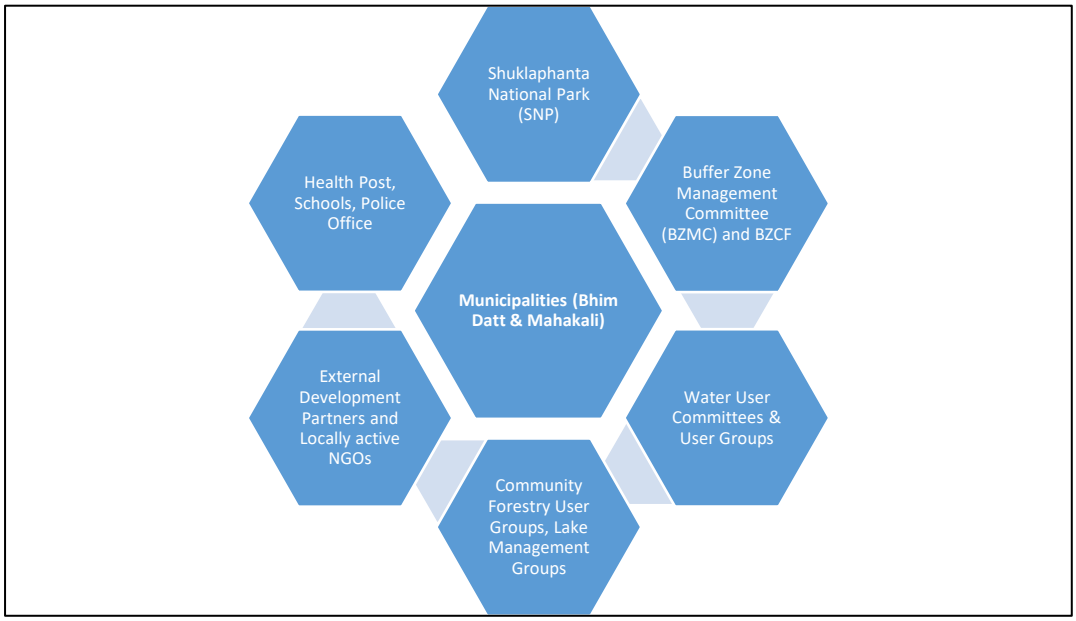
As per the provision of Constitution of Nepal 2015, the Local level bodies have executive and legislative power on items/heads such as local market management, environment conservation and biodiversity; local roads, rural roads, agriculture roads and irrigation; drinking water, small hydropower project, alternative energy; disaster risk reduction; and conservation of watersheds, wildlife and mines and minerals. Local level executive and legislative authority is to be exercised by Rural municipality and municipality (article, 57 (4) and Schedule 8). As per Schedule 9, the Federation, Province and Local level have concurrent power over different items/heads such as agriculture; forest, Jungle, wildlife, bird, water uses, environment, ecology, and biodiversity; and disaster management. Thus, the Constitution also provides right to the thee tier of governments – federal, state and local government – to legislate and implement and enforce the law enacted by the federal, state and local legislature. It is obvious that these actors need to work jointly in concerted manner to promote conservation and sustainable use of these resources.[29] As the setting up of municipality and rural level municipality has slowly begun after the election of local government in Kanchanpur in late June, 2074, it is expected that the Bhim Datt Municipality and Mahakali Municipality will utilize the mandate provided by the constitution and different laws and discharge their constitutional and legal responsibility.

As such, there are a wide range of local authorities that are involved in the management of specific natural resource sectors in the Lower Mahakali Watershed. Figure 19 sets out the full range of local authorities. What becomes clear is that there is a need for a user group approach to fisheries management.

[28] Capture, kill or harm to the 3 species of *Schizothorax*, 12 species of turtles, 2 species of crocodiles, Dolphin and 2 species of otter; capture, kill or harm to the 4 species of *Schizothorax* , 2 species of *Tor* and 1 species of *Neolissochilus* from any of the water bodies in the specific month of the seasons; With respect to the aforementioned fish species, besides the restricted months of the season, restriction is imposed to catch, kill or harm the fish species in other months below the prescribed length (For *Schizothorax* <15 cm, Tor sps. <30 cm, *Neolissochilus* <20 cm). Fish species trapped smaller than the prescribed length in the net or hook should be released into the water;
Kill, capture or harm to the smaller size of 46 recommended species of fish and any species trapped or captured in the net or hook below the recommended size should be released into the water; Allow to trap or kill smaller fishes than the prescribed size for research purpose after the approval of the government or local authority, Capture or kill any types of aquatic life in the following places: (i) 1 km downstream and upstream of water body area in Koshi barrage; (ii) 1 km downstream and upstream of water body in Gandak barrage; (iii) 100 m downstream and 200 m upstream from the inlet in public lakes (from Barahi Temple to Ratna Mandir of Phewa Tal); (iv) 100m downstream and upstream of the permanent dams of water resources project, and (v) At other side of the whole river or stream from the diversion.

[29] The Local Governance Bill 2017 that is under consideration in the Legislative Parliament provides different functions, duties and powers to municipalities and rural municipalities in lie with the provisions of the Constitution of Nepal. For example, the functions, duties and powers under the rubric of Local Market Management, Environment Conservation and Biological Diversity are development of local policy, law, standard, formulation of plan and their implementation and regulation; environmental hazard reduction at local levels; regulation and control of pollution and hazardous material at local level; adoption of low carbon and environment friendly development at local level; determination and management of environment protection area at local level among others (section 11(2)(J)).

Figure 19: Local Authorities With in the Lower Mahakali Watershed



IMPLEMENTATION AND ENFORCEMENT OF ENVIRONMENTAL MANAGEMENT PLANS

In spite of the higher frequency of climatic hazards like flooding and inundation, National Adaptation Programme of Action (NAPA) has categorized Kanchanpur as one of the low vulnerable districts. However, there are very high vulnerable areas and communities in the area of this watershed. This rating is so because of the reportedly higher adaptive capacity of the district in general, as it has a good access to different kinds of services like health, education, water supply, irrigation, etc. Community Forestry User Groups in the watershed are in the process of developing and implementing Community-based Adaptation Plan for Action (CAPA). DDC has formulated District Disaster Management Plan. VDC and Municipality have formulated Local Disaster Management Plan (LDRMP). Likewise, District Disaster Relief Committee (DDRC) has prepared a District Disaster Prepared and Response Plan in 2012. The plan has categorized vulnerable VDCs, and identified safe places/shelters at the time of flooding and inundation. Likewise, District Soil Conservation Office (DSCO) has prepared a sub-watershed management plan. According to DSCO, Kanchanpur a total of 6 sub-watersheds are identified in the Lower Mahakali Watershed i. e. Khaniya Khola, Bangaun Khola, Bhujela Khola, Kalvart Khaniya Khola, and Jogbuda Nadi watersheds. The DSCO Kanchanpur has developed a sub-watershed management plan of Gatadi Khola sub-watershed that is located in ward number 9 of Bhim Datt Municipality. The plan is also being implemented from DSCO in current fiscal year.

Table 10: Micro catchment identified by DSCO Kanchanpur within the area of the Watershed

SN	Name of Sub-watershed	Covered VDC	Ward Number
1	Khaniya Khola	Bhimdatt Municipality	6
2	Bangaun Khola	Bhimdatt Municipality	6 and 10
3	Bhujela Khola	Bhimdatt Municipality	10 and 13
4	Kalvert Khaniya Khola	Bhimdatt Municipality	6
5	Gatadi Khola	Bhimdatt Municipality	9
6	Jogbuda Nadi	Dodhara and Chandani	

Source: DSCO Kanchanpur

NATURE, WEALTH AND POWER INTERLINKAGES

In examining the interlinkages between nature, wealth and power within the Lower Mahakali Watershed, in order to identify key opportunities for leveraging natural and social capital for resilient development, it is clear that a number of key themes come into focus based on the watershed profile presented above.

Firstly, it is clear that the original riverine dynamics resulted in a floodplain dynamics that supported high levels of wetland and riverine biodiversity (including in Shuklaphanta National Park) as well as high and diversified levels of agricultural production. Now that there have been significant and dramatic alterations in the Lower Mahakali watershed primarily due to the Sharda and Tanakpur barrages as well as riverbed mining, it is clear that the floodplain dynamics have been drastically altered, leading to habitat loss and changes in ecological life cycles of migratory fish species among others. Added to this have been the changes instigated by deforestation in the Churia part of the watershed in the north, as well as new regulatory systems for the fisheries sector that have permitted both overfishing and further marginalization of communities such as the Sonaha.

All these transformations, in turn, have been affected by climate change as well. Greater numbers and intensity of floods, as well as changes in rainfall and temperature patterns have led to greater damage to downstream livelihoods through loss of agricultural land and deposition of mud (including in irrigation systems), as well as through more subtle changes in weather conditions for agriculture, fisheries and specific habitat conditions. The major wetlands of the Lower Mahakali appear to be negatively affected by these changing riverine water flows and deposition patterns as they are shrinking and also suffering from water hyacinth and other exotics starting to dominate the local ecosystem dynamics. However, the impact of climate change is significantly intensified by activities for wealth generation such as riverbed mining whereby rising riverbeds are exacerbating flooding.

While many of these activities for wealth generation ranging from irrigation for agriculture, hydropower, timber production, and fisheries have been negatively affected by these transformations within the Lower Mahakali, riverbed mining has produced both negative and positive impacts. Its ability to produce significant revenues for various local government bodies and institutional structures can be leveraged to support river protection and rehabilitation of aquatic ecosystems, which in turn, will support not only recovery of fish production, tourism (and other income generating activities) within Shuklaphanta National Park, and a range of interventions to improve adaptation to climate change (such as early warning systems, disaster response mechanisms, and insurance systems). Riverbed mining, however, needs to be carefully regulated in order to identify particular sites and levels of mining so that its negative environmental and social impacts can be minimized. A careful and integrated analysis of riverbed mining is called for to improve the knowledge basis for this important wealth-generating activity.

The power dimensions of Lower Mahakali indicate a mixed picture. On the one hand, certain regulatory regimes such as the fisheries sector have contributed to overfishing and damage to fisheries ecology. However, the devolution of natural resource management in areas such as community forestry, irrigation, drinking water, lake management as well as buffer zone management indicate that there is reasonably effective local-level management of key resources in the absence of an adequate district-level government system both in an administrative and budget sense. These devolved systems, however, need improvement and support in addition to the need to consider the development of new user group

systems such as for the fisheries sector, as well as creation of a landscape level planning platform that brings these different local user groups together to consider the larger dynamics at work.

The geographical impacts of these overall transformations are not equal. Broadly speaking, there is a greater reliance on seasonal migration (and to a very small extent permanent migration) in order to generate household income in the face of the economic and environmental transformations at work in the Lower Mahakali. In Mahakali municipality, there is a greater concentration of marginalized and vulnerable communities such as Dalits along the river's edge who are exposed to intense flooding incidents. In the absence of both adequate access to early warning systems, disaster response mechanisms and community/household assets to respond to these natural disasters, these communities are withstanding the worst of the transformations. Women, children and the elderly, in particular, are the primary victims since they are the most vulnerable to water-induced disasters.

For the Sonaha in Bhim Datt municipality, they have had to abandon their traditional gold panning and fishing activities because of changes in the river's hydrology as well as due to the new fisheries regulatory regime. In turn, without having any agricultural lands of their own, they have had to turn to wage labor opportunities from riverbed mining as well as seasonal migration to India and elsewhere. Riverbed mining, however, poses health risks, which are not adequately supported by the government's public welfare facilities. Even for those Hindu groups engaged in cattle raising, they are unable to access sufficient grass within Shuklaphanta due to the national park management system and have to resort to buying grass from Indian sellers.

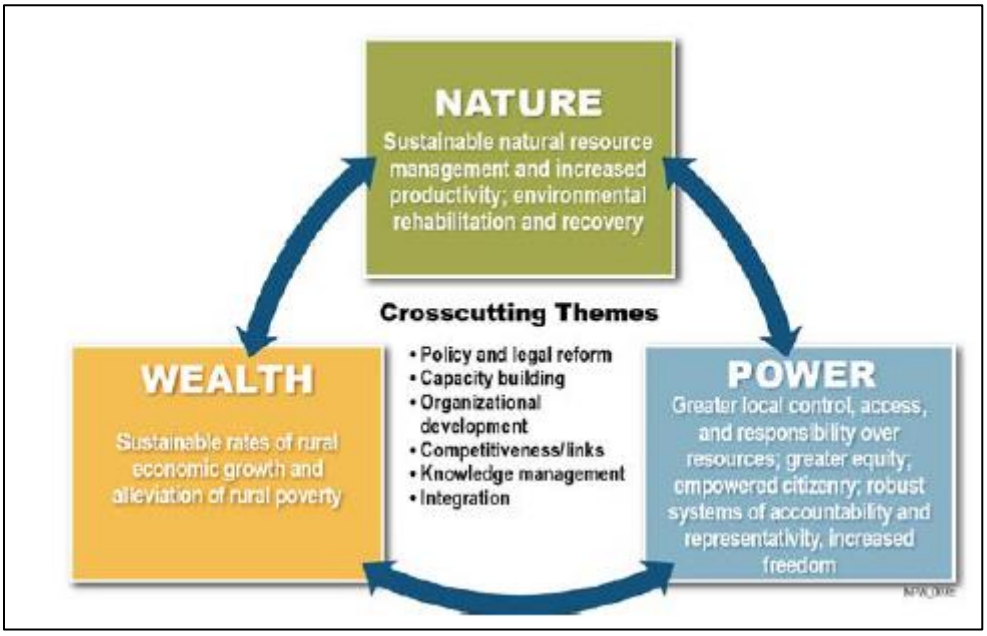
A primary issue for the watershed, therefore, is the way in which the Mahakali Treaty has been implemented in which India has the upper hand in controlling the water flows downstream from the Sharda and Mahakali as well as in regulating how embankments are constructed in areas such as Kutiakhabar in Mahakali municipality. It may be possible to open up lines of communication, in terms of knowledge sharing and better understanding of local-level impacts, by developing transboundary epistemic communities in the face of more formal obstacles to transboundary cooperation.

The secondary issue relates to how riverbed mining is carried out and how the revenue is shared at the district level. While a positive development in terms of supporting the local fiscal base, it needs to be significantly regulated in order to ensure that a wide range of negative environmental impacts are minimized, and in particular that the river equilibrium is not significantly disturbed.

In parallel, challenges related to how regulatory structures for fisheries sector, soil conservation, water-induced disaster management (such as early warning systems, landslide management, embankment construction), and national park management are implemented in practice both in terms of good practices, adequate budget allocations and capacity building in the face of climate change threats need to be addressed both in the realm of policy/law as well as implementation.

Figure 20 sets out the possible crosscutting themes that will emerge from this Nature, Wealth and Power analysis within the Lower Mahakali watershed. Local consultations can help to identify the detailed interventions needed to address the interlinked dynamics to improve overall resilient development to be set into motion.

Figure 20: Nature, Wealth and Power: Outcomes and Cross-Cutting Themes



Source: USAID, 2013

KEY THREATS TO MANAGEMENT OF WATER RESOURCES FOR MULTIPLE USERS

The major issues of the watershed are related to flooding/inundation, sedimentation and deposition, overall loss of viable fisheries, riverbank gravel mining, and transboundary water management. On a smaller scale, although the urban settlement of Mahendranagar Bazaar is slightly outside the watershed boundary, pollution and solid waste is entering the streams and rivers of this watershed from this area. There is a complex set of intersecting drivers behind these issues that can be categorized into five main issues, which are summarized below in Table 11:

Table 11: Priority Issues, Linkages and Recommendations

Ranking	Priority Issues and Threats	Link with Aquatic Biodiversity and Climate Change Adaptation	Recommendations
VERY HIGH	Transboundary water management	The Sharda and Tanakpur barrages have fundamentally transformed the hydrological flows within the Lower Mahakali with increased flow in the summer and significantly reduced flow in the winter months. This has disturbed the ecological life cycles of most aquatic species, and led to problems for agricultural production (too much and too little water issues). The barrages are also hampering the upstream movement of migratory fish as there are no fish passages and ladders. Additionally, there is no maintenance of minimum e-flow in the winter season that is directly affecting aquatic biodiversity of the Lower Mahakali. Lastly, the attempts by Nepal government to construct an embankment in Mahakali municipality for flood protection have been opposed by the Indian government because it would create flooding on their side of the border. Bhim Datt Municipality: Mahakali Municipality: Deuralighat, Aaambhoj (both related to opposition to embankment construction by Indian authorities)	• Strengthen cross-border coordination committee • Establish communication system with barrage management
VERY HIGH	Floods creating inundation, river cutting, and landslides	Increased flooding activity is likely related to climate change. Creates changes in the composition of aquatic species because flood events affect water level, temperature variation, and changes in sediment and turbidity. It also disturbs a wide range of habitats for aquatic life including destruction of fish populations in floods resulting in a decline in fish stocks. It therefore directly and indirectly affects fisheries-based livelihoods. In addition, frequent flood events in the Lower Mahakali area have caused loss of life, livestock and physical assets including loss of agricultural land. The loss of these assets leads to a reduced adaptive capacity to adapt to climate change.	• Provide training and support for low cost stabilization techniques for slopes and river banks, such as bioengineering and river bank planting • Support better control of runoff water to reduce soil erosion and protect agriculture land in upstream area • Raise awareness on ways to better manage forest fires and open grazing, such as training to community forest user groups and Khoto Sankalan Samuh • Strengthen Early Warning System • Construction of raised taps and toilet • Wetland conservation through controlling flooding and its shrinking trend

Ranking	Priority Issues and Threats	Link with Aquatic Biodiversity and Climate Change Adaptation	Recommendations
		Bhim Datt Municipality: Shiva Tol, Badhaipur, Bhujela, Chaukisota Mahakali Municipality: Kutiyakabhar, Jangilath, Shivapur, Chaukisota, Kanjabhoj, Tinnumber Jogbudha, Sundarnagar	• Produce and disseminate behavior change and communication (BCC) materials and radio programmes on watershed management best practices • Improve implementation of DPRP, LDRMP and related local plans concerned with this issue • Relocate or raise infrastructure (e.g., shelter house, Machan, taps, etc) out of the floodplain and other vulnerable areas
HIGH	Riverbed mining	Riverbed mining is an important income source for local governments and the communities living in the riverbank area. Unregulated/uncontrolled mining also creates disturbances to the riverine habitats, lowers the riverbed, makes water diversion difficult, lowers groundwater table and results in cost externalization. Bhim Datt Municipality: Mahakali Municipality: Airi, Odali, Badhaipur	• Promote regulated gravel mining, and excavation • Orient to local bodies, construct companies and contractors • Facilitate to apply IEE and EIA provisions • Facilitate to integrate the issues of riverbed mining in regular and periodic plan of local bodies • Enforcement of existing Laws and regulations related to watershed issues
HIGH	Decline in fish stocks and unsustainable fishing practices	There is over-fishing in the watershed area as a result of the fishing contract system introduced 20 years ago. Those fishing for subsistence purposes, who use sustainable fishing techniques, have been marginalized. Fishing by non-fisher communities with lack of fishing skills depend on destructive fishing methods in the watershed area that damage overall aquatic biodiversity as well as fish population levels. Bhim Datt Municipality: Airi, Odali, Piparaiya Mahakali Municipality: Tinnumber Jogbudha, Shivapur	• Conduct capture Fisheries Survey • Promote Ecotourism (sport fishing, catch and release program) • Mobilize Community Based Antipoaching Unit (CBAPU) to combat destructive fishing • Capacity building of BZMC, BZCF, CFUG at local level • Advocacy and Leadership Building Training of CSO, CBO, Fisher Group, CFUGs ETC • Promote fisheries culture through fisher groups/communities for commercial purpose
HIGH	Expanding the Knowledge Base for the Lower Mahakali Watershed	During preparation of the Lower Mahakali Watershed profile, several important gaps in information were discovered. These include the lack of downscaled climate change projections for the Mahakali River Basin, need for better information on stream discharge within the watershed and the ecological status of freshwater biodiversity, wetlands and fishery hotspots. In addition, there are	• Develop downscaled weather reports and climate change projections for the Mahakali River Basin, including the Lower Mahakali Watershed, and distribute to local communities through local platforms;

Ranking	Priority Issues and Threats	Link with Aquatic Biodiversity and Climate Change Adaptation	Recommendations
		knowledge gaps in terms of the impact of irrigation systems, current and planned, on freshwater biodiversity as well as the impact of increased sedimentation on the functioning of the irrigation systems.	• Develop georeferenced information on aquatic biodiversity and fishery hotspots to guide management of river and fishery resources • Develop the capacity of stakeholders in Bhim Datt municipality, Mahakali Municipality, and Shuklaphanta NP to conduct on-going water quality and stream gauge monitoring • Collaborate with GoN and irrigation project developers to determine impacts on aquatic biodiversity and the impact of sedimentation on current and proposed irrigation systems.

FLOODING

According to the Nepal Red Cross Society, Kanchanpur, in a rapid assessment report of USID's *Sajhedari Bikas* Program (2013), shows that Bhim Datt Municipality of Lower Mahakali Watershed has reported natural disasters (big flood events) 4 to 6 times in the last three years. The incidence of flooding is related to a combination of changes in rainfall pattern that produce either cloudburst intense episodes of rain or monsoonal rain of greater intensity over a longer period, combined with the changes due to the rising river bed and embankment structure management.

The Lower Mahakali Watershed (Mahakali and Bhim Datt municipalities) experience flooding, inundation river cutting issues (DPRP, Kanchanpur). The PANI survey 2017 in the watershed (based on focus group discussions, key informant interview and HH surveys) also supported this fact. The multi-stakeholder consultation meeting conducted during March 2017 also revealed the main DRR issues as flooding, inundation, river cutting and deposition in the Lower Mahakali Watershed. The survey shows that 28 percent of respondents report that floods have increased over the last 5 or 10 years. Major floods in 2037 Nepali Bikram sambat (B.S.) (1980 A.D), 2049 B.S. (1992 A.D.), 2065 B.S. (2008 A.D.), 2071 B.S. (2014 A.D.), 2073 B.S. (2016 A.D.) resulted in displacement, and loss of lives, live stocks, and agricultural lands. River cutting, deposition and inundation are major problems in various areas. 26% of respondents report that landslides have increased compared to the last 5 or 10 years[30].

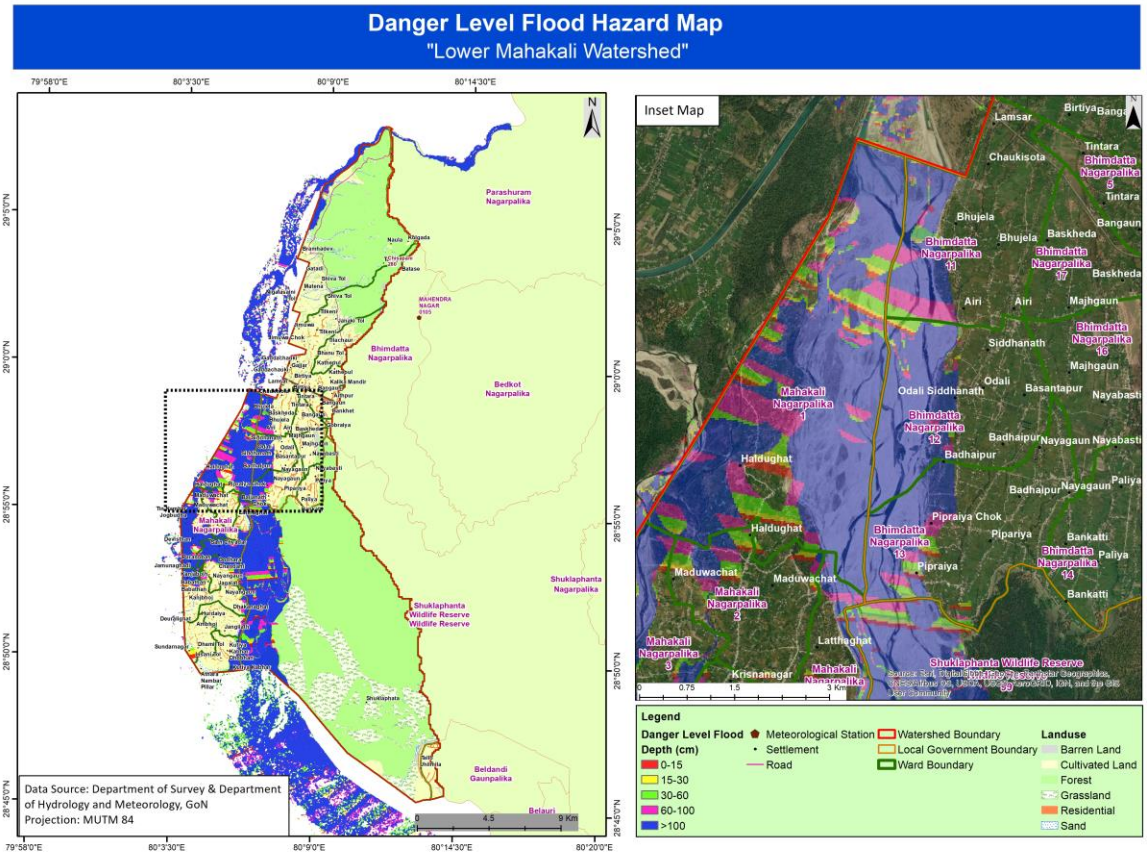
There are a range of flooding issues facing the Lower Mahakali Watershed. One of the primary issues is flooding in Mahakali municipality (ex-Chandani VDC) as a result of excess water from Tanakpur Hydroelectric Power plant in Naglascape (or known locally as Nagra) being diverted to the Jogbudha River (Figure 21 and Table 11). This flooding can take place even in winter months. The high water current of the Mahakali River during the monsoon obstructs the flow of the Jogbudha River for up to 2-3 kms upstream from the meeting point of those two rivers. This ultimately creates flooding and serious inundation in the Dodhara area. The areas that is always heavily affected by floods within the Mahakali municipality are: Dodhara -- Kutiakhabar, Shanti Tole ward no. 10, Muskure Tappu ward no. 7, Sundarnagar and Giri Tole; Chandani – Purnagiri Tole ward no. 2, Shrestha Tole, and Jamunaghari (Ganesh Primary School).

Based on Paani Flood hazard mapping assessment (2019), following villages fall under warning level and danger level of flood during a flood event: Badhaipur, Odali Siddhanath, Haldughat, Pipraiya Chok, Sain Chyadar, Dodhara Chandani, Tatapani, Sisam Jhala, Gatadi, Kutiya Kabhar, Jamunaghadi, Devisthan, Tin Namber Jogbuda, Kanjabojh, Kistighat. The warning and danger levels were assessed based on corresponding gauge height. For Lower Mahakali Watershed, Warning level is at gauge height of 2.94m and discharge of 5500 cubic meters and Danger level is at gauge height of 3.36m and discharge of 6000 cubic meters at DHM station, Parigaun. A Danger level map below shows more details on possible inundation area and villages based on flood hazard modelling.

.

[30] PANI HH Survey 2017

Figure 21: Flood hazard map of Lower Mahakali Watershed



Moreover, the embankments constructed in the areas from ward 7-10 are not high enough to provide protection against these floods. The Indian management system did not allow an increase in the elevation of the embankment as it would lead to further flooding within Indian portions of the Sharda/Jogbuddha river systems. Specifically, the Indian authorities are opposing the construction of a new embankment between Kutiakhabar and Bodhipur in Melaghat area.

In particular, 4 houses which lie between Sundarnagar to Kutiakhabar are at high risk of flooding and inundation. In the floods of 2064/65 B.S. (2007/8 A.D.), 9 people died. An early warning system was started in 2065 B.S. (2008 A.D.) by a local NGO called Nepal National Social Welfare Association (NNSWA). They formed a network to provide early warning working together with the media on information sharing. However, this system has not proved to be effective. There are limited resources for responding to flooding. There is only one boat being operated by the Municipality on the Jogbudha River for evacuation purposes. The Suspension Bridge Division of the Ministry of Local Development is constructing a suspension bridge.

The municipalities in the command area of the Lower Mahakali Watershed are categorized into very high, high, moderate and low vulnerable categories in terms of flooding and river cutting. Bhim Datt Municipality and Mahakali Municipality are in the "very high" category, and therefore vulnerable to frequent floods, inundation and river cutting. Flood events are experienced across different streams that damage land and affect people of different wards[31]

[31] It as per the information mentioned in Disaster Preparedness and Response Plan (DPRP), Kanchanpur

The PANI HH survey shows that major floods occurred in the Lower Mahakali Watershed in Nepali B. S. 2037 (1980 A.D.), 2049 (1992 A.D.), 2065 (2008 A.D.), 2071 (2014 A.D.), and 2073 (2016 A.D.). There was significant displacement as well as loss of lives, livestock, and agricultural lands. Floods are very common in the rainy season in the watershed area. However, even in winter because of the transboundary issue (Naglascape related to Sarada Barrage in India) water from the Sharda barrage flows and negatively effects communities. River cutting, deposition and inundation are major problems in various areas. And early warning system is functioning in some places. For example, NNSWA has formed a network to provide early warning. Media people are also involved in early warning in some places. Municipality has established a fund for disaster management. There are some boats, which operate during inundation at Kutiya Kabhar village. In Badhaipur, a flood monitoring mechanism/committee was formed. Perception of respondents of PANI survey shows numbers disaster events are increasing in recent days as seen Figure 16.

Floods were reported as key hazards of the watershed. They result in river cutting and inundation, mainly in Wards 3, 7, 8, 9, 10 wards of Mahakali Municipality, and 9, 10, 11, 12 and 13 number wards of Bhim Datt Municipality. FGD findings also show that during the floods, women, especially pregnant women, children and elderly people are most vulnerable. Due to the gender division of labor between men and women, women are responsible to take care of children and household goods even in emergency. Land cutting and floods are continuing to increase every year in Mahakali and Jogbudha River. The Kutia-Kabhar community had 105 households for 35 years. Many of those households were displaced by land cutting, inundation, and sand deposit – now, only 41 households remain. Among them, two households belong to Brahmin/Chhettri, one household belongs to Janajati and the remaining 38 households belong to the Dalit community. Among the Dalit community, most are land less (they have no agricultural land). Male members of the family seasonally migrate to India for labor work, and female members and children remain in village. Due to the absence of male members in the village, women and children are more vulnerable during disaster. If male members are at home, they support women to rescue and care for household property. Apart from that, women have a heavy workload in absence of male members.

RIVERBED MINING

Lastly, gravel mining is becoming commonplace in the watershed (see Box 1 further below). It has become a major source of revenue for Kanchanpur district since last 20 years. The DDC of Kanchanpur awards contracts for gravel mining from Mahakali River through a bidding process every year. As reported by the DDC of Kanchanpur, the *Jaya Jaganath Nirman Sewa* has been contracted up to an amount of NRs. 30,000,000/- (thirty million rupees) for this current fiscal year, indicating substantial quantities of sand-gravel-rock are being extracted from the riverbed in Lower Mahakali.

BOX 1: GRAVEL MINING AS A MAJOR SOURCE OF LIVELIHOODS

Since India began to divert the water of the Sharda/Mahakali river for hydro-power and irrigation by constructing dams and barrages, numerous waterholes and small lakes in the river have been lost due to river blockage and the uneven opening of barrage gates by Indian water management authorities/officials. Most importantly, this has also led to a significant decline in fish populations due to habitat destruction but also due to obstacles for migratory fish. In particular, during the winter season, the near closure of the gates for Tanakpur and Sharda barrages has led to an almost complete dewatering.

This has resulted in communities being able to openly and easily access sand-stone crushing and sieving that is a lucrative occupation. Gravel mining has become a source of livelihood for people of the Terai and Hill origins. Men, women and children from those households near the riverbank collect sand and stone in order to sell to the local contractors on site. In addition, greater flooding incidents during the rainy season have brought greater annual deposition of sand-stone into the Terai lowlands. The District Development

Committee (DDC) has issued licenses to individual contractors for gravel mining in the specified areas. These contractors deposit revenue of NRs 3 crore a year and the contractors charge certain fees to the local people who are engaged in the collection and supply.

As a result, most of the households in the Lower Mahakali Watershed work on sand-stone crushing and sieving during the *dry season*. Communities and households near the river bank, mainly from Airi, Odali, Bhujela, Badhaipur (ward number 11, 12 and 13) often go to riverbed mining. On the one hand, this provides a new and often alternative source of livelihood for these households. On the other hand, those living near the riverbank are among those poor, disadvantaged and socially excluded vulnerable people who often find temporary settlement in public lands such as riverbanks. Since these areas fall under high flood risk zones, minimum public services are available locally. As a result, community people are compelled to live in poor, unhealthy and risky zones. Because of poor services, women, the elderly and children suffer from a number of water-borne diseases and malnutrition. They are becoming more vulnerable and being pushed to more flood-prone areas as unregulated gravel mining practices continue to expand in the riverbank areas. Over-extraction and unregulated gravel mining practices from restricted areas with poor monitoring have made the already vulnerable community become further exposed to natural hazards. Lack of proper policy and regulation of gravel mining has made a mockery of the fundamental right to live in dignity, and right to clean and healthy environment guaranteed by the Constitution to the citizens. As local devolution and governance takes place, there is a strong need to address the policy and regulatory concerns behind gravel mining.

DECREASING FISH STOCKS AND UNSUSTAINABLE FISHERIES PRACTICES

Frequent flood events, changes in river flow because of the Sharda and Tanakpur barrages are the major contributing factors of declining fish-stock in the watershed area. Floods and higher deposition have destroyed the fish habitats in the Mahakali River. Over fishing because of higher demand with population growth and urbanization is also a cause of declining the fish-stock. Involvement of non-fisher communities in fishing and use of destructive fishing methods are other reasons behind it.

BOX 2: CHANGING RESOURCE REGULATORY SYSTEM AFFECTING SONAHA

The *Sonaha* are one of the indigenous communities of the Terai who have been living in the Lower Mahakali Watershed for generations, even though they are not officially recognized as *janajatis*. Originally, their traditional occupation was gold panning. Following the construction of the Sharda and Tanakpur barrages, and the resultant minimal flow in winter and floods from opening barrage gates in summer, riverbank erosion and licensing of riverbed mining by DDC, they are no longer able to practice gold panning. Once such community is known as "Gold Sieving" (*sun chaalne*) and lives near the riverbank at Bhim Datt Municipality-13. They combined gold panning and fishing activities.

As a result, the community was compelled to engage in wage labor for the stone and gravel mining activities on the riverbed. Consequently, gold panning skill has almost completely disappeared since they no longer even possess the instruments used for sieving gold. Moreover, there is no longer interest in the younger generation in gold panning, for there is not a single person in the community who can teach them the skill. The severity in loss of this traditional knowledge, skill and practice is also reflected in the fact that all the gold panning equipment has vanished from this 23-household community except for one "Sunauta".

Fishing has been another traditional occupation of the Sonaha in Bhim Datta municipality. However, some 20 years ago, the local government began issuing fishing licenses to contractors based on a competitive bidding process. The licenses were issued to the highest bidder irrespective of any consideration as to

whether the bidder was from a traditional fisher or non-fisher community. Unable to bid competitively, the Sonaha were denied access to capture fisheries, and this prevented the *Sonaha* from utilizing traditional fishing practices. In turn, the fishing license holder issues a *purji* charging NRs 2000 per household per year. The person who has the *purji* is allowed to catch 2.5 kg fish per day. However, if the catch is over 2.5 kg, the excess catch requires a payment of Rs.30-35 per kg. to the *purji* holder. As a result, the local *Sonaha* community have lodged a request to the Shuklaphanta NP Administration to give them permission to fish inside the NP.

The DDC's licensing system has posed serious threats to the *Sonaha* community's livelihood options. Although many people of the *Sanaha* community wish to engage in traditional fishing, only a few people (4-5) have obtained the *purji* from the license holder. In Sonaha Tole of Bhim Dutt, only 5 people have obtained abb *purji*; the rest are buying fish from the market. The households not having *purji* are compelled to purchase fish even for home consumption leading to nutritional problems. In recent years, therefore, this community has secured their livelihoods from sand and gravel mining instead.

Now that Sonaha have become heavily involved in sandstone crushing and sieving, they are exposed to health hazards. They earn about Nrs 500-800 from this kind of wage labor. In the summer dry season (Baisakh, Jetha and Asar), people suffer from dehydration and must be admitted to the hospital. This is the result of undrinkable river water and inability to carry sufficient drinking water. Along with increasing threats from floods and unfair policy interventions, natural resource-based communities are compelled to shift their occupation. Since the Sonaha do not possess land for agriculture, there are few income options available to them. In a broader sense, the potential implications of licensing on the status of aquatic biodiversity is yet to be studied. Nevertheless, it can be inferred on the basis of anecdotal information that the license holder fishing gears and practices are unsustainable in comparison to the traditional fishing practices of communities such as *Sonaha*. Therefore, there are reasonable grounds for reconsidering how access to fisheries can be enabled for marginalized communities who will at the same time protect the natural resource.

TRANSBOUNDARY WATER MANAGEMENT

The construction of the Barrage was started in 1988. The Tanakpur Agreement provided for the construction of the left afflux bund (the retaining wall) on Nepalese territory for which the Nepalese provided 2.9 hectares of land to construct the left afflux bund of 577-meter length. The Agreement provided for the installation of a head regulator at the Tanakpur Barrage. It seems that it hardly maintains e-flow downstream from the dam sites during the winter and spring seasons.

One of the primary issues facing the Lower Mahakali Watershed is the significant change in environmental flows following the construction of two barrages on the Indian side of the Mahakali. The first, the Sharda barrage, was constructed in the 1920s for irrigating lands in Uttarakhand. The second, the Tanakpur barrage, was constructed in the 1980s, essentially to replace the aging Sharda barrage. The construction of the dams for these barrages creates numerous threats for freshwater and wetland biodiversity by inundating important habitats, transforming downstream water flows, suspended load sediments, oxygen and nutrient dynamics, bed load transport, barriers to migration, and also changing microclimates. It is clear that when floodplains are disturbed, the ecology of fishes is significantly affected. The productivity of migratory species, such as mahaseer (*Tor tor*) in particular, is affected to the point of serious decline or even disappearance.

Today the Mahakali/Sharda River is governed by a bilateral treaty between Nepal and India. The Mahakali Treaty of 1996 subsumes earlier treaties such as the Sharda Treaty of 1920 governing use and management of the Sharda barrage, as well as the agreements over the Tanakpur barrage (which was

heavily debated over many years)[32]. This Treaty signaled a change in relations between Nepal and India in water resource negotiations working towards a more equitable stance for Nepal. In essence, although there was a certain level of consultation by the Indian authorities with the Nepalese authorities, the control over the barrage water flows appears to largely remain with the Indian authorities.

Although the Mahakali Treaty of 1996 provides for the creation of an implementation body called the Mahakali River Commission, in practice, the Commission has not been set up and very little basic information is publically available on how the treaty is being implemented. Greater effort is needed to create and provide spaces for increased public engagement and participation in transboundary water negotiation as well as effective treaty implementation. The Pancheshwor Multipurpose project (proposed upstream of the Tanakpur barrage) has been a heavily contested project for many years and although there have been some formal moves afoot (such as environmental impact assessments in 2010) to restart discussions about the project, it remains in its early stages.

During the summer monsoon months, the barrages have kept their gates fully open in order to prevent accumulation of mud and sediments in the Indian irrigation canals. The implication of this is that the Lower Mahakali Watershed receives substantial water flows that are rich in mud. This not only serves to increase river cutting but also deposits a considerable amount of mud on agricultural fields and in the rivers and streams as well. This creates ecosystemic disturbance whereby habitats for fish are destroyed, and the overall balance in freshwater biodiversity is undermined.

During the winter months, only about 5 percent of the water flow is allowed through the barrage gates in order to retain maximum water use for irrigation. As such, this almost dewatering of the area below the barrage following the monsoon leaves many riverbeds dry. Whilst this combination of high water flows in summer and dry riverbeds in winter has enabled the gravel mining (Box 1) taking place along riverbanks, it has fundamentally destroyed the river's ecology. In addition, since many of the communities who live near the riverbank are among the more marginalized and poor residents, their increasing involvement in gravel mining is exposing them to greater health hazards for which they have no public welfare facilities.

RESOURCE USE REGIMES: FISHERIES, SAND MINING

The District Development Committee (DDC) leases the River stretches to a contractor for capture fishing; it is the traditional fisher folks through whom the lessee gets the fish captured. However, they are either required to sell the caught fish to the lessee who later brings to the market for selling or they are required to pay the lessee certain amount of fee for per kilograms of fish caught. So the traditional fisher groups are not happy to sell fish through the contractor. The contractor of capture fisheries has mobilized the people from India to catch fish; thus, nobody is getting involved in the capture fisheries for commercial purposes from the watershed area. They might need capacity building training on capture fisheries and gravel mining, as it is a major source of livelihood of marginalized people.

CLIMATE CHANGE

Climate change is the trend in changes observed for climatic variables over long periods. Long-term changes in temperature and precipitation are analyzed because they strongly affect the biophysical and socio-economic context for both biodiversity conservation and adaptation of livelihood systems to climate change. Temperature and precipitation change can be observed along both temporal and spatial dimensions. An analysis of temperature and precipitation recorded at all stations in Nepal between

[32] Asia Foundation 2015. Status and implementation of transboundary river agreements on the Kosi and Sharda rivers in India. Issue Brief no. 1. New Delhi: Asia Foundation.

1976-2005 (Marahatta et al., 2009) shows an overall increasing trend of temperature and precipitation in the country. However, the changes vary spatially and seasonally.

In the Lower Mahakali Watershed region, an increasing average temperature and decreasing average rainfall trend has been observed (Figure 8). The winter, summer/monsoon, and autumn temperatures have been observed to increase at a rate of 0.04 ◦C/year. The spring temperature rate of increase has been observed to vary from 0.04 ◦C/year to 0.02 ◦C/year, moving from southern to northern part of the watershed. The rate in rise of average annual temperature is observed to vary from 0.02 ◦C/year to 0.06 ◦C/year, moving from southern to northern part of the watershed (Figure 7).

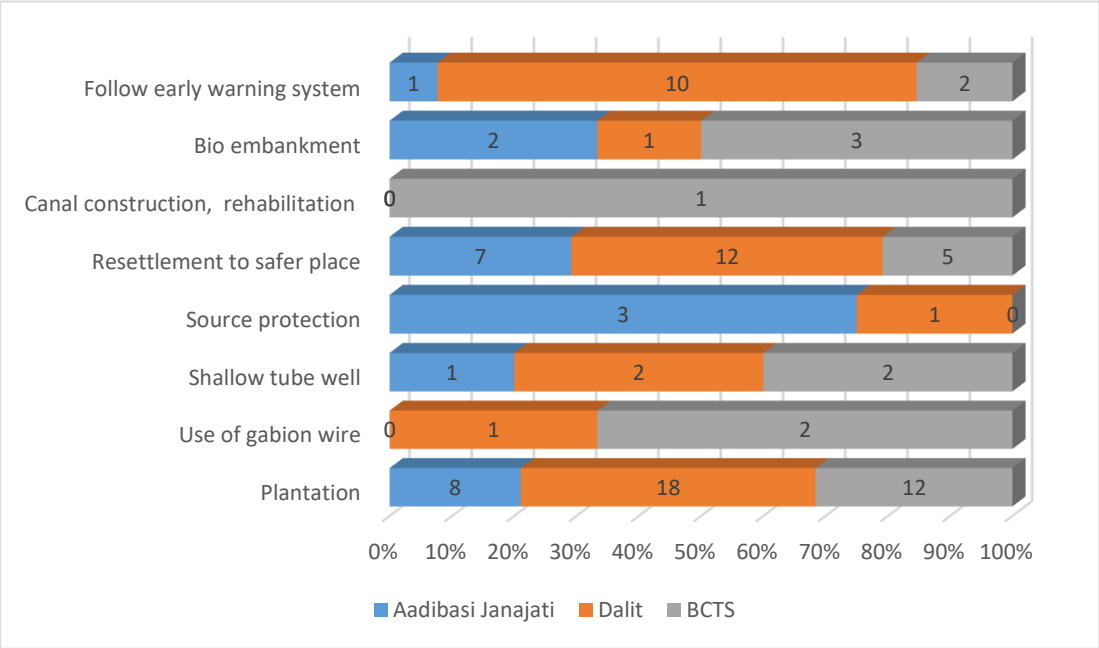
Both spatial as well as seasonal variation in rainfall change trend has been observed in the Lower Mahakali Watershed. The seasonal variation is summarized in Annex 10. The annual rainfall has been observed to decrease at the rate of 10 mm/year (Annex 10). Similarly, mean monsoon (Jun – Sep) rainfall has also been observed to decrease at the rate of 10 mm/ year. Mean pre-monsoon (Mar – May) and mean post-monsoon (Oct-Nov) rainfall has been decreasing at the rate of 3 mm/year and 1 mm/year respectively. However only the mean winter rainfall (Dec – Feb) has been increasing at the rate of 1.2 mm/year respectively.

The community perception of climate change is important for understanding how they are responding and adapting to climate change. The 2017 PANI household survey shows that 44 percent of the total 304 respondents had heard about climate change while 56 percent of the respondents had heard nothing about climate change. Respondents noted that flooding, inundation and landslides are the major climatic hazards in the watershed area resulting in increased sedimentation, deposition and loss of land. The residents were also acutely aware of the stress of groundwater depletion as well as reduced fish stocks and fish species.

Climate change has been leading to erratic and more intense rainfall patterns, as well as shorter periods of rainfall that, in turn, has led to reduced recharge of groundwater tables. This has meant that water availability for drinking and irrigation purposes has been reduced.

Some practices of adaptation are in the Lower Mahakali Watershed but are not sufficient to respond to the increasing trend of climatic hazards. The stakeholders and government authorities are jointly responding to different climatic hazards occurred in the watershed in previous years. They are building an embankment where the river is damaging settlements and agricultural land. Safe places/shelters during the flooding time have been identified and documented. The details of safe places/shelters areas are presented. Different resources to be mobilized at the time of disaster have been identified and documented in District Disaster Preparedness and Response Plan made by District Disaster Relief Committee (DDRC). Different resources to be mobilized at the time of disaster has identified and documented in the plan. The PANI Survey 2017 shows that different adaptation measures have been adopted by surveyed households i.e. early warning system, bio-embarkment, canal construction, resettlement for safer place, source protection, sallow tube well, use of gabion wire, and plantation. The numbers of HH adopting the measures mentioned above are seen in the figure below.

Figure 22: Numbers of HH Adopting Different Adaptation Practices by Caste/Ethnicity (n=43)



VISION STATEMENT FOR LOWER MAHAKALI WATERSHED

VISION

Resilient, healthy and sustainable watershed with ensured easy access to clean and safe water to all creatures by 2030

MISSION

- Ensuring access to clean water for all animals, promoting watershed friendly best practices and technologies, and supporting stakeholders to engage in development in collaboration with local partners
- Control and manage invasive species using alternative options and ensure the provision of reservation to fishing communities along with the promotion of traditional or not harmful and sustainable fishing methods.
- Gravel mining and physical development or infrastructural development will be there considering EIA and upstream down stream linkage. There will be an effective disaster management mechanism with funds and an early warning system, and people will consider the watershed safe.
- Renewable energies technologies will be utilized to fill the gap of electricity supply and demand.
- Enhanced water quality with control of chemical uses and effective waste management in the watershed area.

PRIORITIZED ISSUES IN MAHAKALI WATERSHED

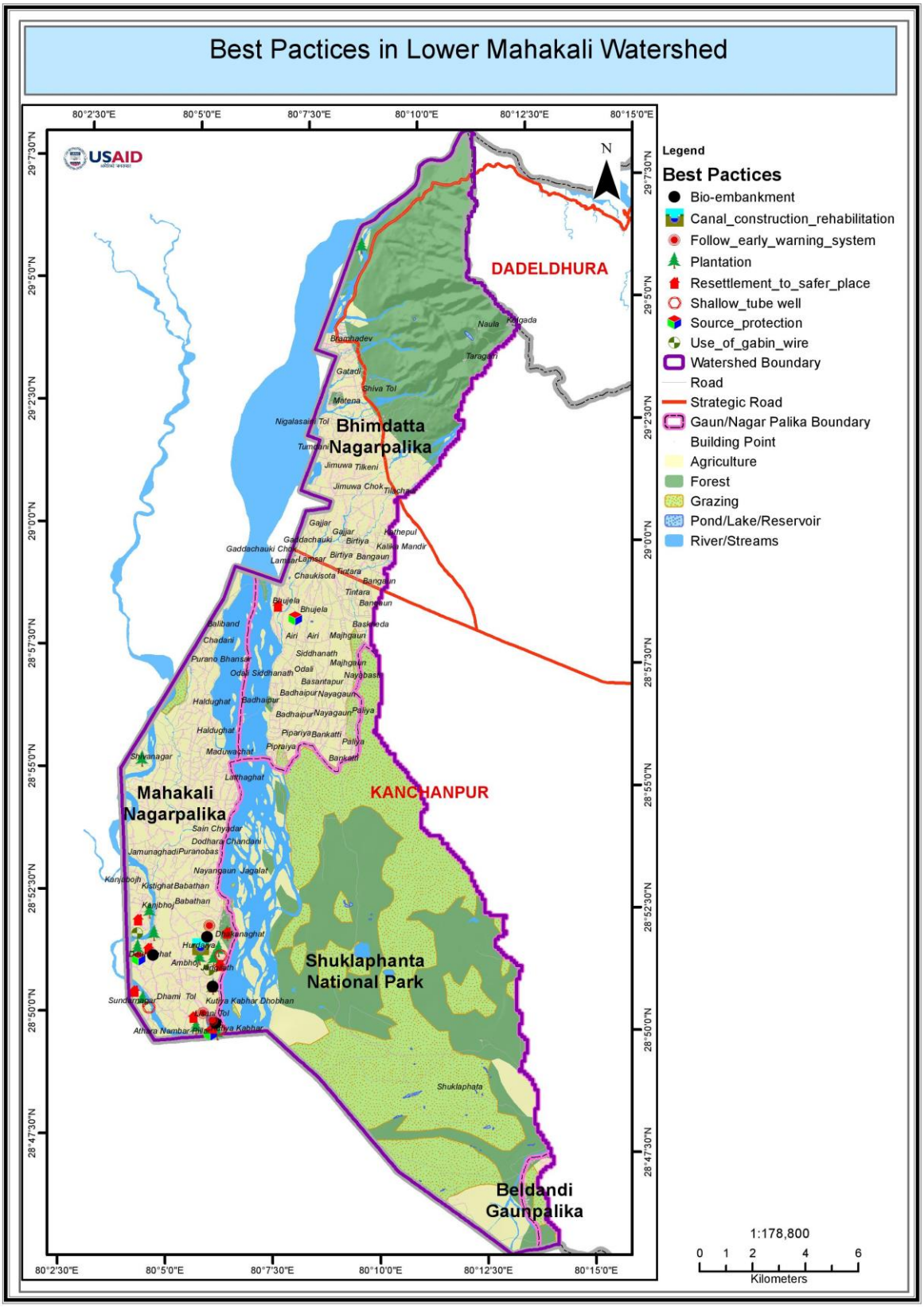
Table 12: Summary of Prioritized Issues by Municipality

Issues	Prioritization	Mahakali Municipality	Bhim Datt Municipality
Climate and water induced Hazards (Inundation, river cutting and land slide)	High (P2)	Kutiya Kabhar, Jangilath, Shivapur, Chaukisota, Kanjabhoj, Tinnumber Jogbudha, Sundarnagar,	Shiva Tol, Bhadhaipur, Bhujela, Chaukisota
Sedimentation, deposition, increased bed	Medium (P3)	Deuralighat, Aaambhoj	Badhaipur
Riverbed mining	Very High (P1)		Airi, Odali, Badhaipur
Decrease in fish stocks-fishing malpractices	High (P2)	Tinnumber Jogbudha, Shivapur	Airi, Odali, Piparaiya
Invasive species in lake and natural ponds	Medium (P3)	Chaukisota	Shiva tol, Badhaipur, Gatadi
Depletion of ground water	Very High (P1)	Chaukisota	
Solid waste and water pollution	Medium (P3)	Chaukisota	

Transboundary Issue (not allow to construct embankment in Nepal side, unpredicted and unexpected water flow from Sharada Baragge)	Very High (P1)	Deuralighat, Aaambhoj,	

Source: Result Sharing and Issue Prioritization Workshop

Figure 23: Best Practices in the Lower Mahakali Watershed



REFERENCES

1. 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. Bhatta, RP (2011): Climate Change Impacts on and its adaptation strategies of Rural Communities of Krishnapur VDC of Mohona Watershed in Kanchanpur District, an unpublished Thesis, IOF, Pokhara, TU

3. Bohara, M. N (2015): Physico-Chemical and Microbiological Analysis of Drinking Water Quality of Bhim Datta Muncipality of Kanchanpur District, Nepal Ambit Journal of Microbiological Research. Vol 1(1) pp. 01-07 August, 2015.

4. DDC, Kanchanpur (2016): District Transport Master Plan (DTMP) of Kanchanpur District

5. DNPWC (2006): Shuklaphanta Wildlife Reserve and Buffer Zone Management Plan, 2006-2011

6. GoN/ Small Towns Water Supply and Sanitation Sector Project (2016): Resettlement Due Diligence Report of Kanchanpur District

7. GoN/MOFSC (2013): Country Report on the State of Forest Genetic Resources, Nepal

8. GoN/MoPE (2010): National Adaptation Programme of Action (NAPA)

9. http://mip.gov.np/Introduction/4

10. https://en.wikipedia.org/wiki/Sharda_River

11. https://en.wikipedia.org/wiki/Shuklaphanta_National_Park

12. Joshi, PD (2002): Study on Park and People Relationship in Royal Shuklaphanta Wildlife Reserve, Central Department of Botany, TU

13. Marahatta, S., B. S. Dongol, and G. B. Gurung (2009), Temporal and Spatial Variability of Climate Change over Nepal (1976-2005), Kathmandu.

14. NHRC/DAO (2012): Disaster Prepared and Response Plan (DPRP), Kanchanpur

15. Sajhedari Bikaas Program (2013): Rapid Assessment Report on Community Development Infrastructure in Eight Districts of Mid- and Far Western Nepal Produced by Nepal Participatory Action Network (NEPAN)

16. United Nations Resident and Humanitarian Coordinator's Office (UNRHC): District Profile of Kanchanpur District, Nepal

17. SWR (2006): Suklaphanta Wildlife Reserve and Buffer Zone Management Plan, 206-2011

ANNEX 1: METHODOLOGY FOR DEVELOPING WATERSHED PROFILE

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

i. Building consensus and common understanding among the stakeholders on both the current situation as well as a vision for the future;
ii. Establishing a benchmark for activities targeting human and ecological communities in the watershed by describing the existing interaction between people and nature;
iii. Identifying potential priority areas for stakeholders to plan and work together on local-level activities to improve management of the watershed, which PANI and other projects aim to support;
iv. Providing a platform for consultation and advocacy for the 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 a) available secondary literature and information related to biophysical condition, socio-economic characteristics, infrastructure, vulnerability and disaster risk, as well as freshwater biodiversity of the watershed b) Entry level Multi-stakeholders Consultation Workshop [MSC] conducted to i] share preliminary analytic results of the watershed conditions, ii] identify priority threats, vulnerability, bio-diversity value by location and the impact groups and priority issues and iv] preparation of detail plan for the KII, FGD and water quality testing and water discharge measurement c) household (HH) surveys to categorically assess the differential impacts of the issue at household level, c) focus group discussions (FGD) were conducted to assess the severity of the problem and or significant value associated with Paani focal interest, and d) key Informant Interviews (KII) were carried out to understand the cause and intensity of the particular issues of the areas. Different guiding checklists designed around *Paani* focal interest areas, cross cutting areas, were used while conducting surveys including governance, gender and social inclusion and policy.

The exit MSC workshop wish aims to share consolidated results obtained from different studies are shared with wide stakeholders that provide foundation for the identification and prioritization of the issues that determine the watershed health condition. This helped to identify solutions, champions, and stakeholders for leveraging knowledge and funds through partnership with multiple stakeholders for the implementation of the problem. We selected the focus groups and key informants through a multi-stakeholder consultation workshop held at the district level.

HH survey data was collected for four broad categories of information a) bio-diversity and climate change, b) drying water sources, c) livelihoods and wellbeing, and d) perceptions of water quality. The surveys were conducted based on locations where the multi-stakeholder consultation workshop identified specific issues or challenges. The numbers of surveys were determined depending upon the

identified issues as well as village cluster or settlement Thus, 307 households were consulted on biodiversity and climate change, 170 households on drying water sources, 369 households on livelihoods and wellbeing, and 41 households for perception of water quality. At the same time, water quality testing was carried out in 7 points of streams of the watershed using the Akvo Flow Mobile App made for this purpose.

As part of the prioritization of the issues, an exit multi-stakeholder workshop was conducted to share the results of the field work that *Paani* had conducted in the recent past. After the gallery work and discussion, the participants brain stormed to identify and prioritize the main issues that directly relate to watershed health. A separate group worked to develop a vision statement for their watershed. Analyzing the current reality, the group discussed in length the course of action that will lead to improved condition of the watershed health. The group also identified key stakeholders, partners and working mechanisms to use to seek commitments on implementation of the priority issues.

Figure 24: Methodological Approach Employed in Primary Data Collection for Profiling

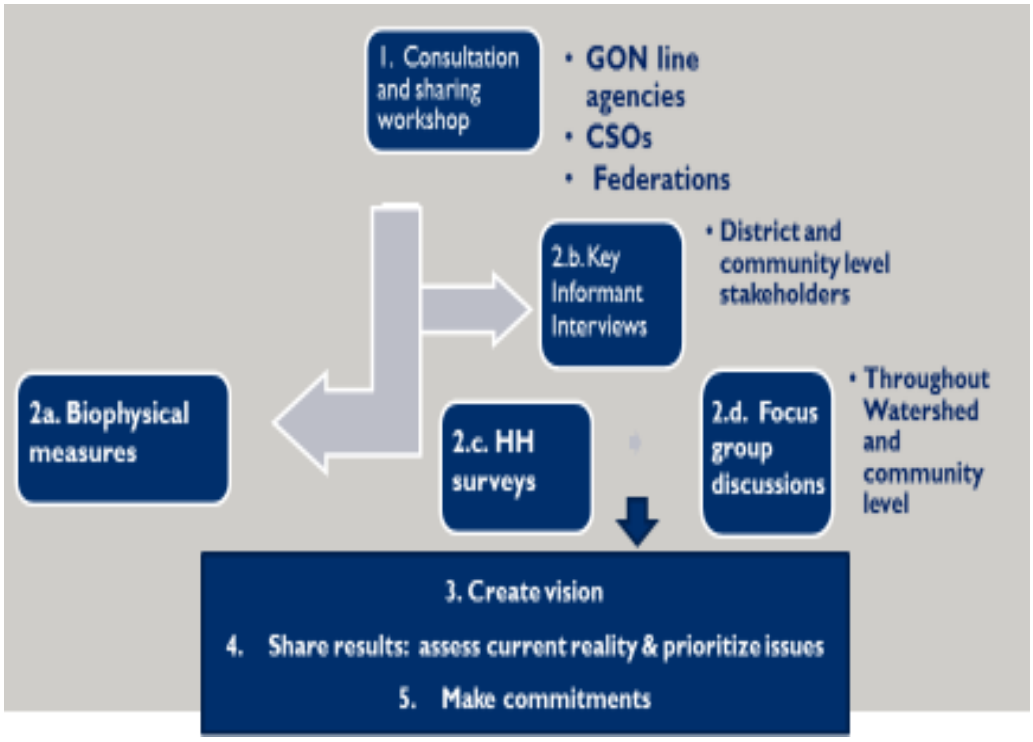
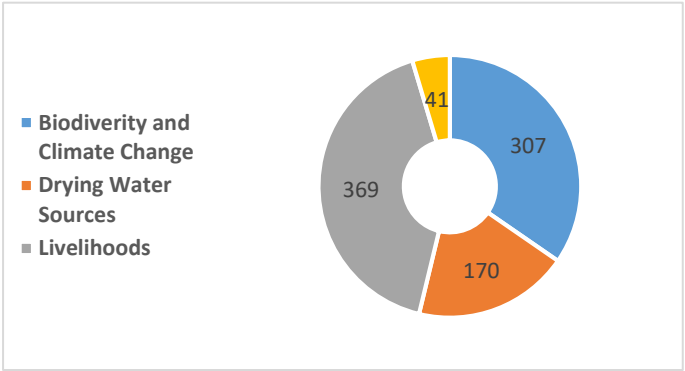
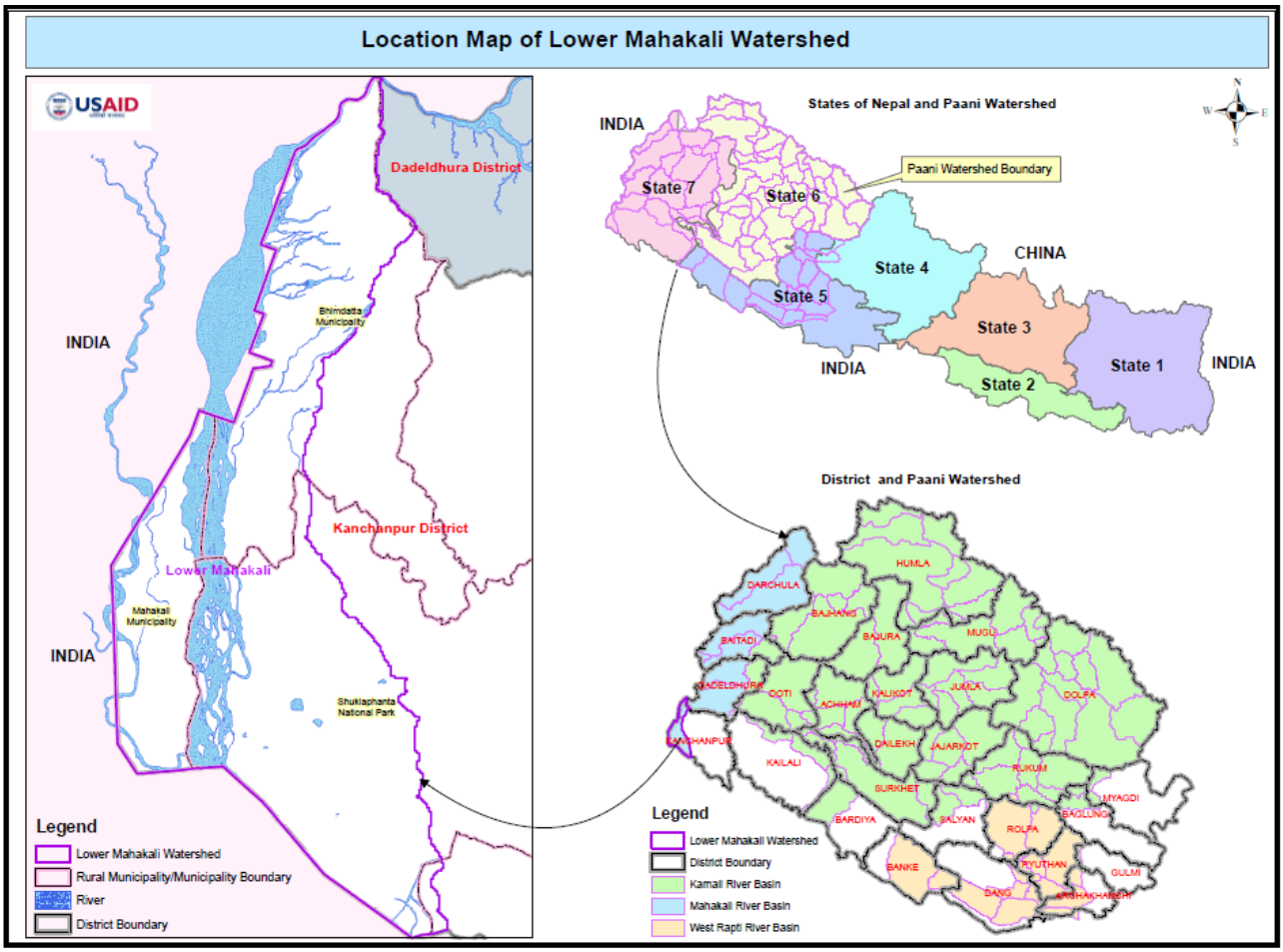


Figure 25: Numbers of HH Surveyed in the Lower Mahakali Watershed for Each Thematic Issue

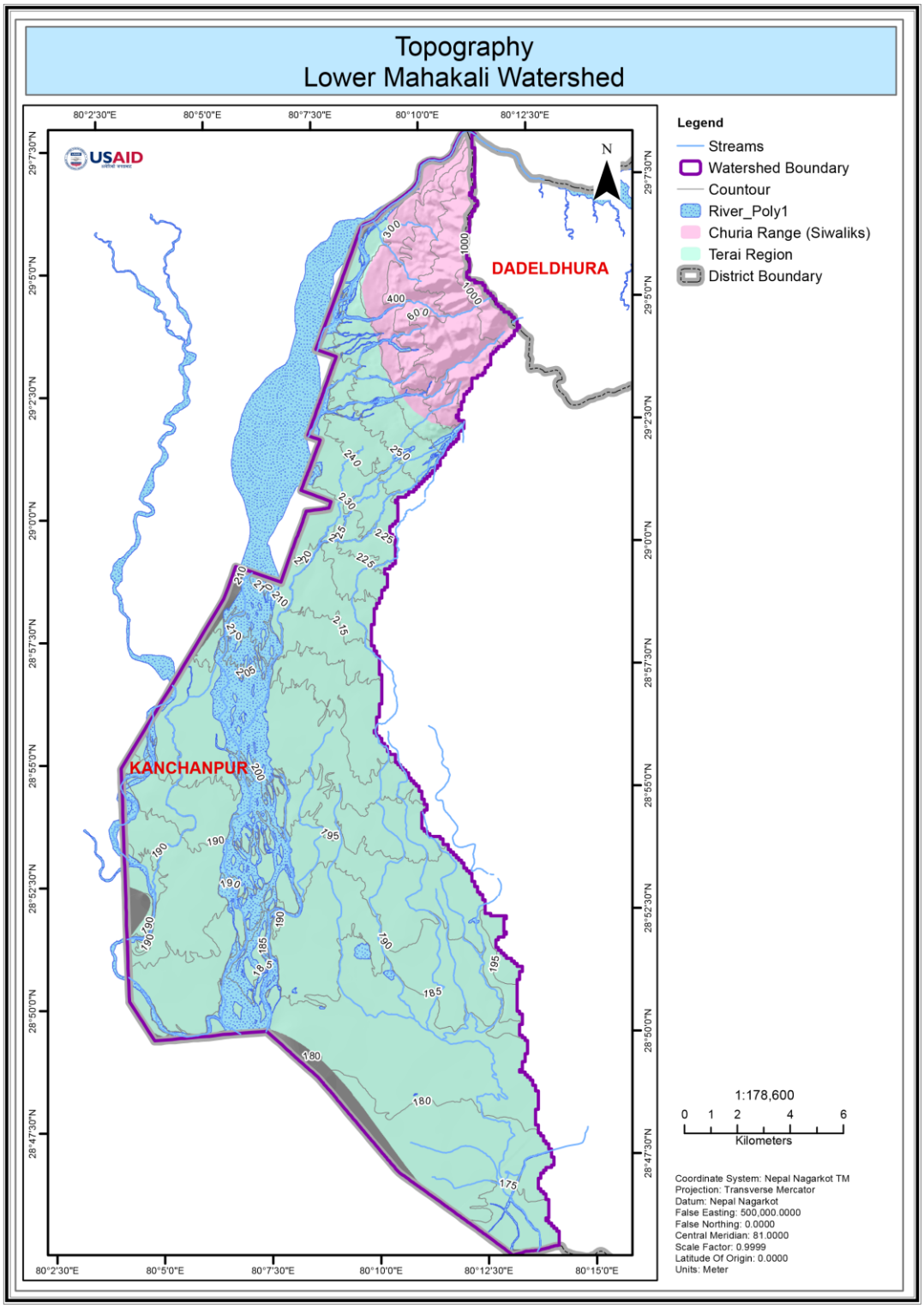


ANNEX 2: LOCATION MAP OF LOWER MAHAKALI WATERSHED

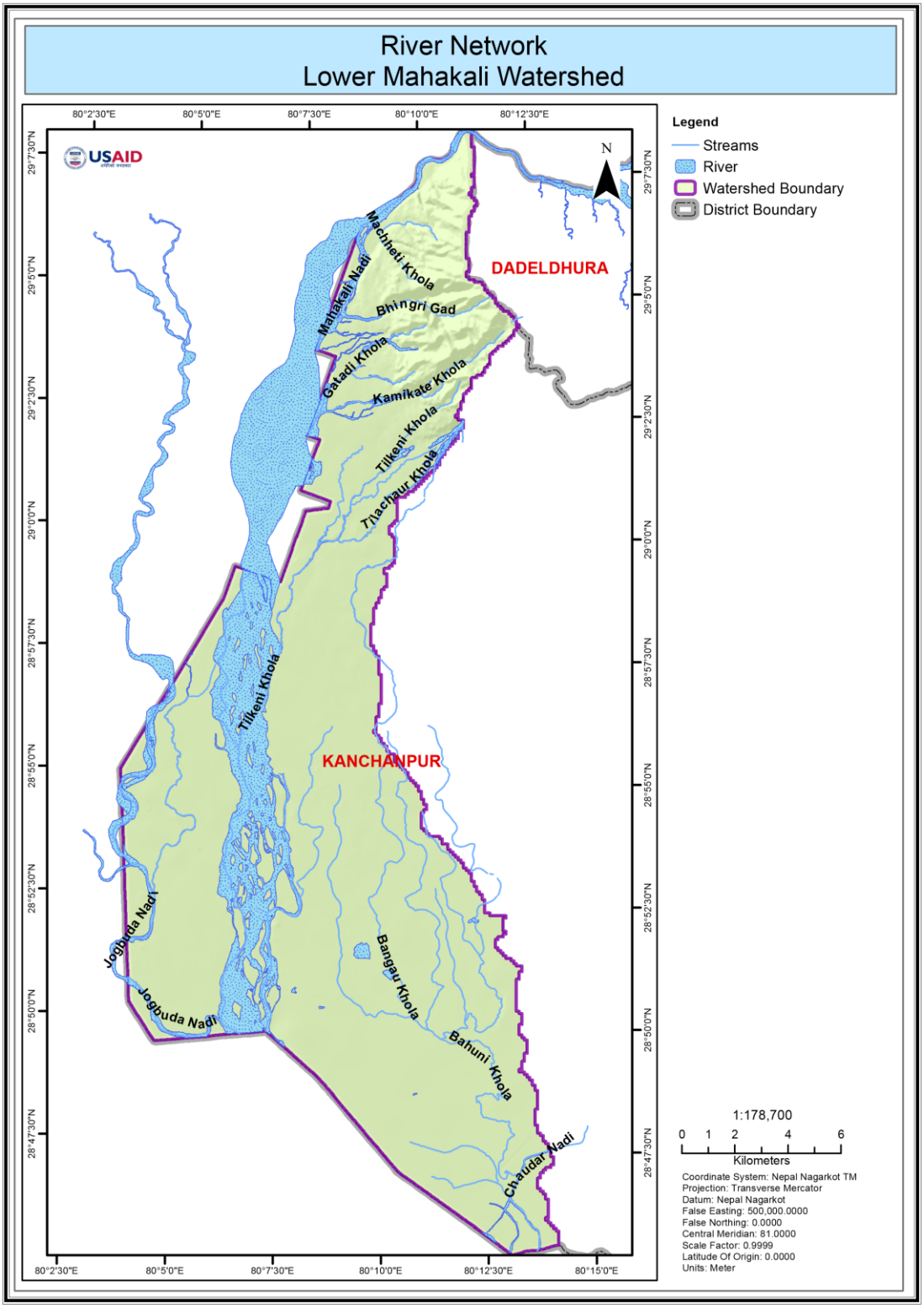


ANNEX 3: MAP OF WHOLE MAHAKALI RIVER BASIN

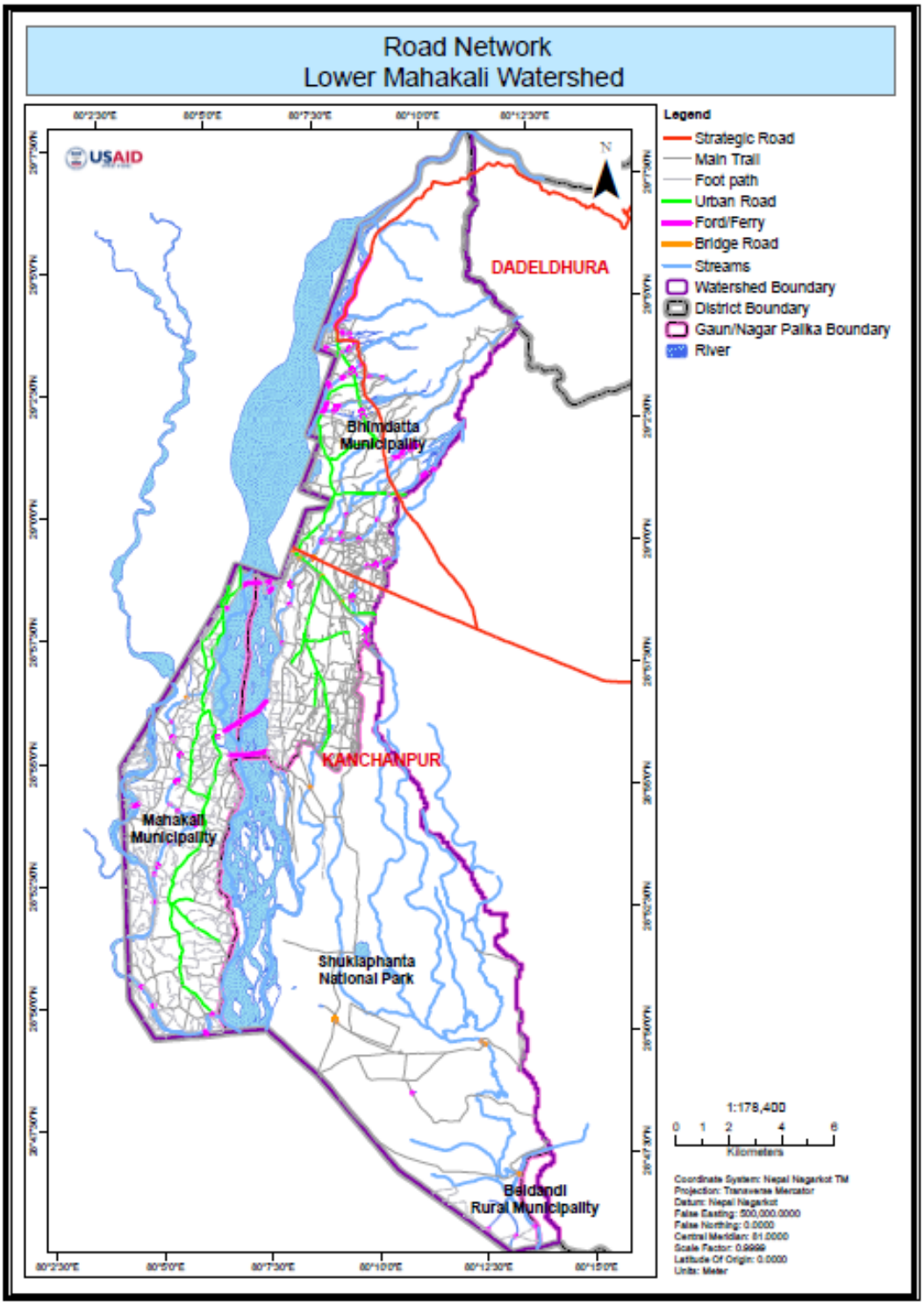
ANNEX4:TOPOGRAPHIC MAP OF LOWER MAHAKALI WATERSHED



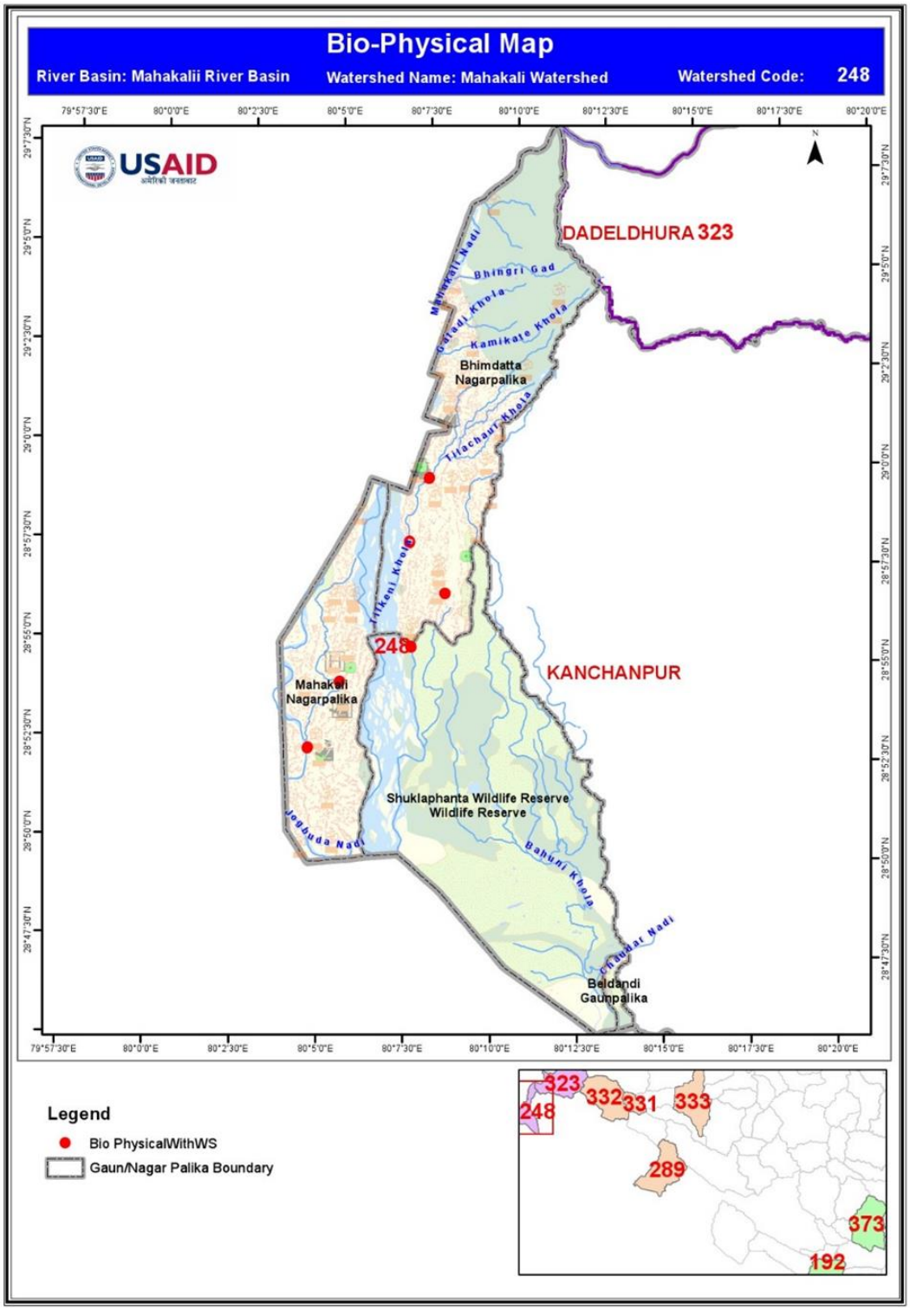
ANNEX 5: RIVER NETWORK IN LOWER MAHAKALI WATERSHED



ANNEX 6: ROAD NETWORK IN LOWER MAHAKALI WATERSHED



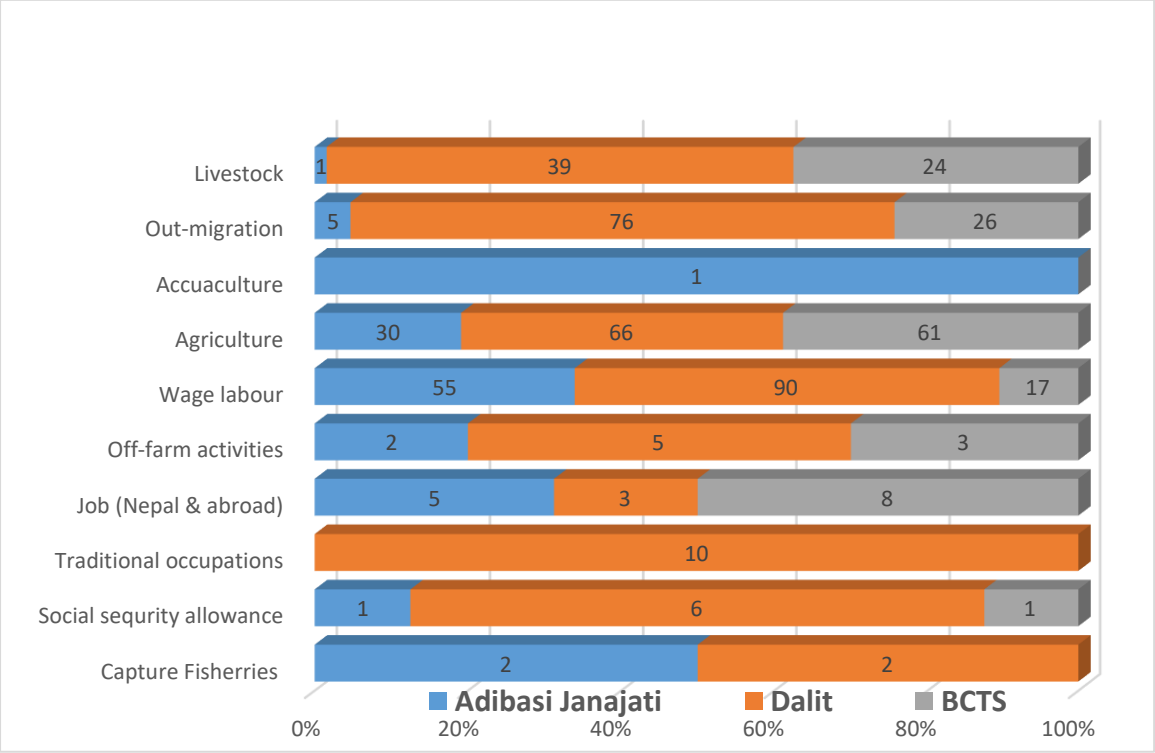
ANNEX 7: BIOPHYSICAL MAP OF LOWER MAHAKALI WATERSHED



ANNEX 8: SECONDARY SOURCES OF LIVELIHOODS IN WATERSHED

Though agriculture and wage labour are the major sources of household income, livestock, capture fisheries, out-migration, job, tradational occupations (blacksmith, talioring, etc.) and off-farm activities (handicraft, tea shop, etc) are also sources. Traditional occupation is only sustaining the Dalit households. It seems that aquaculture and capture fisheries as a source of livelihoods exists for both Dalit and Janajati households. The HH survey data shows that majority of the households engaged in wage labour, out-migration and agriculture are of Dalits.

Figure 26: Secondary Sources of Livelihoods of Households by Caste/Ethnicity (Total HH 369)



Source: PANI Survery 2017

ANNEX 9:VISION AND MISSION OF LOWER MAHAKALI WATERSHED

Figure 27: Vision Building Framework Used During Watershed Profiling Process