

# LOWER MAHAKALI WATERSHED HEALTH REPORT



Community Vision - "A resilient, healthy and sustainable watershed with ensured access to clean and safe water for all creatures"

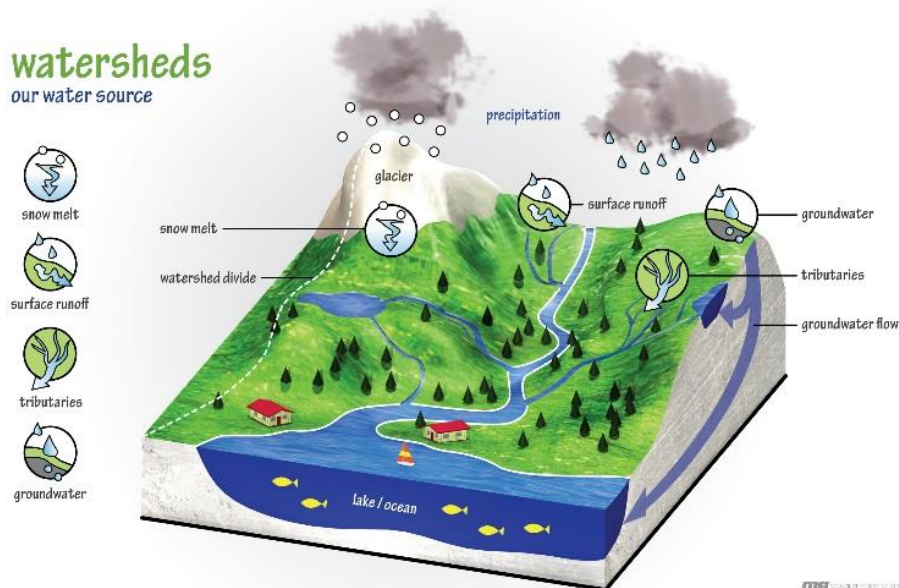


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## What is a watershed?

A watershed is an area of land that contains a common set of streams and rivers that drain into a single larger body of water, such as a river (Figure 1). But watersheds include more than streams and rivers; they also consist of all the people, forests, wildlife, villages, infrastructure, terrain, climate and agriculture within the landscape.

It is important to think about a watershed in its entirety – upstream and downstream – instead of only looking at one element of the watershed. This is because water flows and connects various aspects of a watershed. What happens upstream has an impact on what happens downstream. For example, gravel mining upstream can increase sedimentation for downstream residents. Similarly, water diversions upstream for irrigation can reduce the amount of water available downstream for people and aquatic species.



**Figure 1. Diagram of a typical watershed**

This watershed health report is one of several being written for watersheds across Nepal to inform development visions and processes. The goal of this watershed health assessment is to help people living in the Lower Mahakali watershed make better decisions, protect and restore the watershed, reduce risks, and create sustainable economic opportunities.

This watershed health report uses indicators to measure different aspects of a watershed to determine if the landscape is healthy and able to provide ecosystem services to people living in that watershed. The indicators in this report were determined through a combination of local stakeholder use priorities and watershed health as defined in the literature.

The health indicators in this report are grouped under larger categories of 1) nature 2) wealth and 3) power, each of which explores related aspects of the watershed from that particular viewpoint. A full profile of the Lower Mahakali watershed has also been prepared.

<b>River Basin</b>	Lower Mahakali
<b>Province</b>	Number 7
<b>Total drainage area</b>	311 km <sup>2</sup>
<b>Number of streams</b>	16
<b>Major rivers</b>	Kamikate, Gahatadi, Jogbudha, Malariya Bhunikhola, Bangaukhola, Bangekhola, Bhingrigaad, Bhumethala Khola, Chaudhar Nadi, Gandha Khola, Machhetrikhola
<b>Lakes and wetlands</b>	21 natural lakes, of which Rani Tal (10 hectares) is the most ecologically significant
<b>Land use</b>	Agricultural land, 35%; forests, 29%; shrubs and grassland, 24%; Rivers, streams and ponds, 12%
<b>Municipalities</b>	Bhimdutta, Mahakali
<b>Population</b>	83,580 (48% male; 52% female)
<b>Ethnic groups</b>	Brahmin, Chhetri, Thakuri (53.2%), Janajati (15.2%), Dalit (26.3%), Newar (0.5%), Others (4.8%).

**Figure 2: Key Characteristics of the Lower Mahakali Watershed**

The Lower Mahakali watershed is located within Kanchanpur district of southern Nepal (Figure 3). India borders this watershed to the West and South. Administratively, the Lower Mahakali extends into two zones: Bhimdutta municipality in the West and Shuklaphanta National Park in the South. The vast majority of the watershed is characterized as Tarai plain.

The Mahakali River (known as the Sharda River in India) flows through the center of the watershed, a snow-fed system that starts in the Api-Himal in India at 3,600 m and descends to the Lower Mahakali watershed. The northern 35% of the Mahakali watershed lies in India.

The population of the Lower Mahakali Watershed is 83,580 (CBS 2011). Most families in the watershed rely on agriculture and wage labor for income. The traditional inhabitants of the watershed are Tharus, who largely made their living on fishing. Today, the population is diversified due to in-migration from the hill and mountain regions of Nepal in the far western part of the country.

## Nature

Health indicators in this section include various aspects of the watershed ecosystem, including water, biodiversity, and land use.

## Water

The condition of water resources within a watershed depends on a large number of factors that affect the water cycle, including rainfall, glacier melt, infiltration and withdrawals for irrigation, among others.

## Rainfall

No long-term rainfall records for the Lower Mahakali exist, so nearby rainfall stations (Mahendranagar and Belauri Santipur) were used to estimate average rainfall based on the Thiessen polygon method. The average dry season rainfall (November to April) is 20 mm compared to the monsoon season rainfall (June to September) of 372 mm. The average annual rainfall for the watershed is 1,706 mm.

## Water availability and accessibility

The Mahakali River and its tributaries are the main water source for domestic, agricultural and industrial use in the water. A household survey carried out by Nepal Federation of indigenous Nationalities (NEFIN) found that 94% of households had difficulty in procuring enough water for daily needs year round.

Water accessibility, on the other hand, indicates the degree of ease for users to obtain water. Obstacles to water accessibility can be physical (e.g., distance to water points) or cultural (e.g., water sources available only to certain castes), or both. Based on NEFIN's household survey, we found that of those who depend on public water sources, 33% of families do not have equal access to water. Further analysis reveals that a higher proportion of Dalits (40%) do not have equal access to water, compared to 14% of Brahmins and Chhetris. Nearly 5% of households reported they travel more than 30 minutes per day to obtain water.

## River and lake water quality

During the summer monsoon, barrages on the Mahakali are kept fully open to prevent accumulation of mud and sediment in the Indian irrigation canals downstream. 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 destroys habitats for fish and undermines the overall balance in freshwater biodiversity. During the winter months, only about 5% of the water flow is allowed through the barrage gates in order to retain

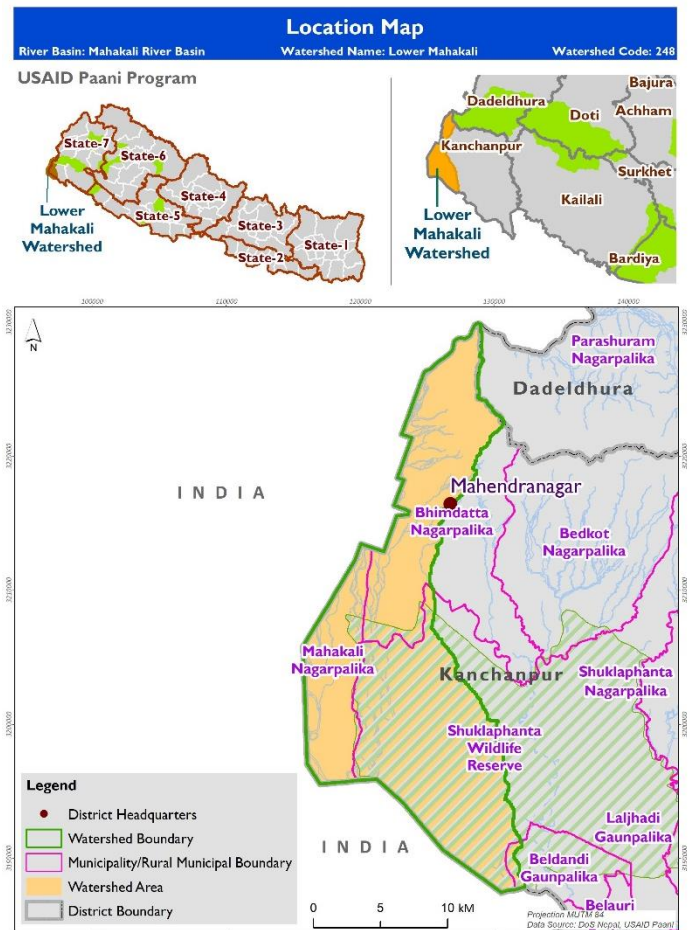


Figure 3: Map of the Lower Mahakali watershed

maximum water use for irrigation. This almost complete dewatering of the area below the barrage following the monsoon leaves many parts of the riverbed dry.

Six points in the watershed were selected to take measurements during dry and wet seasons from seasonal and perennial streams. Water samples were collected and tested for pH, iron, nitrite-nitrogen, ammonium, phosphate, and temperature. The six water measurement sites are illustrated in Figure 4. Generally, water quality in Lower Mahakali falls within accepted ranges for drinking, agriculture and irrigation. Ammonium and phosphate levels appear to be slightly elevated.

### Biodiversity and Habitat

Biodiversity and habitat speak to the overall environmental strength of an area to support a wide range of animal and plant species as well as human uses, such as fishing or agriculture.

### Land use and land cover

The majority of the land area in the Lower Mahakali watershed is dedicated to agriculture (109.81 km<sup>2</sup> or 35%) while broadleaf forests occupy nearly one-third (29% or 90.75 km<sup>2</sup>). Only 0.01 km<sup>2</sup> (100 hectares) of land is categorized as urban settlement. However, for the past decade, urbanization of the watershed has increased rapidly. Nearly 70% of the forested areas have been converted into agricultural land and non-point sources of freshwater pollution are increasing.

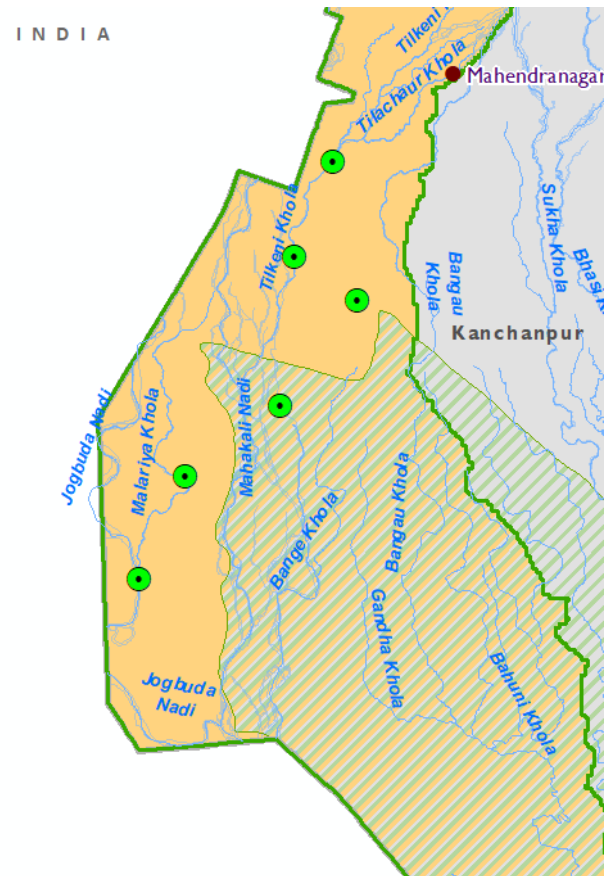
### Fish diversity

The watershed contains several lakes, rivers and oxbow lakes in the watershed area. Prominent wetlands of Shuklaphanta National Park include the Rani Taal (10 ha), Sikari Taal, Kalikitch Taal, and Tarapunal, among many others. None are presently identified as Ramsar site eligible for conservation support from UNESCO, although they have that potential.

In the watershed, 69 species of fish have been identified (Shrestha, 1990). A more recent study indicates that the Lower Mahakali is one of the most important watersheds in Nepal in terms of biodiversity because it supports several endemic fish species such as the catfish, *Pseudoecheineis serracula* (Rajbanshi, 2013).

### Wealth

Indicators in this category refer to the current economic conditions within the watershed as well as future prospects. In this section, we focus on the most prominent forms of industry and livelihood in the Lower Mahakali area.



**Figure 4: Water sampling points in the Lower Mahakali watershed**

### Infrastructure and extractives

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

### Large hydropower

The Tanakpur Hydroelectric Power Plant is located in the watershed. Built in 1992, this run-of-river dam produces peak power of 92MW. Because it diverts water to support its operation, the plant affects water quality and aquatic life in the area. Excess water from the plant is released at Nagla escape to the Jogbudha River and has been cited as a reason for flooding in the region.

### Capture fishery practices

Overfishing has become a problem in the Lower Mahakali watershed since it was opened to commercial fishing in the 1990s. As a result, traditional subsistence fishing communities, such as the Tharu and Sonaha, have been marginalized. Destructive fishing methods, often used by commercial firms and contract anglers, have decimated existing fish stocks.

Aggressive fishery practices affect not only fish, but also fish-eating birds that reside in the watershed. Some wetland bird species have shown precipitous declines over recent years, including the Brahminy Kite (*Haliastur indus*), Caspian Tern (*Sterna caspia*), Black-bellied Tern (*S. acuticauda*) and River Tern (*S. aurantia*) which is found true in the Lower Mahakali watershed.

### Irrigation and sustainable agriculture

Within the Tarai landscape of the watershed, fertile agricultural land has supported a multiple-cropping regime that includes paddy rice, upland rice, wheat, millet, lentils, peas and several other crops. A number of large-scale irrigation projects have been implemented in the area to support agricultural production, and recent agricultural diversification efforts by the Government of Nepal (GoN) promote commercialization.

### Gravel mining

Aggregate gravel mining and riverbed mining have become important sources of income in the watershed and more popular as changing river hydrology has exposed more rocks and boulders for harvesting, particularly in the dryer months. These practices, however, greatly impact aquatic biodiversity, largely because they influence additional changes in river hydrology.

It seems unlikely that this trend will change as the practice generates important revenue for local governments in Kanchanpur district. In 1991, the District Development Committee (DDC) Act opened up opportunities for district governments to pursue independent sources of revenue. Since then, sand and gravel mining has risen sharply. Of the money earned, 35% goes back to VDCs and local municipalities for

development work. Furthermore, mining has become an important source of livelihood for many people in the area.

Contracts for riverbed mining on the Mahakali River are awarded by the DDC to private companies each year. A local newspaper (*Jaya Jaganath Nirman Sewa*) reports that NR 30 million in contracts have been offered in the current fiscal year, indicating that substantial quantities of sand, gravel and rock are being extracted from the watershed.

### Roads

The Lower Mahakali watershed contains approximately 51 km of district roads and 20 km of strategic roads. The East-West Highway, which runs through the watershed for 44 km between Mohana Bridge and Gadda Chauki, is mostly blacktop, though some gravel and earthen portions remain. There are few rural roads within this watershed, and these have little impact on water quality and aquatic biodiversity.

### Irrigation

Irrigation plays a large role in the economy of the Lower Mahakali, as 55% of households use irrigation canals that draw from the river. In focus groups, many participants who did use irrigation cited frequent problems with the canals due to sedimentation and poor maintenance. Thirty-five percent harvest rainwater, while another 23% use groundwater.

How increased sedimentation from river flows affect the major irrigation systems in the Lower Mahakali merits closer analysis. Wards 11-13 of Bhimdutta municipality, which lie in flood-prone areas, ironically do not receive much irrigation water. The canal that runs to this area canal is 6 km long and comes from Banskhedra. Water reaches only half the households in Ward 12 due to having only a small hume pipe for irrigation to a large number of users. This situation has bred conflict between upstream and downstream users of the canal.

Winter wheat is cultivated In the Lower Mahakali but since irrigation water is unavailable, it is difficult to obtain decent production levels.

### Climate resilience and disaster risk reduction

Increased gravel mining and rising temperatures that accelerate glacial melt in the Himalaya have increased and intensified disaster hazards in the Lower Mahakali. Gravel mining strips away natural buffers that regulate water flow, while melting glaciers increase the water volume in the river. These factors are compounded by excess flows that are released at Nagla escape near the Tanakpur Hydroelectric Plant. As a result, flooding has become a more frequent and more forceful occurrence in the watershed.

Floods in the Lower Mahakali also disrupt fishing communities, threaten important pedestrian bridges, and erode valuable farm and residential land.

Interviews in the area showed local concerns that revenue from gravel mining was not being re-invested in river protection. Rather, it was expressed, these profits were being channeled toward road construction and other infrastructure projects that were not concerned with water and river health.

### Early warning systems

Given the increased risk for flooding in the Lower Mahakali, early warning systems have become increasingly important, particularly for people living in Dodhara (at Kutiakhabar, Shanti Tole, Muskure Tappu, Sundarnagar and Giri Tole) and Chandani (at Purnagiri Tole, Shrestha Tole, and Jamunaghari).

To address this problem, early warning systems have been installed at some locations in the watershed, the first in 2008 by a local NGO. This system was coordinated with media to disseminate information quickly and efficiently, however, the results have not been so effective. A second early warning system was established in Darchula upstream, which relied on police to inform lowlands by mobile phone about impending flood waters. Upon receiving this information, several boatmen would begin transporting people and goods to safer ground. In some areas of the watershed, siren systems are being tested.

### Power

Indicators in this section refer to the strength and accessibility of governance institutions in the watershed, as well as the level of inclusiveness across gender, caste, and ethnicity in decision-making processes.

#### Governance challenges in the Lower Mahakali

That the Lower Mahakali is a transboundary watershed between India and Nepal creates the most significant challenges, in terms of understanding and agreeing on management issues, and in coordinating institutions, roles and responsibilities to address the key issues.

Within Nepal, governance presents a mixed picture. The watershed is managed through a bifurcated administrative arrangement (between Bhimdutta and Suklaphanta), whereas the area within the National Park is under management by the Ministry of Forests and Soil Conservation with its own hierarchical structure, although allowing for local participation. 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, local organizations (e.g., community forest user groups) expand their mandate to include fisheries, biodiversity concerns, and lake and pond management. Natural resource management in this area shows there has been some effective local-level management of key resources even in the absence of an adequate district-level government system and associated budgets. Nonetheless, the capacities and resources of these local governance systems are limited. A landscape level planning platform has not emerged that could bring different local user groups together, strengthen their coordination with local governments and Suklaphanta NP, and enable an integrated planning perspective to consider the larger dynamics, such as upstream-downstream linkages and protecting ecosystem services. With regard to the latter, certain regulatory regimes—such as for mining and fisheries—have not followed existing laws on sustainable fisheries and, in fact, may have contributed to damaging fisheries and aquatic ecology.




It appears that significant differences may also exist in people's knowledge of and involvement in local committees. Household surveys, for example, indicate that 75 % of Brahmin Chhetris were aware of local committees, and 71% were involved in or affiliated with local groups. In contrast, only 50% of Dalits were aware and just 42% were involved local groups.

### Watershed health assessment – Summary

The health indicators presented in this section take into account factors related to biophysical health, infrastructure, socio-economics and governance within the watershed. Each of these indicators was















assessed through consultation with stakeholders in the Lower Mahakali and assigned a score between 0-5 points.










Color Symbol	Description	Treatment measures
[4-5 points] 	Good health condition, no additional treatment required	Intervention required to keep condition intact
[2-4 points] 	Fair condition, functioning at risk, be alert to maintain and improve condition of the watershed	Promotion of good practices needed to improve health condition; special attention if not additional treatment may be necessary.
[<2 points] 	Poor condition, impaired functioning, decreased quality and quantity of ecosystem services in the watershed	Special measures must be adopted to restore watershed health conditions and ecosystem services









We are concerned with assessment *and* monitoring, and employ the following rating system.




Based on the designated indicators for assessment, we rate the health status of the Lower Mahakali watershed as ***moderately good*** (Table 1).

THEME	Watershed Health Indicators	Watershed Condition	Elaboration of rationale
WATER 	Water availability		<ul style="list-style-type: none"> <li>- 76 % of respondents reported that water sources have been drying up, and 94% experience difficulties due to the drying of water sources.</li> <li>- Increasing population will increase demand</li> </ul>
	Water accessibility for community and agriculture		<ul style="list-style-type: none"> <li>- Nearly 5% of households spend more than 30 minutes fetching water</li> </ul>
	Water quality for drinking, irrigation, and energy generation		<ul style="list-style-type: none"> <li>- Water samples tested for pH, iron, nitrite-nitrogen, ammonium, phosphate, and temperature and found at normal range</li> <li>- One third of the respondents perceived the quality of their drinking water as "bad".</li> </ul>

<p><b>BIODIVERSITY &amp; HABITAT</b></p> 	Household sanitation		<ul style="list-style-type: none"> <li>- Improper management of non-point source pollution and household waste</li> <li>- Recently, Kanchanpur is declared as open defecation free district.</li> <li>- 97% of households have a toilet</li> </ul>
	Solid waste disposal		<ul style="list-style-type: none"> <li>- Non-point source pollution and high use of chemical fertilizers and pesticides. Overall, 92 % of households use chemical fertilizers.</li> <li>- Unsustainable gravel, rapid urbanization, and mining cause environmental deterioration</li> </ul>
	Land use and land cover		<ul style="list-style-type: none"> <li>- The majority of land in the watershed consists of the following: agriculture (35%), forests (29%), shrubs and bushes (24%), rivers and streams (12%).</li> <li>- Forest cover has been changing due to rapid urbanization and increasing gravel mining</li> </ul>
	Species diversity [fresh water]		<ul style="list-style-type: none"> <li>- Sixty-nine species of fish have been identified.</li> <li>- Several endemic fish species supported in this watershed</li> <li>- Some rare migratory fish have been affected by changes in water velocity, water levels and development</li> <li>- 96% said that native fish populations had decreased</li> </ul>
	Invasive species [aquatic]		<ul style="list-style-type: none"> <li>- No serious observation of invasive species (aquatic and terrestrial).</li> </ul>
	Fishing practices		<ul style="list-style-type: none"> <li>- Increased use of gill nets, explosion and poison for fishing</li> <li>- The productivity of migratory fish species in the Tanakpur dam area has been affected to the point of serious decline and/or even disappearance.</li> </ul>
	<b>SUSTAINABLE AGRICULTURE</b>	Climate and physiography	

			<ul style="list-style-type: none"> <li>- Average annual temperature is rising at a rate of 0.02 °C/year to 0.06 °C per year.</li> </ul>
	Soil management [conservation, fertility]		<ul style="list-style-type: none"> <li>- Wide scale adoption of modern tools and technologies, including seeds, fertilizer and irrigation</li> <li>- Of those involved in agriculture, 96% reported that soil fertility has decreased in the past 5 to 10 years.</li> </ul>
	Agriculture productivity [data]		<ul style="list-style-type: none"> <li>- Higher productivity reported throughout the watershed</li> </ul>
	Sustainability of irrigation		<ul style="list-style-type: none"> <li>- Water sources are drying and water is limited during winter</li> <li>- Less than half (48%) of households surveyed had permanent irrigation, while 52 % had seasonal.</li> <li>- Transboundary treaties limit the amount of water available to Nepal</li> </ul>
<b>SUSTAINABLE INFRASTRUCTURE &amp; MINING</b> [environmentally-friendly framework]  	Sustainability of hydropower		<ul style="list-style-type: none"> <li>- Tanakpur Hydroelectric Power Plant and two associated barrages are changing environmental flows downstream</li> </ul>
	Sustainability of gravel mining and construction materials		<ul style="list-style-type: none"> <li>- Unsustainable gravel mining in process along the Mahakali River</li> <li>- Gravel mining industry is drawing more population, placing more demands on the watershed</li> </ul>
	Sustainability of rural roads		<ul style="list-style-type: none"> <li>- Most roads are paved or graveled, and have been constructed according to government plan</li> <li>- Unplanned construction of roads is minimal</li> </ul>
<b>CLIMATE RESILIENCE AND DISASTER RISK REDUCTION</b>	Climate induced threats – intensity and severity [floods and landslides]		<ul style="list-style-type: none"> <li>- Rapid urbanization, high in-migration from hill areas, road construction, and encroachment on public land have accelerated and intensified flooding and landslides</li> </ul>

	<p>Community response, measures to adapt to climate change impacts</p>		<ul style="list-style-type: none"> <li>- Early warning systems have been set up in some locations.</li> <li>- Only 18% respondents are aware of existing early warning system. Among them, 81% feel they have equal access to the system.</li> </ul>
	<p>Community access to early warning systems</p>		<ul style="list-style-type: none"> <li>- A network has been formed to connect early warning information with the media and local armed services</li> </ul>
<p><b>GOVERNANCE AND EQUALITY</b></p> 	<p>Inclusive participation in local planning; Women, marginalized castes and ethnic groups hold key positions in Natural Resource Management (NRM) groups</p>		<ul style="list-style-type: none"> <li>- Less than 1% of the women and marginalized persons are holding decision-making positions within user groups.</li> <li>- Poor, marginalized, and rural groups have limited access to and lack influence in decision making processes</li> </ul>
	<p>Persistence of active NRM groups [Biodiversity, disaster, climate change, water, agriculture, forest, irrigation, farmers]</p>		<ul style="list-style-type: none"> <li>- Forest user groups and irrigation groups are active in conservation activities</li> <li>- Many community members are engaged but occasionally unaware of the group's role and effectiveness in terms of facilities and subsidies</li> </ul>
	<p>People comply with laws and policy provisions, including local norms and standards</p>		<ul style="list-style-type: none"> <li>- Some compliance with laws and policy provisions, including local norms and standards</li> <li>- High awareness among community members of laws and regulations</li> </ul>
	<p>Mechanism placed to resolve outstanding issues, benefit sharing, sand mining, irrigation, hydropower</p>		<ul style="list-style-type: none"> <li>- In most cases, the community is able to resolve outstanding issues around benefit sharing and other topics</li> <li>- Poor, marginalized and rural people have limited access to and influence in decision making processes</li> </ul>

	Equitable access and benefit sharing arising from use of Natural resources (ecosystems services and products)		<ul style="list-style-type: none"> <li>- Poor, marginalized and rural people have limited access and influence in decision-making process.</li> <li>- In most cases, the community is able to resolve outstanding issues around benefit sharing and other topics</li> </ul>
	Coordination between the rural municipalities, municipalities, provinces and line agencies		<ul style="list-style-type: none"> <li>- Low coordination between districts and provinces for improved watershed management</li> <li>- High awareness among community members regarding roles, responsibilities, and local services</li> </ul>
	Adoption of climate-smart, environment and watershed management friendly practices [across all thematic areas]		<ul style="list-style-type: none"> <li>- Some local adoption of adaptation measures, based on knowledge and experience</li> <li>- Some conservation of lakes, ponds, and maintenance of irrigation channels, bio-engineering structures, and plantations in ravine and gully sides</li> </ul>

**Table I: Summary of watershed health indicators for the Lower Mahakali**

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