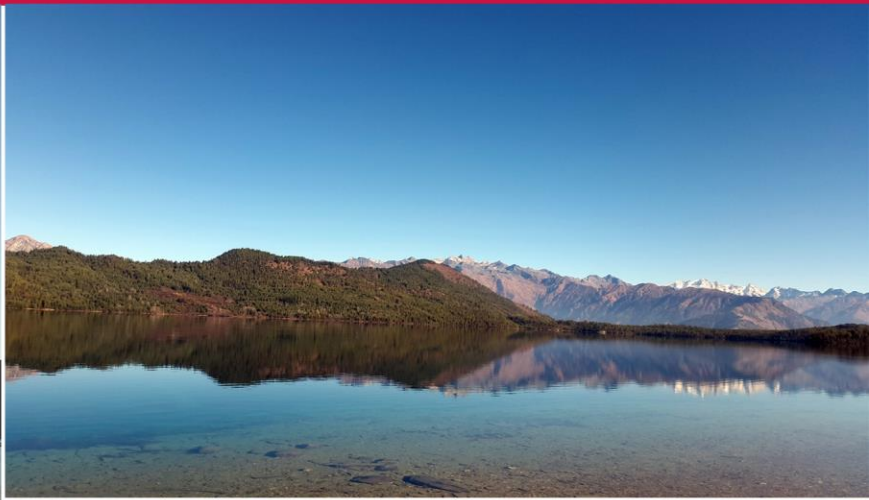


RARA KHATYAD WATERSHED HEALTH REPORT



Vision Statement: “Well-managed lake, conserved biodiversity as foundation of ecotourism, Ensured inclusion and equity in prosperous Rara-Khatyad Watershed”



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What is a watershed?

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

A watershed should be understood in its entirety – upstream and downstream – rather than by looking only at one element of the watershed. Water flows connect various aspects of a watershed, and what happens upstream has an impact on what happens downstream. For example, landslides and soil erosion upstream can increase sedimentation for downstream residents. Similarly, water diversions upstream for irrigation reduce water available downstream for people and aquatic species.

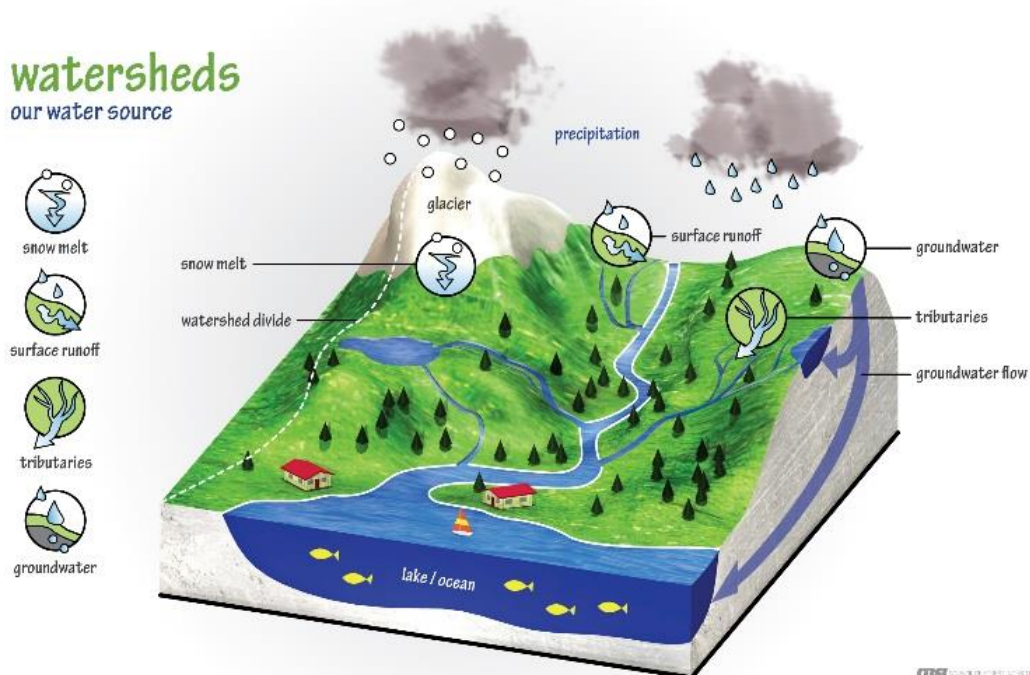


Figure 1: Diagram of a typical watershed

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 Rara Khatyad 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 Rara Khatyad Watershed has also been prepared.

Watershed	Rara Khatyad
River basin	Karnali
Province	Sudurpaschim (No. 6)
Total watershed area	308 km ²
Physiographic zone	High mountain (100%)
No. of streams	25
Major rivers	Khatyad, Missichaur, Kawa, Thado, Bihani, Nakharji, Kahka, Nauli, Buichana, Dudhe and Lyachudi
Lakes and wetlands	Rara Lake, Bagad Jiula, Khesma, Chhote, Gamtha, Nilasain Daha, Mani Daha, Mauli Daha, Rig Daha
Land use	Forest (49.2%), grazing (25%), agriculture (20.3%), barren land (3%), water bodies (2.5%)
Total drainage length	963 km
Drainage density	647 km ³
Municipalities	Soru GP, Khatyad GP, and Chhayanath Rara NP
Population	16,919 (49.5% female; 50.5% male)
Population density	55 person/km ²

The Rara Khatyad Watershed (Figure 2) falls within the Karnali River Basin and includes parts of the Mugu district in western Nepal. This watershed stretches over 308 km² with a population of 16,919 and population density of 55 people per km². All of the watershed is categorized topographically as high mountain. Under the new federal system of governance, the watershed will be administered primarily by Khatyad Rural Municipality, or *gaunpalika* (GP), in the west, which covers 87% of the watershed, and Chhayanath Rara Municipality, or *nagarpalika* (NP), in the east (12%). A tiny portion of the watershed (1%) overlaps into Soru GP to the north. Rara Lake and Rara National Park, two popular tourist destinations and important biodiversity areas, are located in the eastern half. Rara Lake is entirely contained within Chhayanath Rara GP, while approximately 50% of the national park lies in the same unit.

The main waterway, Khatyad Khola, originates in Rara Lake and is nourished by several tributaries that are both snow and rain fed. While many households depend on the river for irrigation and other daily water needs, flow in recent years has been negatively affected by deforestation, road construction, climate change, intensive agriculture, and steep slope cultivation. Each of these factors has increased the likelihood and incidence of landslides in the watershed, exacerbated increasingly by intense rainfall and prolonged periods of no rain that impact communities and aquatic habitats.

Rara Lake is of special importance to the watershed, not only for the resources it provides to the surrounding communities, but also for its biodiversity and recreation potential. The lake and its tributaries provide a wide range of fish that are crucial to local diets and attractive to sport fishing groups – although fishing is currently banned in the lake and only permitted on rivers. Rara Lake also contains numerous species of plankton and algae that serve as the foundation for aquatic life in this area.

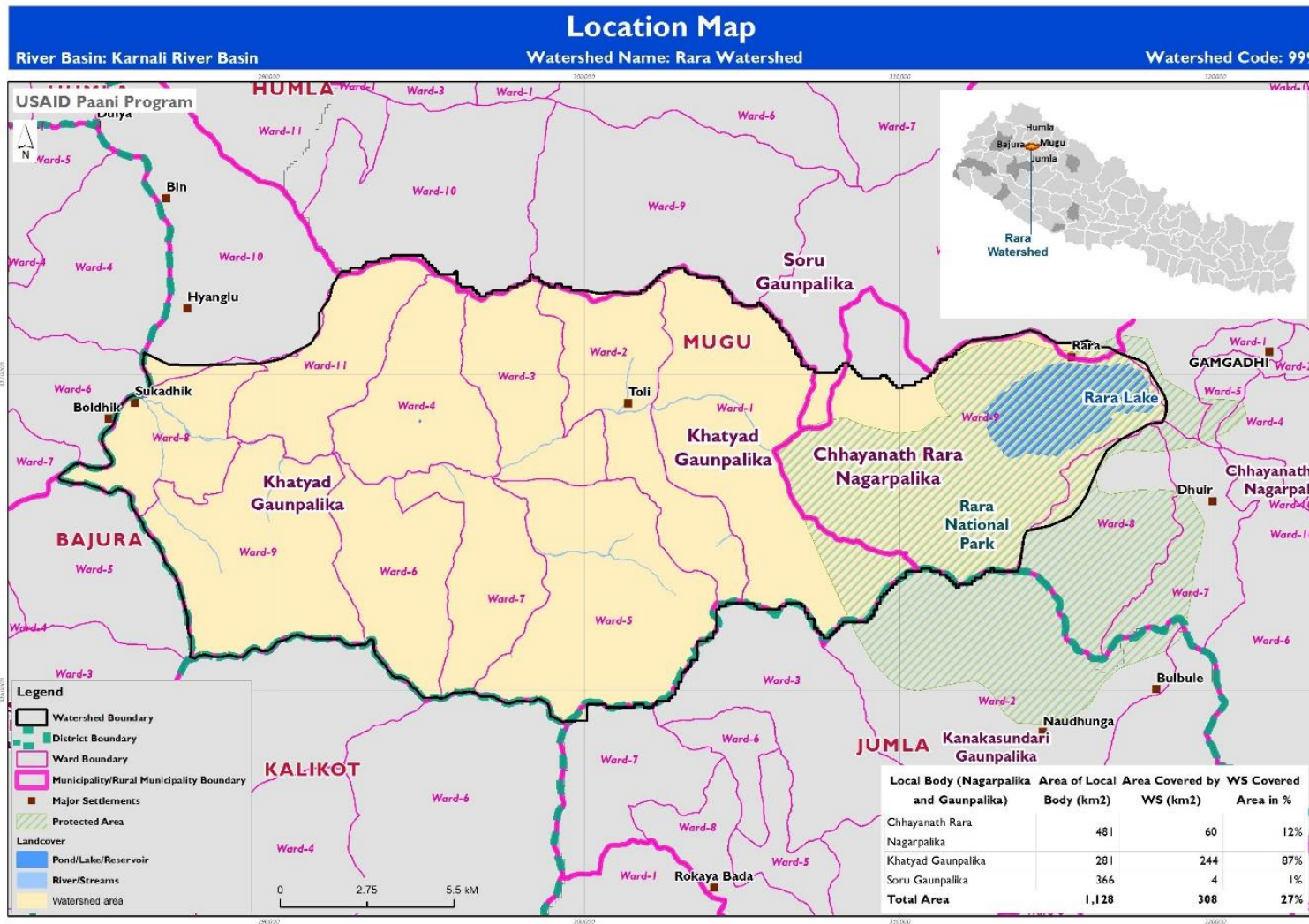


Figure 2: Map of the Rara Khatyad Watershed with administrative units

Nature

This section examines the environmental and natural resource dimensions of the watershed, including climate and weather, hydrology, biodiversity, and land use within the Rara Khatyad Watershed, paying special note to trends and changes that may threaten the health and sustainability of these assets.

Water

The condition of water resources within a watershed depends on a large number of factors that affect the water cycle. In the Rara Khatyad Watershed, these include rainfall, infiltration, and withdrawals for irrigation, among other factors.

Rainfall

Rainfall estimates and projections were made using data collected from a station in Rara (the only station in the watershed) and a second station in Thirpu, located 17 km from the southern boundary in Mugu district.

The Thiessen polygon method was used to estimate the average rainfall in the Rara Khatyad Watershed. The highest and lowest monthly rainfall amounts are observed in August and November, respectively, and the seasonal averages are as follows:

Winter (Dec-Feb): 100 mm
 Pre-monsoon (Mar-May): 158 mm
 Monsoon (Jun-Sep): 462 mm
 Post-monsoon (Oct-Nov) 34 mm

The average annual rainfall for the watershed is estimated at 755 mm.

Water availability

Household surveys (n= 633) found that 1.7% of households have water on the premises, while 88.5% require less than 30 minutes to obtain sufficient daily water. The remainder of households (9.8%) require more than 30 minutes per day. Disaggregating households by caste/ethnicity, we find that 16.7% of Janajati, 15.4% of BCTS, and 8.1% of Dalit families require more than 30 minutes per day.

96.5%

HHs perceive that water availability has declined over the past decade.

88.5%

Households need < 30 minutes to obtain sufficient water for daily needs.

Water accessibility

On the question of access, 96.3% of households reported having equal access to public water resources in the watershed. When disaggregating these numbers by caste/ethnicity, we find that 3.7% of Janajati households claimed unequal access to water, compared to 6.0% of Dalit families, and 3.1% of BCTS

families. The reasons given for unequal access included caste-based discrimination, long distances to water collection points, and rising water scarcity in certain areas of the watershed.

Water quality

Water quality tests were taken in several locations using an Akvo Caddisfly kit. Water quality in the watershed was determined by testing a range of parameters, including pH, nitrate nitrogen and nitrite nitrogen, ammonium, and phosphate. Dissolved oxygen was found to be low near the Rara Lake exit, which may be due to the high nutrition load in that area, but within acceptable ranges in other locations. Favorable dissolved oxygen levels were reported in all areas, which is crucial to fish survival. High ammonia levels were detected at Kawa Khola and Putta Khola, while high pH values were found at Putta Khola alone.

45.8%

Households perceive the quality of water they drink is good

Land use and Land cover

Located in a “high mountain” zone, the land cover of Rara Khatyad is largely alpine: 49.2% of its land cover is forest, dominated by hardwoods and conifers. Twenty-five percent of the watershed is used for grazing livestock, while 20.3% is cultivated for crops. Lakes, rivers, ponds, and barren land account for the remaining area (Figure 3).

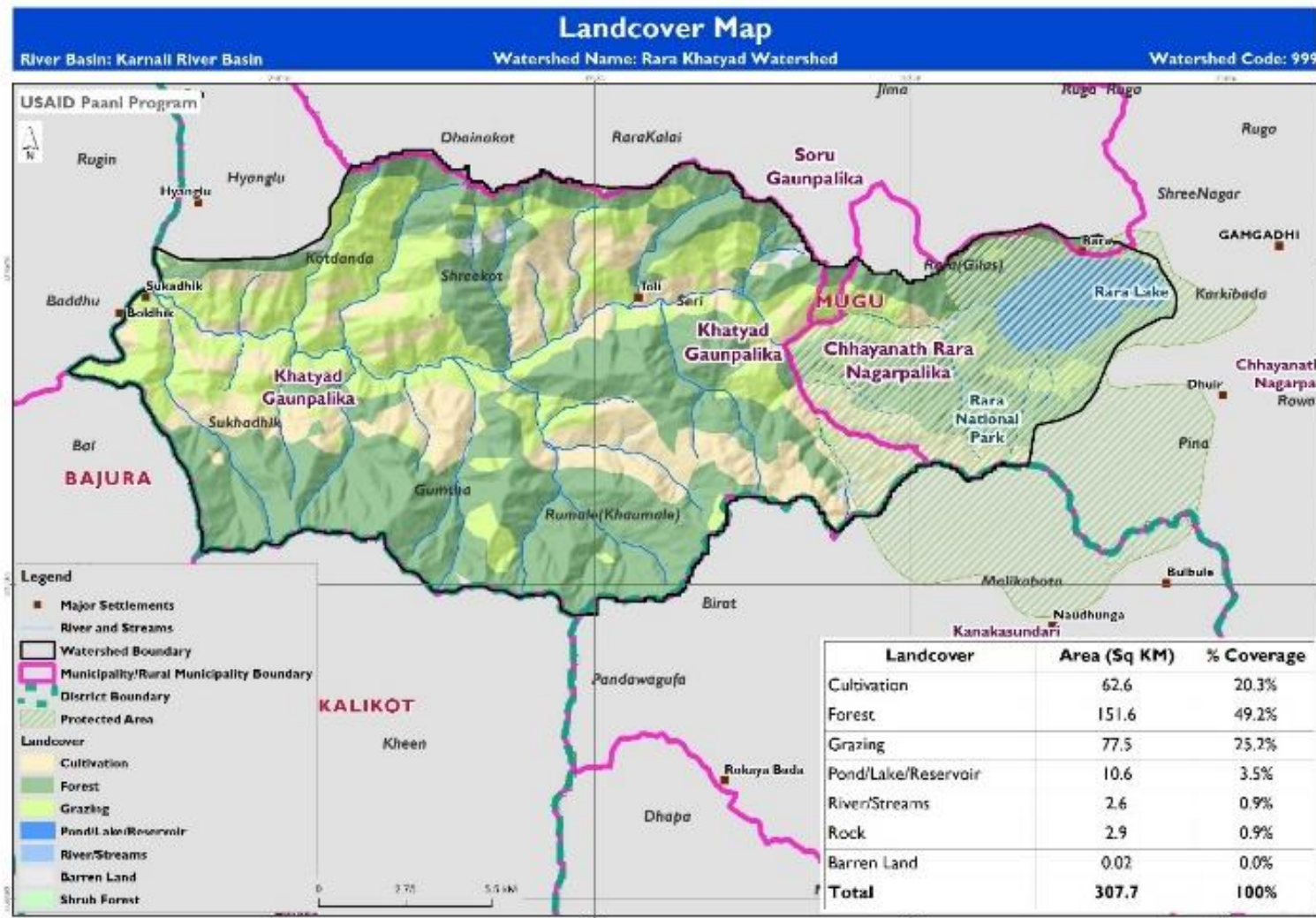


Figure 3: Land cover in the Rara Khatyad Watershed

Looking more closely at forest types, GIS mapping finds that 68% of the trees found are mixed hardwood, followed by Banjoh oak (19.2%), pine (7.4%), and fir (2.7%). The remaining dominant species include sal, cedar, and sisau.

From 2000-2016, forest cover has declined. According to data from Global Forest Watch, the watershed lost 33 hectares of forest (or 4.2%), while no forest gain has been recorded. The forest loss appears concentrated around Rara Lake, raising concerns about preserving this important buffer zone.

Biodiversity and invasive species

Rara Lake holds special significance in terms of biodiversity for three endemic fish species and one endemic frog that originated here: snow trout (*Schizothorax nepalensis*), snow trout (*Schizothorax macrophthalmus*), Rara snow trout (*Schizothorax raraensis*), and Rara Lake frog (*Paa rarica*).

The floral diversity of the watershed is considerable: 170 species are found in Rara National Park alone. Among the better known species are the rhododendron (*Rhododendron arboretum*), brown oak, and several species of pine: blue pine (*Pinus excelsa*), West Himalayan spruce (*Picea smithiana*), black juniper (*Juniperus indica*), and Himalayan cypress (*Cupressus torulosa*). Numerous medicinal herbs also grow in the area, many of which local residents harvest for sale and personal use.

As noted above, three species of fish and one frog are endemic to the watershed. However, local residents rely on a large variety of species for sale and household consumption. Through focus group discussions (FGDs) and key informant interviews (KIIs), Paani found seven species of fish in Rara Lake, and 23 species in the watershed. The snow trout (Nepali name: Asala) remains the most important and plentiful fish, but its numbers are declining, according to local residents. The snow trout migrates to the area between March - April and breeds there from May - July. Regarding invasive species, Eurasian watermilfoil (*Myriophyllum spicatum*) can be found in Rara Khatyad; however, this species is not considered invasive in Nepal.

63.7%

of respondents say native fish populations have decreased

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 Rara Khatyad Watershed.

Fishing

No households rely on fishing as a primary livelihood source because fishing in Rara Lake and the surrounding vicinity is prohibited. Along the further reaches of the Khatyad Khola, some households practice traditional methods to harvest fish for personal consumption or sale in local markets. Of the 633 households surveyed, 378 (59.7%) said they fished at some point during the year. Among the traditional fishing methods observed in the watershed were casting nets, dip nets, gradient traps, and loop lines. Three percent of the households that fished admitted to using electric current, which is forbidden by law.

Sustainable agriculture

Cropping practices in the Rara Khatyad Watershed are largely determined by altitude, climate, and the availability of irrigation. Farmers use traditional methods and the observed use of modern inputs such as fertilizers and improved crop varieties was only nominal.

All the major crops (i.e., rice, wheat, millet, barley, and potato) can be grown in the watershed, while a large variety of lesser crops are grown for sale and to round out local diets, such as: oats, maize, mustard, cabbage, radish, cucumber, and cauliflower. In a few select areas, apples, apricots, and walnuts are grown.

The collected holdings of agricultural land in the watershed is 6,500 ha, which amounts to an average land holding of 0.85 ha per household—quite low on a national scale. Of the 6,500 ha, only 663 ha (10.2%) are irrigated; the rest is rain-fed.

Farmers may utilize technical support through an agricultural service center in Shreekot. Occasionally, the center will distribute seeds and conduct soil tests for pests and disease. There is no market center for agricultural products yet developed, so most sales occur through local markets.

Infrastructure and extractives

The design and construction of infrastructure, such as roads and hydropower plants, have an impact on the health of the watershed if appropriate preventive, mitigated and control measures are not adopted on time. For example, poorly designed rural roads on steep slopes can increase soil erosion and landslides. Similarly, hydropower plants that divert or impound water will restrict the amount of water available for aquatic life that people depend on for their livelihoods. Irrigation canals, while bringing benefits to one group of farmers, can also reduce the amount of water available to other farmers. As demonstrated by these examples, it is important that the design, construction, and operation of infrastructure projects account for the full range of social, economic, and environmental impacts within the watershed. Sustainable infrastructure should provide equitable distribution of benefits with minimal long-term, environmental impacts.

Hydropower

There are eight micro-hydropower plants in the Rara Khatyad Watershed area, but two are currently inoperative due to unresolved mechanical issues and one is under construction. Of the five still in operation, they collectively generate 160 kW of electricity.

The Birbagar project, currently under construction, has drawn support from the Asian Development Bank (ADB) through collaboration with Nepal's Alternative Energy Promotion Center (AEPC). Environmental impact assessments (EIAs) of this project indicate that aquatic life will be affected along a 1 km stretch above and below the dam.

These projects have inspired some conflict between operators and local residents regarding water use. At the Bihani Khola project in Gamtha, residents complained that the project unnecessarily lowered the amount of water available for irrigation. Since the conflict could not be resolved, the project ceased operation soon afterward.

Mining

The development focus on irrigation, hydropower, and road construction in the Rara Khatyad Watershed has meant a corresponding rise in mining from riverbeds. Sand and stone are extracted for construction purposes, while silicon, shilajeet (pitch), and limestone are taken for commercial sale. However, according to interviews with government officials and local leaders, extraction levels are presently deemed sustainable.

Roads

There are no strategic or national roads in the watershed, but 169 km of rural roads have been constructed by local GPs and NPs, in addition to 92 km of foot trails. Many of these rural roads were constructed between 2010-2012 through a World Food Programme (WFP) initiative.

Unfortunately, many of these roads were reportedly developed without proper environmental assessments prior to construction, and have thus increased the likelihood and occurrence of landslides in the watershed. Use of environmental assessments has increased in recent years, and Gabion boxes were observed in many places to stabilize areas of weak road.

Leaders from Chhyanath Rara NP expressed plans for developing rural roads that will traverse parts of Rara National Park, which raised concerns from park officials who voiced apprehension about proper environmental assessments. Landslides not only damage property, but also degrade aquatic habitats in the rivers below.

Informants in Gamtha reported that road construction in this area tends to disproportionately affect marginalized groups, who often live in areas that are vulnerable to landslides.

Irrigation

The high elevation of the Rara Khatyad Watershed means that irrigation is especially needed for agricultural and household water use. There are 68 irrigation schemes in the watershed, serving 7,390 households and providing water to 1,382 hectares of land. All of these schemes follow a customary system of management wherein all households contribute labor to maintain the system, or pay a tax if they are unable to provide that labor.

In Seri, the community elects a person (*Nayak*) who manages the system to facilitate equitable flow to all households within that scheme. The *Nayak* (known as *Baidar*, in Jamma) also resolves local conflicts over water access, either finding a workable solution or taking the case up to the government-level for more formal resolution or compensation, as the case may dictate.

The District Irrigation Office supports the community by providing technical support and construction materials, and by supporting repair and rehabilitation work as needed.

Water for the irrigation system is almost evenly divided between the river (50.4%) and rainfall (45.8%). Only 2.1% use harvest rainwater for irrigation.

Climate resilience and disaster risk reduction

Given its high elevation and sharp topography, the area around the Rara Khatyad Watershed is vulnerable to the effects of climate change, particularly in regard to its disposition toward natural hazard events like floods and landslides.

Local response to climate change has been slow in the Rara Khatyad Watershed and few climate-resilient activities have been observed. One Village Development Committee (VDC), Sukhdhik, has implemented a Local Adaptation Plan of Action (LAPA). This LAPA reveals several climate change-related issues that need to be addressed, including natural hazards, forest degradation, agricultural productivity, and information gaps on available technology.

There is no early warning system (EWS) operating in the Rara Khatyad Watershed. Local households rely on FM radio for disaster-related information.

Power

In this section of the report, we detail and analyze the social, institutional, and regulatory structures through which water resources management, aquatic biodiversity management, and adaptation to climate change are planned and operationalized within the Rara Khatyad Watershed. 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.

Local institutions and inclusiveness

User groups for community forestry and water and sanitation provide an important forum for local stakeholders to share responsibility for and benefits accrued from natural resources in the Rara Khatyad Watershed.

As such, natural resource management (NRM) groups have voiced concerns echoed throughout this report: unsustainable road construction, increasing pollution and unmanaged solid waste, and increasing impacts of climate change.

Household participation in NRM groups is impressively high: 91.5% claim affiliation with at least one group. Disaggregating membership by caste/ethnicity, surveys find that 100% of Janajati households, 93.4% of BCTS, and 82.2% of Dalits belong to an NRM group.

National guidelines require that 33% of members in a user group be either female or from a socially marginalized group. All user groups in the watershed currently exceed this standard. However, only 17.5% of leadership positions in these groups were found to be female, when national mandates stipulate a 33% minimum.

To address these issues of women in leadership, Khatyad GP is requiring public construction committees to have 40% female membership, and will provide a 5% public construction waiver to those committees that are comprised of all women. Ideally, initiatives like these will become more common, and long-standing inequities of gender discrimination can be confronted and overcome.

Policies, frameworks and regulations

The Constitution of Nepal 2015 guarantees the right of every person to live in a clean and healthy environment. Accordingly, the national government has ratified numerous policy provisions and programs for conserving natural resources and promoting environmental management. A few examples of these policies include the National Park and Wildlife Conservation Act - 2029 (1973); the Soil Conservation and Watershed Management Act – 2039 (1983); the Forest Act – 2049 (1993); and the Environmental Protection Act – 2053 (1997).

The Local Government Operation Act 2017 (LGOA) provides municipalities and rural municipalities with powers, functions, and duties to formulate, implement, and regulate local policies. LGOA also authorizes local governments to develop plans related to local-level disaster preparedness and response planning, EWS, and distribution and coordination of relief materials. Observations and focus group discussions revealed that all NP and GP authorities have been executing these powers related to disaster management; however, local civil society organizations say that not enough energy has been devoted to conservation.

While there are national laws and policies that require proper environmental assessment prior to mining and construction, local residents reported that compliance with these provisions was generally low in the watershed. When asked why compliance was low, respondents said that low literacy among the population and general lack of knowledge regarding policy specifics were responsible.

Surveys and KIIs indicated that much of the non-compliance seen in the Rara Khatyad Watershed was owed not to disregard for policy, but rather, general lack of knowledge and awareness. For example, the Aquatic Animal Protection Act forbids certain forms of fishing, such as electric current. However, when questioning fishermen about using electric currents, Paani found that none knew they were in violation of the law. However, in some cases, there were individuals who knowingly violated the law, in particular, fishing in protected areas of Rara National Park and poaching animals from this area.



Similarly, non-compliance with solid waste regulations has resulted from a lack of approved or reliable system for proper disposal. Members of the buffer zone management committees said they were unable to provide proper monitoring and enforcement of existing solid waste policy.


Regarding wetland management and protection, the nine wetlands of the watershed were declared a RAMSAR site, which requires local governments to implement measures to promote conservation. However, local leaders in Khatyad GP and Chhyanath NP admitted they had been unable to fulfill these obligations due to a lack of resources and capacity. This suggests that international mandates, such as RAMSAR, though well-intentioned, draw their actual strength from the host country’s ability to support them.

Watershed health assessment – Summary

The list of health indicators presented in this section takes into account factors related to biophysical health, infrastructure, socio-economic and governance within the watershed. Each of these indicators was assessed through consultation with stakeholders in the Rara Khatyad Watershed and assigned a score between 0-5 points.









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













Color Symbol	Description	Treatment measures
<p>[4-5 points]</p> 	Good health condition, no additional treatment required	Intervention required to keep condition intact
<p>[2-4 points]</p> 	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.










<p>[<2 points]</p> 	<p>Poor condition, impaired functioning, decreased quality and quantity of ecosystem services in the watershed</p>	<p>Special measures must be adopted to restore watershed health conditions and ecosystem services</p>
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Based on the designated indicators for assessment, we rate the health status of the Rara Khatyad Watershed as **fair** (Table 1). Water quality, no invasive species, and active NRM groups are among the most positive factors impacting watershed health. Hydropower, solid waste management, and destructive fishing practices pose the most serious and immediate challenges to residents in the area. Declining water availability, agricultural productivity and intensifying gravel mining are areas that need more attention in the future.

Table 1: Summary of health indicators for the Rara Khatyad Watershed

Theme	Watershed health indicators	Rating	Rationale for rating
<p>WATER</p> 	<p>Water availability</p>		<ul style="list-style-type: none"> • Households have more difficulty obtaining sufficient water compared to a decade ago • Concerns about drying springs and other sources.
	<p>Water accessibility for community, agriculture</p>		<ul style="list-style-type: none"> • Limited water in summer for irrigation • Nearly 89% of households spend less than 30 minutes per day obtaining water
	<p>Water quality for drinking, irrigation, and energy generation</p>		<ul style="list-style-type: none"> • Water is safe for consumption and irrigation • Future concerns about non-point source pollution and road construction affecting water quality
<p>BIODIVERSITY & HABITAT</p> 	<p>Household sanitation</p>		<ul style="list-style-type: none"> • Mugu recently declared open-defecation free • Nearly 90% of households have own toilet • Rising mis-management of non-point source pollution and household waste reported
	<p>Solid waste disposal</p>		<ul style="list-style-type: none"> • Watershed lacks infrastructure to enable proper waste disposal • Lack of awareness among population on need for proper solid waste management
	<p>Land use and land cover</p>		<ul style="list-style-type: none"> • Nearly half the land is covered by forests and one-fourth is cultivated • Forest cover in slow decline due to urbanization at market centers and population growth

	Species diversity [fresh water]		<ul style="list-style-type: none"> Rivers in the watershed support several endemic species and 23 species of fish overall 65% of population say native fish populations are decreasing
	Invasive species [aquatic]		<ul style="list-style-type: none"> No invasive species reported nor observed
	Fishing practices		<ul style="list-style-type: none"> Increasing use of destructive fishing practices such as gill nets and electric current 65% of population say native fish populations are decreasing
SUSTAINABLE AGRICULTURE 	Climate and physiography		<ul style="list-style-type: none"> Average temperature rates are rising between 0.02 and 0.04 °C/year
	Soil management [conservation, fertility]		<ul style="list-style-type: none"> Nearly 86% of respondents said soil fertility had declined over the past decade
	Agriculture productivity [data]		<ul style="list-style-type: none"> 89% of households said agricultural productivity had declined over the past 10 years
SUSTAINABLE INFRASTRUCTURE & MINING 	Sustainability of hydropower		<ul style="list-style-type: none"> No major hydropower plants in the watershed, but a number of microhydro schemes have caused conflict about water use and access Several micro plants are non-operating due to lack of maintenance
	Sustainability of gravel mining and construction materials		<ul style="list-style-type: none"> Rising infrastructure development is intensifying the demand for materials Limited monitoring of existing mining sites
	Sustainability of rural roads		<ul style="list-style-type: none"> Most road construction does not follow established environmental protocols; the effects of construction impact aquatic habitats and raise the likelihood for landslides Poor and Dalit families are disproportionately affected by the construction
CLIMATE RESILIENCE AND DISASTER	Sustainability of irrigation		<ul style="list-style-type: none"> Drying water sources reported in the area Irrigation user groups are disorganized and do not fulfill working potential

RISK REDUCTION 	Climate induced threats – intensity and severity [landslides, floods and landslides]		<ul style="list-style-type: none"> • Mining, hydropower, and road construction are exacerbating conditions for landslides and negatively affecting water sources • Weather patterns changing rapidly – more intense rain, more cold waves and less snowfall
	Community response, measures to adapt to climate change impacts		<ul style="list-style-type: none"> • Several climate-smart practices in use, including Gabion boxes, re-forestation, and tunnel farming
	Community access to early warning systems		<ul style="list-style-type: none"> • No early warning system in the watershed
GOVERNANCE AND EQUALITY 	Inclusive participation in local planning; women, marginalized castes and ethnic groups hold key positions in NRM groups		<ul style="list-style-type: none"> • Only moderation participation of women and people from marginalized groups in membership and leadership positions • Marginalized groups have limited access to decision-making processes
	Persistence of active NRM groups [Biodiversity, disaster, climate change, water, agriculture, forest, irrigation, farmers]		<ul style="list-style-type: none"> • Forest user groups are active and engaged in various conservation activities
	People comply with laws and policy provisions, including local norms and standards		<ul style="list-style-type: none"> • Low compliance with policy generally due to low awareness of existing conservation and environmental policies
	Equitable access and benefit sharing arising from use of Natural resources (ecosystems)		<ul style="list-style-type: none"> • Most benefit-sharing issues resolved within the community • Marginalized groups have limited access to decision-making processes

	services and products)		
	Coordination between the, municipalities [rural] municipalities, provinces and line agencies		<ul style="list-style-type: none"> • Cross-jurisdiction coordination between municipalities and provincial-level authorities is low • Community members are unaware of the roles and responsibilities of local government regarding the environment
	Adoption of climate-smart, environment and watershed management friendly practices [across all thematic areas]		<ul style="list-style-type: none"> • Several climate-smart practices in use, including Gabion boxes, re-forestation, and tunnel farming