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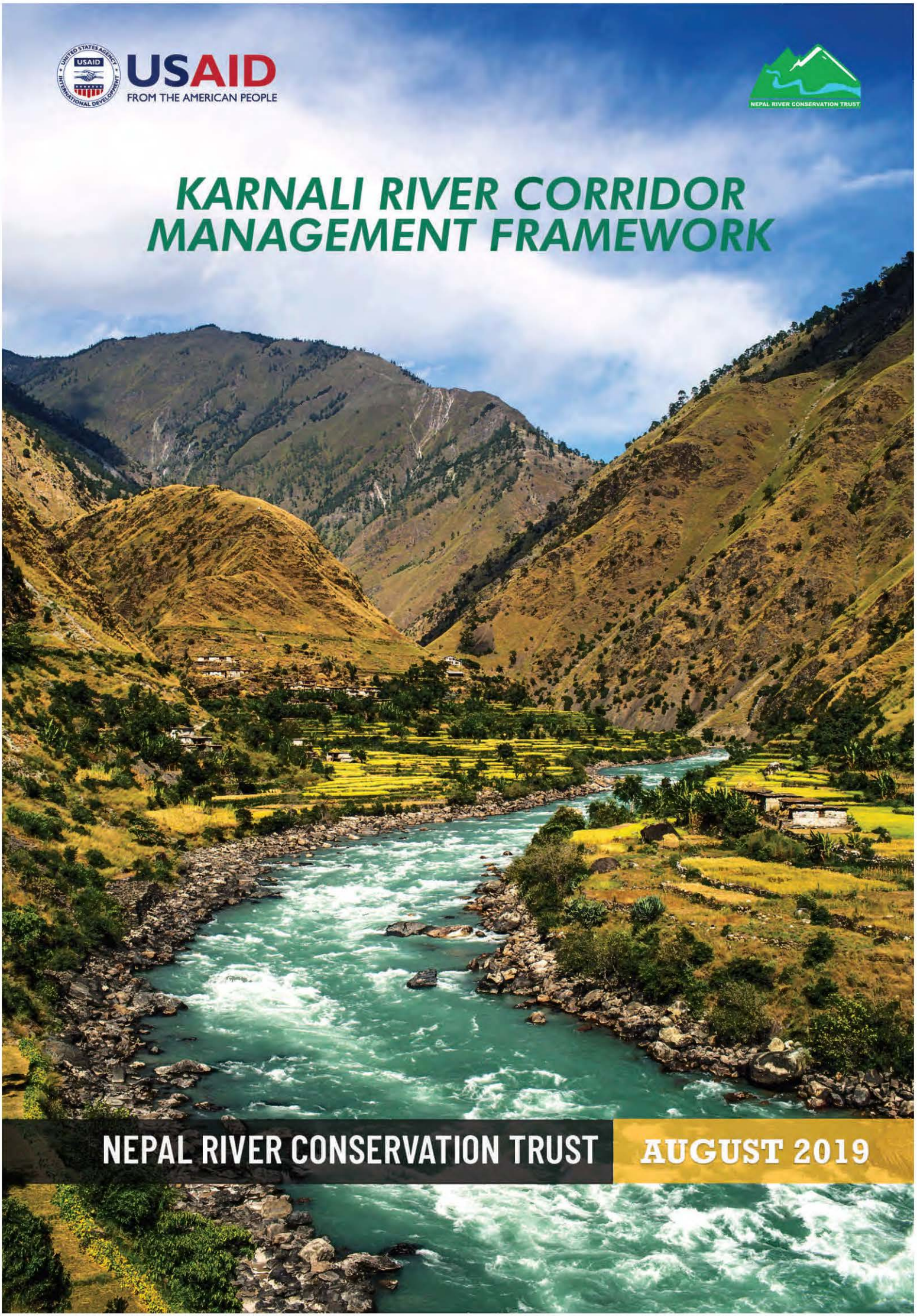
KARNALI RIVER CORRIDOR MANAGEMENT FRAMEWORK



NEPAL RIVER CONSERVATION TRUST

AUGUST 2019

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Karnali River Corridor Management Framework

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KARNALI RIVER CORRIDOR MANAGEMENT FRAMEWORK

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ACKNOWLEDGEMENTS

This Karnali River Corridor Management Framework is prepared based on data collected during the Karnali River Scientific Expedition 2018, organized by the Nepal River Conservation Trust (NRCT) in September and October 2018 with support from USAID's Paani Program and a variety of other sponsors and supporter, as well as during consultations and interviews with experts in the water sector held thereafter and feedback collected from the differently positioned stakeholders who participated in the 3rd National River Summit in March 2019.

Nepal River Conservation Trust highly acknowledges to the American people through the United States Agency for International Development (USAID) for funding support. Similarly, We acknowledges the collaborative partners for their generous support from ICIMOD, Patagonia (Tides Foundation), Waterkeeper Alliance, Fly Fisher International, Tiger Tops, Turkish Airlines, Yeti Airlines/Tara Air, ProPrint, American Whitewater Magazine, NRS, Ultimate Descents Nepal, Nature-Treks.com Himalaya, Shambhala Holidays, local and provincial government and representatives from the Karnali and Sudurpaschim Province.

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We are hopeful for your support and cooperation for the upcoming programs and activities that will be initiated and conducted by Nepal River Conservation Trust (NRCT) in future.
Thank you.

Mausam Khanal
Executive Director
Nepal River Conservation Trust

Foreword

A Vision from the President of the Nepal River Conservation Trust

"PANCHASHEEL - the 5 Principles" for Karnali Province Prosperity

1. Karnali the Home to Many Religious Faiths

The Karnali emerges from the earth in the Mount Kailash region. A region that is sacred to Hindu, Buddhist, Sikh, Jain and Bon religions and a sacred pilgrimage site for hundreds of thousands of tourists annually. The Kailash region is the source of four life-giving rivers supporting billions of people, the Brahmaputra flows to the East, the Indus to the North, the Sutlej to the West and the Ganges and Karnali rivers flow South. The Karnali river flows over 1080 kilometers through China and Nepal to India where it merges with and supplies the greatest flow of all tributary streams to the holy Ganges river. The Karnali is the last free-flowing and most pristine river of this group and the last free-flowing mainstem river in all of Nepal. As rivers are the arteries of earth, we need to protect them to sustain our human civilization. As such, the Karnali is truly eligible as a World Heritage Site.

2. Karnali as Cultural Heritage - the Root of Nepal's Civilization

The Karnali provided an ancient trade route, bringing salt, wool and meat from Tibet to trade for rice from India. The trail is witness to many varied and rich cultures. Tibetan Buddhists live along the river corridor in Kailash region and in river valleys of upper Humla in Nepal. *The Khas* civilization - the source of Nepal's national language, *the Raute* - the last nomadic people of Nepal, *Chettri, Magar, Tharu* and *Sonaha* ethnic groups are also found along the Karnali river corridor. The unique cultures of each of these ethnic groups is vibrant today and witnessed by their lifestyles, architecture, farming and fishing practices, religious beliefs, and cultural celebrations.

3. Karnali as Nature's Library

The Karnali boasts great ecological diversity on land and biological diversity in its waters. The Karnali river flows through almost every ecological zone found on earth and all eight physiographic provinces of Nepal. The river supports over 79 species of fish, including the endangered Golden Mahseer and Giant Catfish and other aquatic species of global significance such as the Ganges River Dolphin and Gharial. In addition, multiple wildlife species depend on the stream flows and riverine habitats created by the Karnali. Few other rivers in the world support this biological diversity or flow through such great ecological diversity in such a short distance. The Karnali, as a free-flowing river, can serve as a reference library to help understand climatic changes under natural conditions. Protection of this resource aids global biodiversity.

4. Karnali as a Sacred River Corridor and World Heritage Site

Creating legislation that legally designates the Karnali as a Sacred River Corridor would solidify this section of the Karnali river basin as an icon of Nepal perhaps even a World Heritage Site. The Kailash - Karnali Sacred River Corridor can be developed for pilgrimage, culture, and eco-adventure tourism. It could be a place where hundreds of thousands of visitors come and explore this pristine and sacred landscape annually. Any development within this corridor would be done in an environmentally sustainable

way that protects people, their culture and the environment including the river system. In addition, within the Sacred River Corridor, sections of the Karnali would be protected as "Wild and Scenic Rivers" as well as Mahseer, Ganges River Dolphin and Gharial Conservation Zones. These protections would bring prominence to the area and would ensure that the outstanding natural and cultural values of the river are protected into eternity.

The Karnali River is at a cross roads. Hydropower development is planned in the lower river with four main stem dams already licensed, though construction has not yet begun. Hydropower licenses have already been issued for 6510 MW production on Karnali tributary streams. According to the Department of Energy, Nepal has a potential to generate over 43,000 MW of economically feasible hydroelectricity. Only two percent of that is currently being produced. The way forward is strategic, sustainable hydro energy development rather than random development that has greater environmental consequences.

Basin level system scale analyses and planning will inform development of the main stem and tributaries of the Karnali. In particular, those sections with higher conservation values should be considered to ensure that aquatic biodiversity is protected. If these sections are dammed, many opportunities are gone forever. It is time to sit back and think hard before we commit another mistake. Many nations of the world (US, Australia, New Zealand, Japan, Bhutan) have now realized their error in damming their rivers and are protecting remaining free-owing sections with laws and regulations and removing dams in critical fisheries habitat. The Karnali could be a symbol to the world of informed, sustainable watershed development. The decisions made now could ensure a healthy, vibrant, river and economy and would be an invaluable gift to future generations.

5. Karnali as a Gateway to Prosperity

If the base of development and prosperity is tourism, organic agriculture and local cottage industries, then the Karnali River is as good as Everest in the east, Annapurana and Dhaulagiri in the central region and the Janaki temple and Lumbini in the south. We must protect this gift of the nature. If the man made Great Wall of China can generate over ten million tourists, the Karnali, as a wondrous gift of nature, can attract millions of visitors to explore this Sacred River Corridor. Karnali is already world renown for rafting and kayaking, considered among the five best whitewater rivers in the world. If the entire corridor is branded well and environmentally sound infrastructure developed to retain the natural character of the area, the entire Karnali corridor could be world renowned as a jewel of Nepal.

President
Nepal River Conservation Trust

Introduction

Purpose of this Assessment and Report

The Karnali River is one of Nepal's greatest environmental assets and a major source of cultural heritage. What might the future of the Karnali River basin look like? What can we do to preserve the mighty, beautiful, and sacred Karnali River? How can we balance development and conservation? How can we work to realize a more ecologically sustainable future, and who will act?

This report draws from data collected during the Karnali River Scientific Expedition, which was organized by the Nepal River Conservation Trust in October and November of 2018 and supported by the Paani Program. This expedition was undertaken to gain an understanding of the environmental and cultural resources of the Karnali River corridor, and to collect data that can be used to raise awareness about the unique qualities and invaluable resources of the Karnali.

In this document, we present the outline of a Karnali River Corridor Management Framework that can be used to ensure that water resources and riparian lands are managed to maintain important social and environmental values. We highlight the environmental and sociocultural diversity throughout the river corridor and make several specific policy recommendations about how development and conservation initiatives might be balanced. We argue that holistic planning and coordination is needed to ensure that short-term development objectives do not degrade or ruin the long-term future of this area. In this document, we suggest that a development vision that recognizes the outstanding and remarkable values of the Karnali River and focuses on promoting social and environmental health can be a way of bringing prosperity to the region, for the people who live in the Karnali region now and for future generations.

The Karnali River is Nepal's longest and most pristine river – the main channel of the Karnali has not yet been obstructed by hydropower development, unlike all of the other major rivers of Nepal. While some sections of the river system face specific pressures, our study indicates that the Karnali River is currently in very healthy environmental state overall. Therefore, Nepali policymakers have a rare opportunity to preserve environmental health before it is degraded – in contrast to other watersheds in Nepal and around the world, where retroactive restoration efforts are required. We argue that Nepali policymakers must act soon to preserve riverine health and to develop new plans for sustainable development that can enhance the long-term well-being of the diverse communities living along the river throughout Nepal.

Given the establishment of a federal system and provincial governments in Nepal, this is a critical moment to initiate environmentally-oriented legislation at the local and provincial level – to work with newly elected officials to focus on environmental issues and questions of environmental governance at the local and provincial scale, where environmental issues matter most and where conservation programs can have immediate impact. This became apparent during our expedition, while conducting interviews with local elected officials and interacting with provincial government members. There is a great deal of excitement at the local and provincial level about the possibility for new initiatives, and some key actors are interested in the possibility of environmentally-focused legislation. How might we develop these conversations going forward? This report helps to start these conversations so that Nepal can determine the way forward in a

way that meets their needs.

In short, as development progresses, informed decisions need to be made that protect the people, culture and natural resources of the Karnali into the future. Short-term land use decisions that forego options for the future or result in irreversible resources impacts should be carefully considered before they are implemented. Those decisions can change the fate of the Karnali forever.

The Karnali Scientific Expedition 2018

In September and October of 2018, the Nepal River Conservation Trust (NRCT) organized a 44-day scientific expedition from the headwaters of the Karnali River in Tibet/China, through Nepal, to its confluence with the Ganges River in India. The interdisciplinary expedition team consisted of seven scientists, three research assistants, an environmental journalist and a documentary photographer.

During the expedition, the team traveled about 1,080 kilometers along the Karnali River, moving mainly by foot and by raft, complemented by a few days of vehicle travel as required in China and India. The purpose of this expedition was to collect data throughout the Karnali river system in Nepal and to document the outstanding sociocultural and environmental values of the Karnali region. Understanding the socio-environmental values of the Karnali will help policymakers improve regional planning. Overall, NRCT seeks to promote dialogue about sustainable development in the Karnali region, and the possibility of establishing a "Sacred River Corridor" along the main-stem of the Karnali River.

Scientific Methodologies Used

During the expedition, our team used a multi-disciplinary methodology to collect data which included methods used in the fields of hydrology, stream ecology, geology, anthropology, sociology, and geography. Team members characterized the geologic and hydrologic attributes of the river system, collected data on water quality and aquatic species health (within both the Karnali and its tributary streams), and social scientific data about livelihoods, cultures, social change, and the ways that different populations relate to the river along the river corridor. Along the way, team members discussed topics such as environmental change, infrastructure development, fish species and distribution, and disaster risk management with a total of 288 local stakeholders.

Water Quality Sampling

Water quality analysis was carried out from 20th September to 5 November 2018 during the Karnali expedition. A HI 9828 Multiparameter Meter was used to measure water temperature, pH, Dissolved Oxygen (DO), Electrical Conductivity (EC), and Total Dissolved Solids (TDS) in the main Karnali River and in its tributaries.

Aquatic Habitat Sampling

Tributary and mainstem streams were sampled for aquatic organisms utilizing a D-metal frame with 500-micron mesh placed opposite to the river flow direction. The substrate was disturbed by hands up to 5 cm depth to dislodge the animals from the substrate. At each site, the subsamples from ten micro-habitats were then made a composite sample and preserved in 90% ethanol for further processing in the lab. In the lab, the samples were washed and all individuals picked by forceps and preserved in 85% ethanol. The sorted biological specimens were identified into genus and family taxonomic level. The most order of Ephemeroptera, Plecoptera, and Trichoptera were identified upto genus level and non insecta to genus and species level. Other insect were identified into subfamiliy and family levels by referring various Identifications keys (Nesemann et al. 2007, Yule et al. 2004 and unpublished keys 2006 of ASSESS HKH project). Nepal-based biotic index (GRSbios) was applied to determine river quality class of each study site. GRSbios index is calculated by sum of score of each taxon divided by number of scored taxa resulting GRSbios/Average score per taxon (ASPT). The value ranges from 1 to 10 where 1 represented highly tolerant taxa and 10 represents highly sensitive taxa. The values then compared with river quality transformation scale that gives river quality class (RQC) for each site. The river quality classes range from I to V representing high status and bad RQC.

Landtype Association Mapping

Landtype Associations are differentiated by dominant categories of geomorphic process (fluvial, mass wasting, tectonic), landforms and geology. Landtypes were mapped at a scale of 1:100,000 using geomorphic characteristics interpreted from Google Earth images and global terrain models, topographic and geologic maps. Using ArcGIS, a polygon was drawn outlining individual landtypes. The map units were confirmed or updated in the field during the Karnali Expedition. Stream dissection frequency and depth class, stream drainage pattern, and primary lithology were determined. Interpretations of each map unit was made for landslide risk, hydrologic function, and road suitability. Lastly, each map unit was characterized by the physiographic province (Dahal and Hasegawa, 2008) and Meybeck Mountain Relief Class it represented. The

area of each Landtype Association was determined. A geo-referenced, ARCGIS file of Landtype Association mapping in the Karnali River Corridor is available as part of this deliverable for use and further study.

Rapid Social Assessment

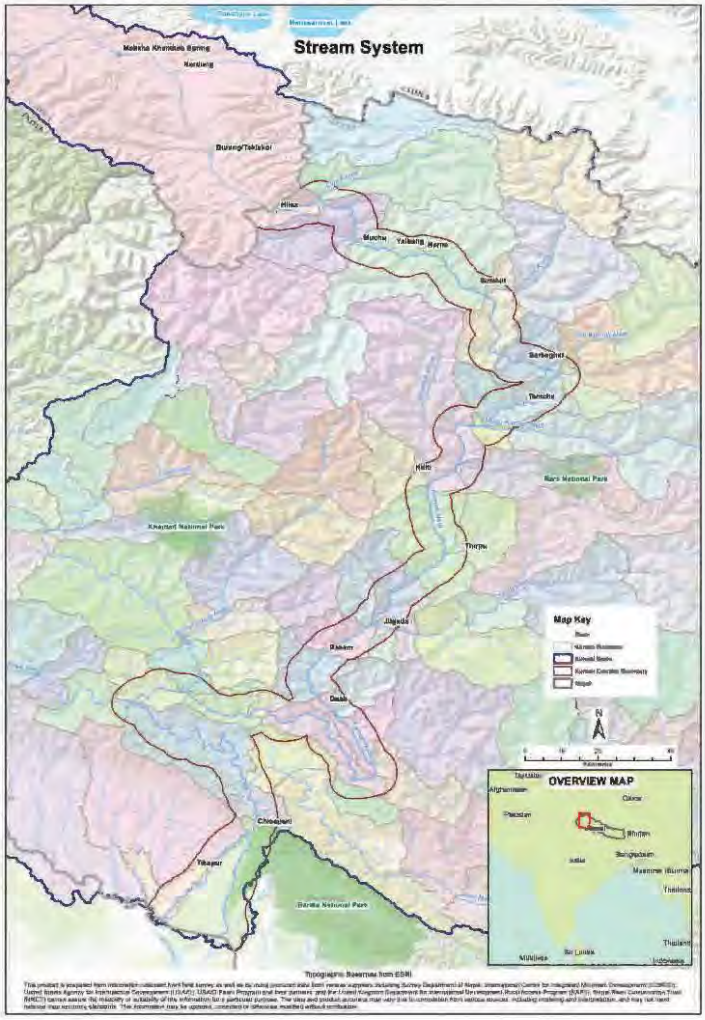
Our social science team used a mix of rapid social assessment methods to understand the social and political landscape of the Karnali basin as it relates to natural resource governance, and the different ways that people value the Karnali and the resources it provides. In total our social science team conducted 216 interviews with differently positioned stakeholders (69.0% men and 31.0% women) and engaged another 72 people through multi-stakeholder dialogue events, as we moved downstream through the river system. About half of these interviews were key-informant interviews (with local and provincial government officials; civil society and NGO representatives working in the Karnali zone; and other community leaders) and the other half were informal interviews with local people that we encountered along the river course (some permanent residents within riparian communities and some in transit throughout the watershed for work). These interviews helped us understand the different ways that people conceptualize social and environmental change in the Karnali region.

Overview: Understanding the River and its Landscape

Water Resources

Sources of the Karnali River

There is a well-established but not true myth that the Karnali River flows from Rakshas Tal on the Tibetan Plateau. The flow of the Karnali River does not come from Rakshas Tal but instead the headwaters of the Karnali River come from the meltwater of glaciers on the north side of the Himalaya in the Tibetan Autonomous Region of China (see map of Karnali Watersheds below provided by IWMI). The Machakabab Spring, sacred to Tibetans, in the Tibetan Autonomous Region contributes to the flow of the Karnali along the way. There are ten major tributaries of the Karnali that contribute to the volume of water and sediment being transported throughout the system.



Stream Flow Contributions

It is important to understand which tributaries contribute the most flow to the Karnali. Based on stream flow as simulated from SWAT model developed by IWMI under USAID's Digo Jal Bikas (DJB) project the following information is available. Only 0.3% of the total flow of the Karnali comes from the Tibetan Autonomous Region of China. At the point where they merge, the Mugu Karnali contributes 42% of the flow that the Humla Karnali does making their contributions of flow at that point almost equivalent. Field observation, however, showed that the Mugu Karnali was carrying a heavier suspended sediment load. The Bheri River, in the lower part of the Karnali River basin contributes 28.6% of total stream flow. Significant alteration of this amount of flow (such as with the Bheri/Babai Diversion project, will have consequences for all mainstem Karnali downstream resources. Heaviest sediment loads were identified at the confluence of the Seti, Thuli Gad and minor tributary streams emerging from the Siwalik Hills.

The Benefits Local People Attributed to the Mainstem of the Karnali Include:

Fishing
Drinking water
Energy (firewood)
Hydropower
Farmland
Washing Clothes
Bathing
Swimming
Rituals and cremations
Sand, gravel and cobbles
Gold
Groundwater resources
Floods that deliver fertile sediments
Transport

And on Tributary Streams...

Micro-hydropower
Mills
Hot springs
Irrigation
More farmland

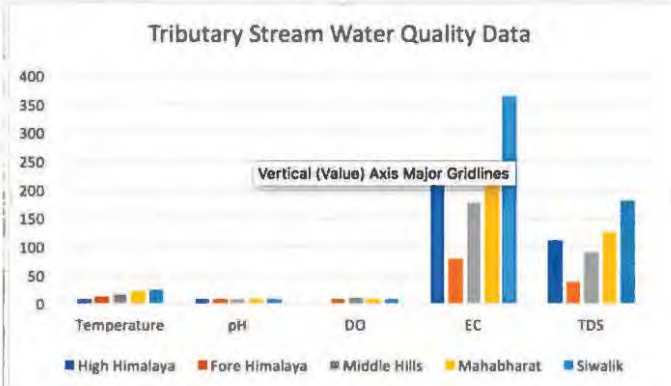
With Development of the area and Increased Awareness the Benefits could be Viewed more Broadly Including:

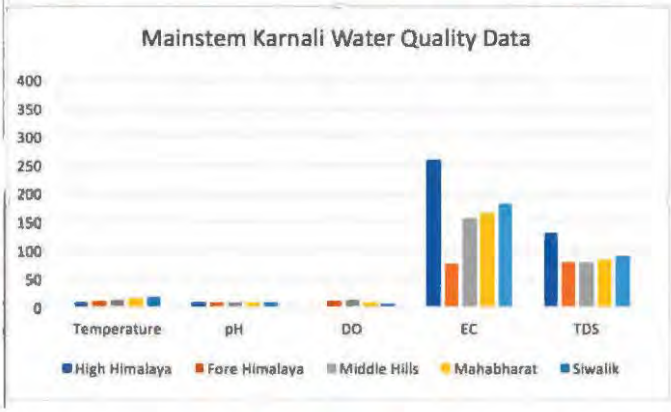
Scenic value (Ecotourism)
Solar pumped irrigation
A thriving whitewater industry
Productive native fisheries
High value fishing camps
Wildlife values
Thermo-regulation of climate

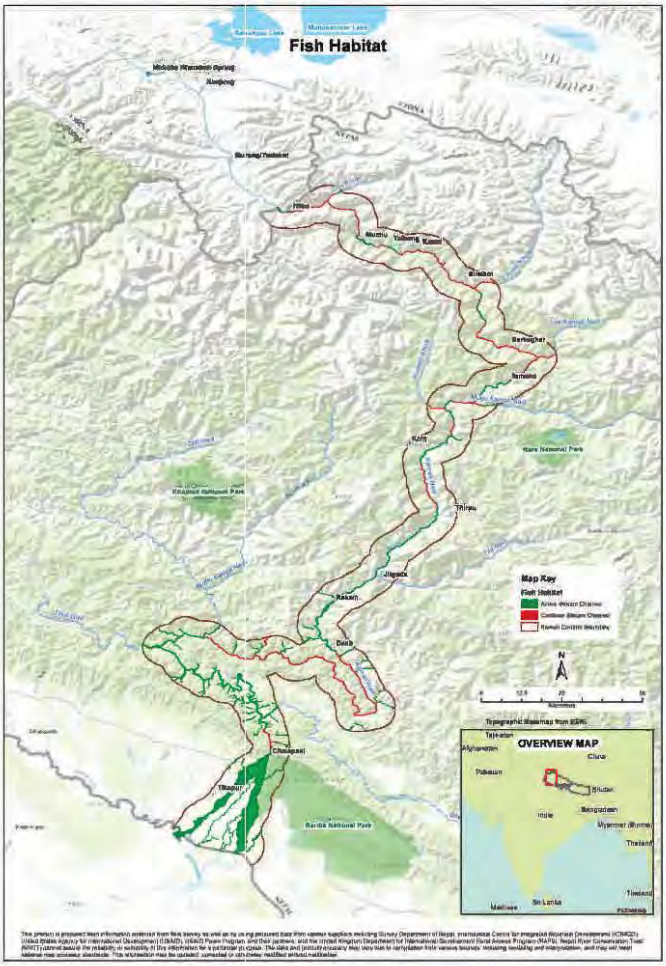
Tributary Name	% of Total karnali River Flow	% of Karnali Flow at Point of Entry
Karnali from China		0.3
Limi	13	0.2
Chuwa	13	0.4
Loti	13	0.4
Mugu	42	2.6
Kuwadi	19	1.5
Tila	14	1.8
Lohore	4	0.7
Seti	27	10.4
Thuli Ghad	1	0.6
Bheri	35	28.6

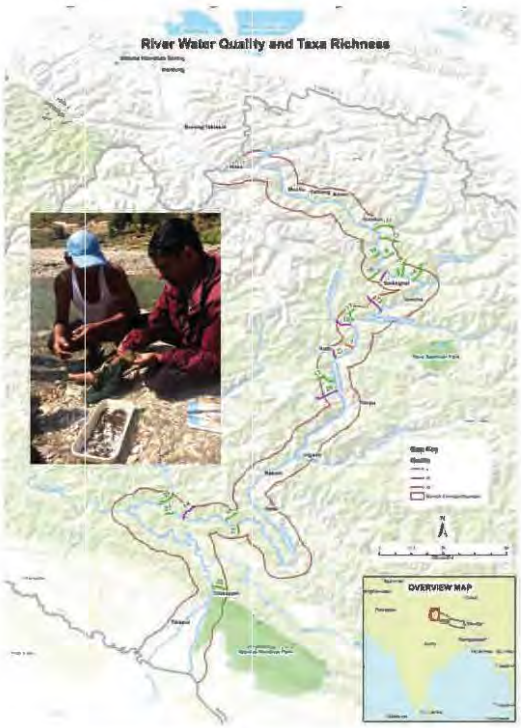
Stream Health/Water Quality

Fifty- four tributary streams and twenty-four Karnali River mainstem sites were sampled. Water quality in the Karnali River is good and, according to information presented at the 3rd National River Summit, the most pristine basin-wide of all watersheds in Nepal. Tributary streams and the Karnali River mainstem follow similar patterns of water quality with water temperatures increasing the lower one goes in the watershed ranging from 7.80C in the High Himalaya to 23.60C in the Siwalik Hills. pH is constant, if a little high, at 7.6 – 8.3. Dissolved Oxygen is sufficient for organism survival averaging 8.7ppm. Electrical Conductivity and Total Dissolved Solids are related because the more salts and ions in solution, the higher the ability of the water to pass an electric current. Tributary streams have higher concentrations of salts and ions in solution than the mainstem with the water coming from the Siwalik unconsolidated sediments the highest in dissolved nutrients. All are within the ranges tolerable for healthy fish populations.



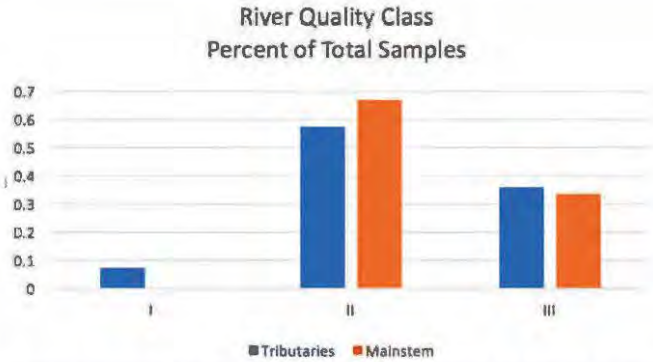






River Quality Class throughout the Karnali River Corridor is ranked ~30% Fair (Class III) to ~10% Excellent (Class I) with the majority of samples (~60%) in both tributary and mainstem streams rated as Good (Class II) based on the biotic index determined from the number and kinds of aquatic macroinvertebrates inventoried throughout the expedition.

Fish sampling and fisherman interviews provided an indication of fish species distribution and catch rates. It is critical to determine life history information - spawning and rearing habitats and timing to establish appropriate fishing regulations and to better understand impacts of infrastructure projects on aquatic species lifecycle survival .



Tributary streams and the aquatic life they support are the source of food for aquatic organisms in the mainstem of the Karnali. Currently, most of the tributary streams have high species richness.

Active stream channels are where sediment is deposited and serve as fish spawning areas. Confined channels are sediment transport corridors and provide deep pools and rearing habitat.

Existing Instream Infrastructure and Effects on Aquatic Habitats

Instream infrastructure alters stream geomorphology. Three types of instream infrastructure already exist and were mapped during the Karnali River Expedition. They include: gabions and levees constructed to protect from streambank erosion and to "train" the stream to stay in the channel; irrigation diversions that transfer stream flow to other areas to enhance irrigation of crop lands; and unregulated sand and gravel mining operations.

Gabions and rock/concrete levees have been constructed along the Karnali in the Terai and around Rakum to minimize flooding and erosion of floodplains, stream terraces and alluvial fans. It was observed that gabion baskets are being undercut by the stream flow and falling into the river sometimes just 4 years after construction. Gabion baskets and rock rip-rap are a "go-to" construction method to try to control stream flow. It is critical to understand and allow for natural stream processes. Appropriate land use planning would keep housing and other infrastructure out of flood prone areas and away from erosion zones.

Impacts of Gabions and Stream Training Projects

- Cut off floodplains from main river channel reducing natural capacity of river to spread and reduce flood velocity and destroying wetland capacity to function
- Attempt to train the river into a single channel in sections of deposition where multiple channels are the natural result of stream processes thereby:
  - *Enhance vertical channel incision removing sand and gravels used by spawning fish*
  - *Fail to ensure bank stabilization as they get undercut and fall into stream channel*
  - *Cause localized channel widening when they fail*
  - *Increase flooding velocity outside of the levee when they fail during a flood.*

Stream diversions remove stream flow from the main river channel and transfer it to areas to enhance irrigation. It is critical to ensure that stream flow diversions do not disrupt stream channel processes or distribution of sediment movement which maintain habitat for aquatic organisms.

Impacts of Irrigation Diversions

- Reduced flow in downstream area
- Altered ability of stream to transport sediments
- Altered fish habitat
- Lowered water depth needed for Ganges River Dophin (2.5-3 meters)
- Concentrates salts onto farmlands
- May cause waterlogging of farmlands they fail

Gravel mining, flood flows and water withdrawals into the Rani Jamara Kulariya Irrigation Project just below Chisapani, has shifted the main Karnali River flow from the Geruwa channel to the main channel on the west side of the alluvial fan. Dolphin can no longer use the Geruwa channel due to lack of river depth. Wildlife ecologists are concerned about alterations of wildlife habitat associated with loss of flow in the Geruwa channel in Bardiya National Park.

Stream Impacts of Sand and Gravel Mining

- Lowers streambed elevation
  - *Bank erosion adjacent to and upstream of excavation*
  - *Stream "headcuts" at lower elevation and poses a threat to upstream bridges and nearby infrastructure*
- Decreased adjacent groundwater
  - *Threatens viability of riparion forests and crops*
  - *Decreases use of area by wildlife*
- Changes the use of river by people
- Changes channel shape and gradient (morphology)
- Destroys aquatic habitat, silts in spawning areas downstream
- Decreases water quality
- Decreases fisheries productivity
- Coarsens the river bed material
- Reduces recreation potential of river

Some Solutions to Regulate Sand and Gravel Operations

- Designate stretches of river where extraction is allowed based on ecological principles – concentrate activity
  - Allow in-stream mining only during low flow periods
- Determine mining levels based on annual volume replenished
- Determine an absolute maximum excavation depth
  - Not below depth of thalwag
- Limit in-stream excavation to bar skimming
  - Excavate only on downstream 1/3 of bar
- Contracts for mining given in a transparent manner
- Change construction to use manufactured sand
- Alter building designs to not use concrete
- Establish off-channel quarries that will not capture river
  - Above 100 year floodplain
  - Restore for agriculture or forest establishment
- Establish hillside quarries and use crushed rocks for roads
- Recycle concrete
- Increase public awareness of mining impacts
- Establish a monitoring (direct and cumulative effects) and compliance program
- Minimize release of fine sand to river
- Retain/restore vegetation at water's edge and on stream banks.

The Effects of Hydropower Development on Aquatic Habitat

The fate of the world's rivers is currently threatened by impacts from development, hydroelectric dams, irrigation withdrawals, construction of embankments or levees, and pollution. According to WWF, of the world's 64 remaining large free-flowing rivers, at least 17 are in danger of being dammed. Human population growth and development pressures for water, food, energy, coupled with climate change threats is ever increasing. If unchecked, the potential to permanently alter the natural flow and ecological health of the worlds rivers is imminent. The need for innovative institutional arrangements, which address the overuse of water, and under provision of ecosystem health is critical in order to maintain the ecological health of river systems (O'Donnell and Talbot-Jones 2018).

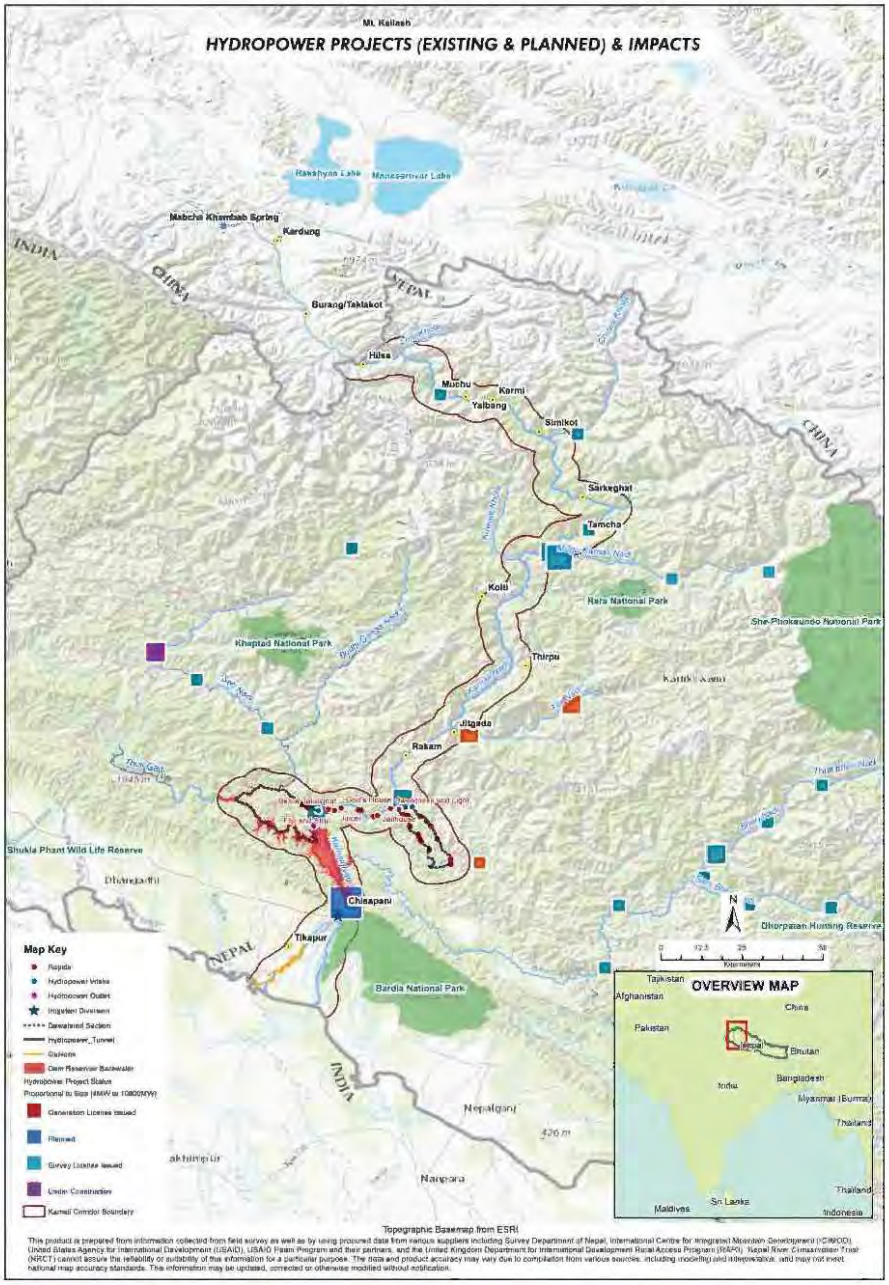
Ecologically, free flowing rivers are critical for maintaining biodiversity. Natural flow levels support specific ecological functions including groundwater recharge, fish rearing and spawning, and providing a variety of habitats which support both aquatic and terrestrial species (Dandekar 2018). In addition, naturally flowing rivers provide critical "regulating services" such as flood control, soil nutrient balancing, and purification and dilution of pollutants. Lastly, unencumbered river systems provide and enhance recreational opportunities, aesthetics and spiritual values thus supporting ecotourism and enhanced livelihoods for the cultures around them.

Right now, the pace of hydropower development is rapidly increasing in Nepal - after years of frustrations, sluggish growth, and development failures. As the national power generation capacity increases and the memory of energy scarcity and recent blackouts begins to fade, a new kind of strategic thinking and planning is increasingly needed, even necessary. It is becoming clear that Nepal does not truly need all of the dams that are currently licensed, and that the export market for electricity might not be as lucrative as previously expected. At the same time, the cost of other alternative energy sources is dropping, and Nepalis are becoming more aware of environmental issues – in terms of water, biodiversity, and climate change.

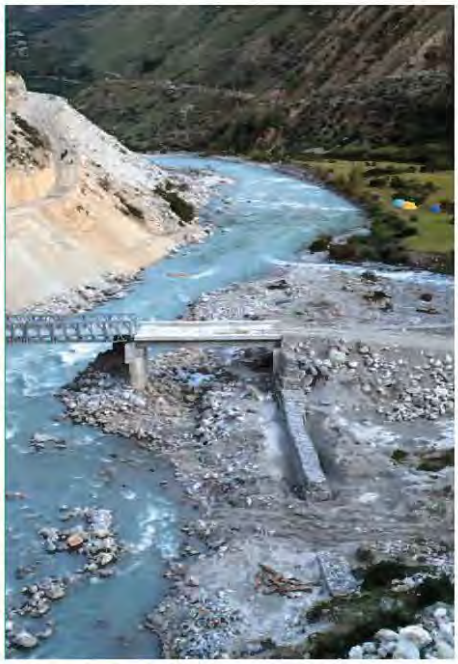
To be clear, neither NRCT nor this report is unilaterally opposed to hydropower development. Rather, we recognize the very real fact that Nepal needs hydroelectricity and that requires building some dams. But as leading Nepali water scholars like Dipak Gyawali and Ajaya Dixit have said for decades now: there are good dams and bad dams, and some level of discernment is needed in Nepal. So how to come up with a new model of hydropower development that strategically prioritizes "good dams" in carefully-chosen sites, rather than the existing 'all dams, anywhere' approach? How can the process of strategic planning and cumulative impact assessment begin?

The Girijapuri Barrage, built on the Karnali (Ghagara in India) just 16km below the international border has no passage for aquatic species. It isolates dolphin populations above and below and truncates fish migration. It backwaters streamflows into Nepal dropping sediment and causing flooding. The barrage transfers water to two irrigation schemes taking 75% of the flow. During high flows, sediments in the channel below the barrage are entrained at much higher than normal rates and are eroding streamside farmland at much greater rates than in the past. Tens of thousands of people are left homeless and landless in the

Many prapased hydropower projects in tributary streams and in Upper Humla affect little fish habitat and would minimize effects on stream flow and sediment transport. They could be strategically placed and priaritized for development to maximize future options and protect aquatic species.
Karnali main stem hydropower



Karnali moin stem hydropower developmentond irrigatian withdrawals, with subsequent flooding and dewotering of stream channels, will eliminate habitat for the Golden Mahseer and similar species below the Tila confluence. These infrastructure development projects will also destroy opportunities for whitewater rafting. Lastly, stream flow and sediment distribution changes below Chisopani will alter habitat of the Gonges Freshwater Dolphin threotening one af the last remaining populations in Nepal.



Connecting the River to the Land

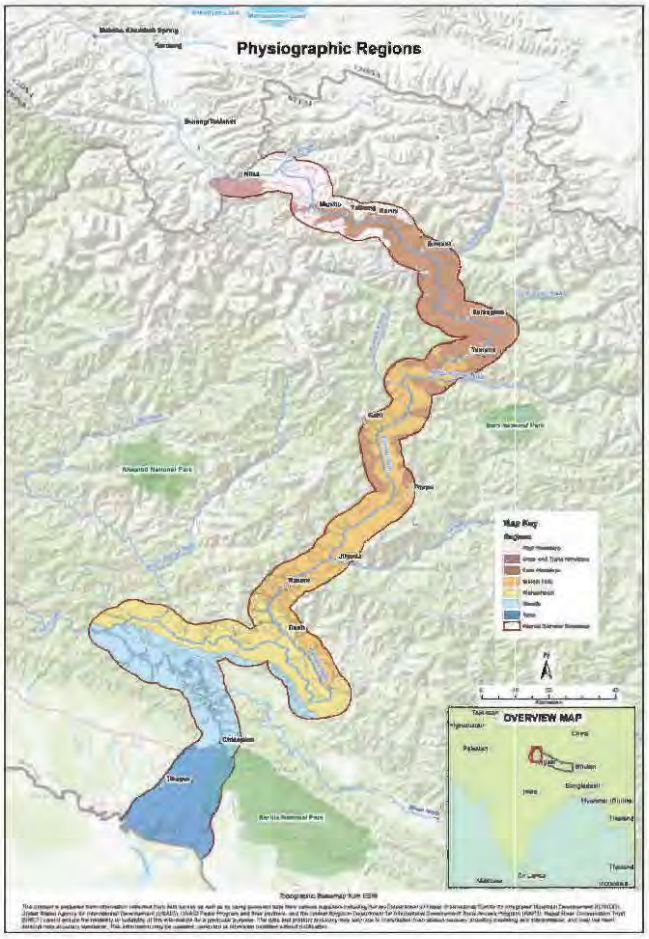
Physiographic Provinces

The Karnali river corridor has a globally significant ecological diversity profile both on land and in the river system as seen in the previous chapter. The Physiographic Regions described and mapped by Dahal and Hasegawa (2008) were refined during field reconnaissance of this expedition. These provinces are grouped to describe the climatic and geologic profiles of Nepal.

Just below the Tibetan Plateau, the sediments of the Tethys Sea, an ocean environment that once separated Eurasia and India can be seen in the hills around Hilsa attesting to the might of the tectonic uplift.

The Karnali cuts a V-shaped river canyons through the strong slopes of the Fare Himalayas.

Broad fertile valleys developed during successional phases of uplift of the Siwalik range. Remnant lakebeds can be seen 300-350 feet above current stream level in this small Dunn Valley area above the Bherri confluence.

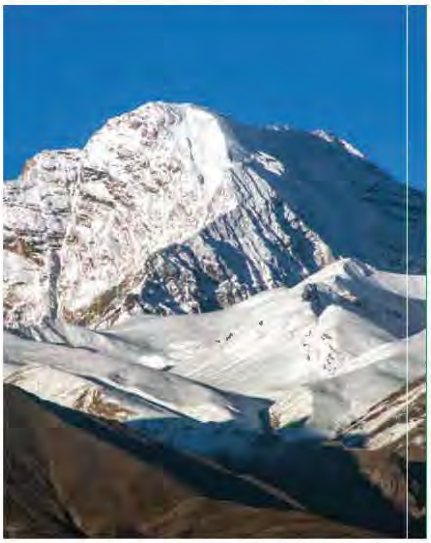


The High Himalyan tria of peaks (Api, Nampa, Saipal) and Chaya Ri with many smaller mountains over 6000 meters are found in the High Himalaya Region. Rock, snow and ice dominate the landscape

The softer rocks of the Middle Hills open into wide valleys suitable for farming. The rising of the Mahabharat range turns the flowof the Karnali eastward, dropping sediments in the Rakam area.

These physiographic regions can be used to market the Karnali as one of the most diverse ecological wonders of the world that can be experienced over a short 507km (350mi) journey.

The Karnali emerges onto the Gangetic Plain below Chisapani in the Terai physialagic province. The nature of the wide alluvial fan that developedthere has constantly shifting stream courses that bring both floods and sediments that maintain fertile forests and farmland and accasionally bring in flakes of gold.



Landtype Associations

Landtype Associations, mapped from field reconnaissance, interpretation of Google Earth images, topographic and geologic maps, are groupings of similar landforms. The groupings highlight the dominant processes that formed the land and from that interpretations can be made about the inherent stability and hydrologic functions which influence their management. This publication introduces the concepts in an easily understood way and presents the results of the mapping to introduce the different types of land found in the Karnali River corridor. This mapping is useful to engineers, local planning groups, and natural resource professionals working in this area. If the information is used for planning prior to development of infrastructure projects (i.e roads and dams), many environmental impacts can be avoided or mitigated. As development options are implemented throughout the Karnali basin, wise environmentally sustainable decisions can be made which avoid unnecessary environmental impacts and which protect the high scenic and water quality which the area currently supports. These are the features which, if maintained, will support long-term sustainable development and the scenic qualities which draw tourists to the area.

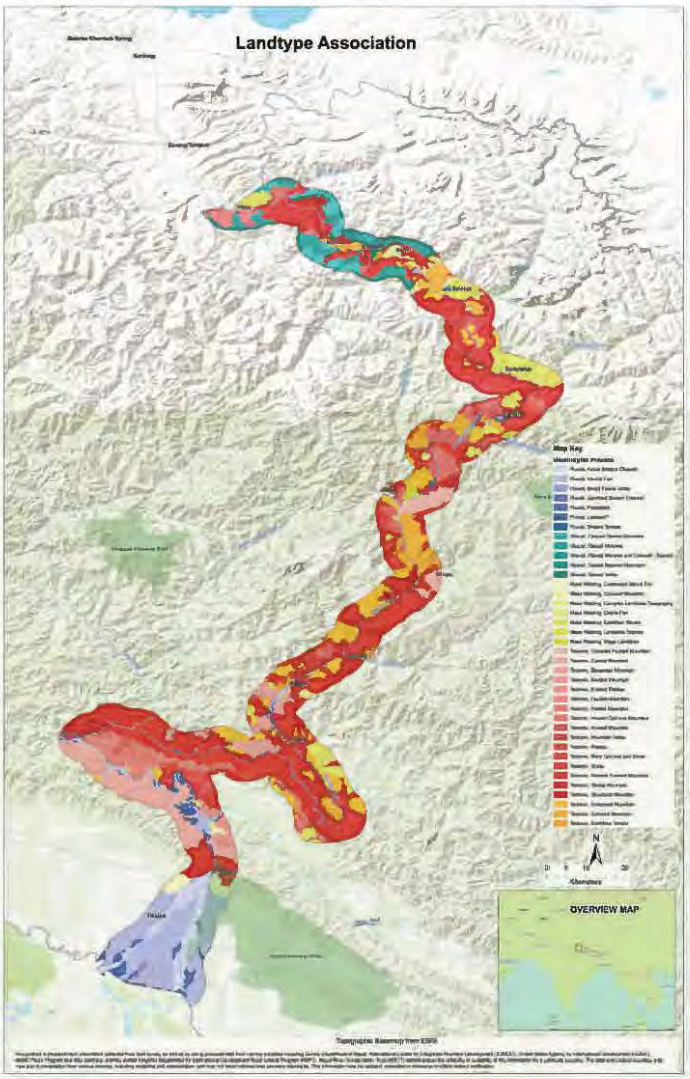
The Karnali Corridor has been mapped into four major land forming processes including:

- ***Tectonic landscapes*** - are a result of the uplift of the Himalaya at the boundary of the Eurasian and Indian tectonic plates. All the Karnali Corridor north of the Terai has been uplifted. Sixty-six percent of the Karnali River Corridor has been mapped as tectonic. These areas have strong bedrock dominated slopes and shallow soils. Depending on the different rock types entrapped in the uplift, they may or may not be prone to landslides. Most of these landscapes are forested or, in drier areas, support shrub and grasslands with cactus in the very driest portions of the corridor.

- ***Glacial landscapes*** - there are a few active glaciers within the corridor, however there are many landscapes that show where glaciers have been in the past. Nine percent of the Karnali River Corridor is mapped as glacial. Glaciers leave behind sculpted bedrock mountain slopes, and deposit coarse, porous, unconsolidated material with large boulders at the sides and end of the ice flow. Many of the deposits are highly erodible with constant sluffing of the unconsolidated material from road cutslopes, seeps and springs often appear at the lower valley edges of these deposits. Agricultural activity needs to work around large glacial boulders left by the melting ice. The soil deposited can be fine grained to coarse grain with variable ability to store water.

- ***Fluvial landscapes*** - are those laid down by water. These landscapes compose seventeen percent of the corridor. Seventy-six percent of the fluvial landscapes are alluvial fans, developed at the mouths of canyons coming in from side tributary streams and stream terraces along the Karnali. These areas provide fertile farmlands.

- ***Mass Wasting Landscapes*** - following uplift, many landscapes readjust. Those with signatures of past large-scale movement comprise eight percent of the Karnali River corridor. Most villages Deora, all indicate ancient movement of this landscape. These deposits increase the availability of farmable land in above the valley floor are perched on ancient landslide terrain. The movement of the hillslope not only flattens the land but also forces seeps and springs to the surface where they can be used for home, farm and agricultural uses. Land movement could either be through rapid mountain collapse or be slow-moving. Movement may be on-going or triggered by earthquake or heavy precipitation events.



In several places, there are signatures of large landslides or debris torrents that have crossed and blocked the Karnali for a period. This action is likely to occur again. There is some evidence of very large scale mountain collapse that deposited significant material downslope: the large ancient debris fans near Kolchi; lakebed and deep sediment deposits near Simikot; the broad fluvial valley forming the Kunda River near Kolti, with deposits potentially from Mt. Deora, all indicate ancient movement of this landscape. These deposits increase the availability of farmable land in this otherwise steep landscape. Development of infrastructure should protect these valuable lands and ensure construction practices don't reactive the landslide movement.by undercutting the slopes.

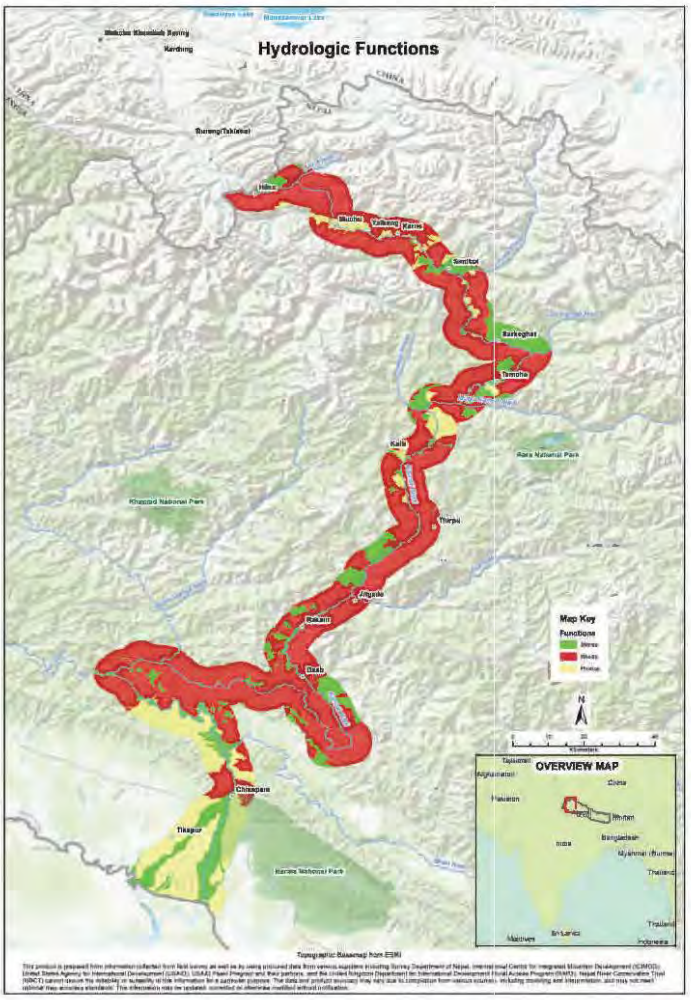
Deep glacial moraine deposits dominate the landscape at Muchu and Tumkot. Note the many large boulders and sandy soils

The fluvial deposits of the Karnali create productive farm and forest lands once it leaves the mountains and deposits onto the Gangetic Plain.

The broad fluvial valley above the Bheri confluence represents the Dun Valley physiographic province.

The bedding plain structure shows clearly in this tectonic mountains at the fault where the Mugu & Humla Karnali meet.

This mountain collapsed following uplift, creating flatter slopes and deeper soils that store water and support a community.



Hydrologic Function

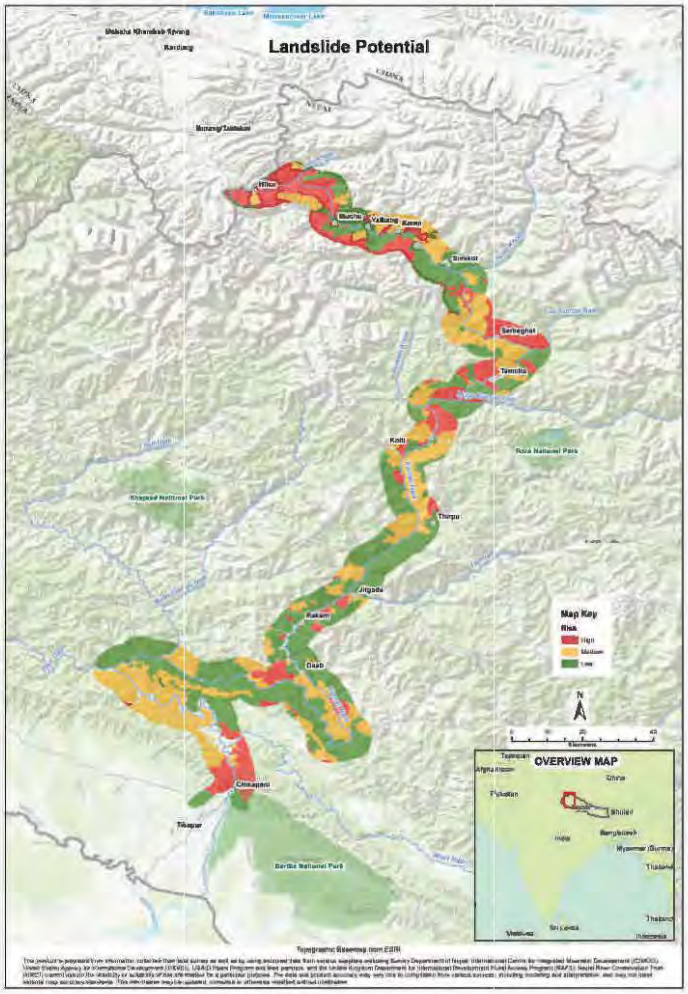
How a landscape moves water is important for understanding how quickly a stream may respond from runoff from the area during a storm event and if that landscape contributes to low season streamflow. Each Landtype Association is ranked for how it moves water. Landscapes either shed water rapidly during storm events if they are composed mainly of rock outcrop or their soils are shallow to bedrock. Landscapes that have deep soils or soils that are moving, such as earthflow terrains store water in shallow groundwater systems and that water flows longer into the drier periods of the year. These landscapes will be more resilient to climate change which brings longer periods of drought. Porous landscapes display few or no river channels on the surface, they are coarse grained soils and soft bedrock materials such as those found in the weakly cemented sandstones and conglomerate landscapes of the Siwalik Hills.

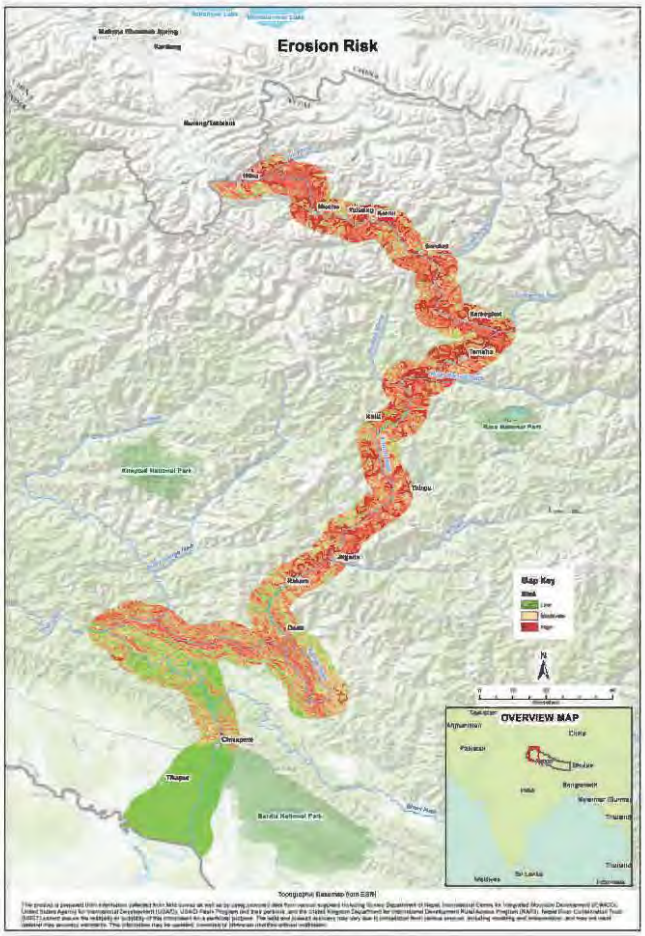
Disaster Risk Profiles

Landslide Risk

Potential for landslides was based on interpretation of remote sensing and field reconnaissance. Areas ranked high for landslide potential displayed active landslides under natural conditions (i.e. even without any infrastructure development). There are areas of the corridor that are on landslide terrain, particularly earthflow terrain that are ranked low for landslide potential since they appear to be stabilized in place, however, earthquakes and large precipitation events could once again trigger movement of these areas.

As the landslide research team at Durham University has argued, these are truly "evolving hazards" that are changing over time, in relation to geological and climactic shifts.





Erosion Risk

Erosion risk is for surface soil erosion only and is based solely on slope class with slopes <30% low erosion potential, 30-60% is moderate erosion potential and >60% slopes are high erosion potential. Removal of vegetation increases the potential for surface soil erosion. Terracing for agriculture decreases the risk of surface soil erosion.

Flooding Potential & Disaster Risk Reduction

All landforms that were mapped as active or confined stream channels or as floodplains are highlighted on the flood risk map below. Stream terraces are seldom flooded but could be added to this layer to understand rare flood events or areas that may be inundated during glacial lake outburst floods.

Flood protection and bank stabilization is needed in some strategic areas -such as Hilsa, where the Chinese side of the border is reinforced but the Nepali settlement is exposed. However, there are many other locations where 'river training' projects and the construction of gabion levees cannot solve seasonal flooding problems, and in some cases may worsen the impacts of floods. In these cases, thoughtful land-use planning is needed, not more in-stream infrastructure

History and Cultural Heritage in the Karnali Region

People of the Karnali

The Karnali region is home to a broad diversity of people, with different ethnic, cultural, and religious orientations. In his historical analysis of the Karnali region, Barry Bishop (1990) described the Karnali as a 'cultural kaleidoscope' that bears the imprint of several historical waves of expansion and rule from Kathmandu, the Kumaon and Garhwal regions of Northwest India, the kingdoms of Burang and Guge in Tibet, and parts of Central Asia. Over time, a distinct pattern of cultural and religious synthesis emerged as "each mix adjusted to its own particular environment" (p.73) and established interdependent and intercultural links based on trade throughout the watershed. While stratified culturally and geographically, the polyethnic societies of the Karnali region were based on "symbiotic relationships that had social and spatial dimensions and that operated within and across both ethnic and ecological boundaries" (p.78). In this way, the Karnali River Corridor has always been a diverse zone or pathway for intercultural exchange.

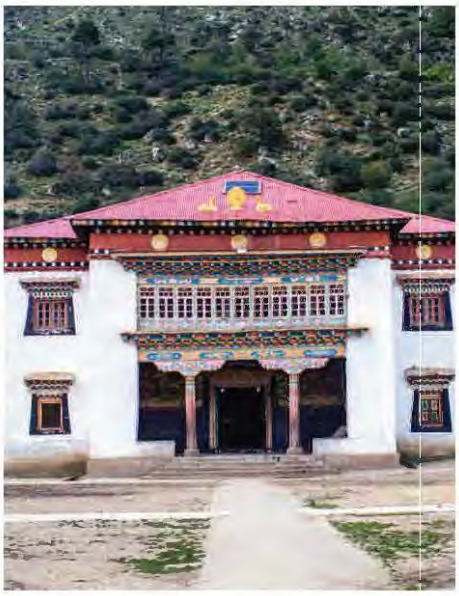
Importantly, we can see both the effects of historical change and these unique patterns of cultural diversity on display today in the Karnali region. Cultural diversity is on display at multiple scales. At the broader scale, the Karnali region is home to major groups who identify with diverse Aryan, Tibeto-Burman, and Turkic origins reside throughout the watershed. At a more focused scale, ethnic and cultural diversity becomes even more apparent – from the *Bhotia* or *Bhote* people living in Upper Humla, to the *Khas* people distributed throughout the middle Karnali region, to the *Majhi* fishermen living along the banks of the lower river, to the *Tharu* and *Sonaha* people of the Bardiya plains. In the lower and middle regions of the Karnali, the legacies of the Malla era are still apparent, on display at several important archeological sites that speak to the origins of *Khas-kura* (the root of contemporary Nepali language) – such as the 13th century stone monument erected

at Dullu. In the upper regions of the Karnali, one can find forms of Tibetan Buddhist society that are increasingly rare in the Tibetan Autonomous region itself – especially among the people of the Limi Valley, the *Nyinba*, and other *Yultshodun* groups whose lineage connects them with the people of Burang/Taklakot in Tibet (Lama 2002).

Historically, several important trade routes have wound together through the Karnali watershed – linking upstream markets to the north and downstream markets to the south, as well as a variety of specific economic between adjacent watersheds. For centuries, the Karnali region was a zone of connectivity and a major trading corridor – especially for the salt trade with Tibet and other caravan trades (Fürer-Haimendorf 1975, van Spengen 2000; Saxer 2017). For most people, living in this harsh landscape required a blend of different kinds of work and livelihood strategies – from agriculture, animal husbandry, seasonal trade, home industry, harvesting wild herbs and other resources, and seasonal out-migrations for work. Trade was complementary to other practices of subsistence, and trade formed the basis for important connections with populations in other resource regions.

Cultural Heritage Sites

Several communities along the Karnali (such as Halji, Yangar, Dulli, and Tumcha) provide a glimpse into the cultural and religious heritage of Nepal. Engagement with locals in these areas, visiting temples, staying in historic houses provides unique and much sought-after opportunities for tourists.



Religious Diversity

Throughout the region, people practice a variety of distinct religions, guided by unique combinations of Hindu, Buddhist, shamanic and animist beliefs. This diversity reflects a complex history of religious intermixture, coexistence, and syncretism, as well as a variety of ongoing religious practices that enliven the landscape.

In the Upper regions, most of the Buddhist gompas are affiliated with the Nyingmapa sect, though the 13th century Tumkot Gompa is Sakyapa, and 11th century Halji Gompa in the Limi Valley follows the Kagyu sect of Buddhism. The Yalbang monastery, led by the Rinpoche Pema Rigsal, is a growing religious center, with almost two hundred monks and a complementary monastery of Buddhist nuns or anis. After many years of relative neglect, the monastery at Tumkot is now being restored and renovated to accommodate more residents. Throughout the Upper Karnali region, many communities also recognize a range of different territorial deities. In the middle and lower Karnali watershed, the vast majority of people are Hindus (both caste-based and out-caste Khasa Hindus) who practice a diverse range of Hindu traditions. There are also a handful of temples and shrines along the river dedicated to Hindu deities, such as the temples at Tallo Dungeshwor and Karpunath.

Throughout the Karnali region, a variety of different forms of Shamanist and Animist practices persist, reflecting earlier indigenous religious practices that existed prior to the arrival of Buddhism and Hinduism in these areas. Tsewang Lama suggests that each *Khas* village has at least one or two shrines for Shamanic gods, that honor a mixture of Indic and indigenous gods, and also that some shamanistic practices are also practiced in Buddhist communities further upstream (2002: 27). Shamanism. In lower Humla and Jumla, the *Khas* people recognize a unique family of a family of incarnating gods, referred to as Masta - twelve brothers and their kin who are imbued with *non-dharmic values* and who speak through the medium of oracles or shamans known as *dhami*. Both Buddhists and Hindus recognize a variety of territorial deities and demigods throughout the region – in short, the entire landscape throughout this region is animated by the presence of gods and other sacred beings.

Transboundary Flows: The Sacred Landscapes the of Mt. Kailash Region

The Karnali River flows from the sacred region of Mount Kailash in the Tibetan Autonomous Region of China. The River begins as the Mapcha Khabab in a glaciated valley to the West of Lake Mansarovar and Rakshash Tal, near the area referred to as the Garuda Valley in the ancient kingdom of Zhangzhung. Streams running from the glaciers of the sacred mountain of Mount Gurla Mandata are another source of the Karnali. In this section, we provide a basic overview of the sacred landscapes of the Mount Kailash region.

Mount Kailash, also known as Kang Rinpoche in Tibet, is known to be the center of the cosmos and the abode of the gods within the Buddhist, Hindu, Bon and Jain faiths, as well as in a variety of different Shamanic religions. In a variety of faiths, this holy mountain represents the highest form of spiritual evolution, the center of a sacred mandala, and the point where the realms of heaven, earth, and hell meet. In Hindu mythology, Kailash is said to have emerged from the "churning of the cosmic ocean" and to be the site where the fourteen principal gems at the center of the cosmic system were deposited (Lama 2002). Pilgrims of many faiths visit Kailash each year to do kora or circumambulation of the mountain, and to visit the various gompas and shrines that surround this holy mountain.

The sacred landscape that surrounds Kailash is thought to be a remnant of the original Cosmic Ocean and the life-giving center from which four great rivers flow: the Sutlej, the Indus, the Brahmaputra, and the Karnali (Ganga). Each of these four rivers flows from the mouth of a different creature – the Sutlej from an

Elephant's mouth (Langchhen Khabab) in the West, the Indus from a Lion's mouth (Singchhen Khabab) in the North, the Brahmaputra or Yarlung Tsangpo from a Horse's mouth (Tamchhog Khaba) in the East, and the Karnali River from a Peacock's Mouth (Mapcha Khabab) in the South. Lake Manasarovar, which sits at the foot of Mt. Kailash at an elevation of 4590m (15,059 ft), is a remnant of the Sea of Tethys that once covered the Tibetan Plateau and is considered to be a holy Lake of Wisdom in many religious traditions. Tibetan Buddhists call this lake as Mapham Yumtso, which means "Unconquerable Turquoise Lake", and they believe that the queen of the *naga* (the ancient serpent gods) resides here, sending forth life-giving waters to the world (Jinpa et al 2005). For Hindu and shamanic dami pilgrims drinking its water or bathing in the lake is thought to wash away pollution carried from the womb and help bring pilgrims wisdom and understanding. For Hindus, Lake Manasarovar is also considered to be the soul of Brahma; for Shamans, bathing in the lake renews their ability to interpret divine knowledge (Lama 2002: 110). Each year, thousands of pilgrims from multiple faiths visit this sacred lake to bathe in its waters and circumambulate its periphery – they come on individual pilgrimages or as part of major collective yatras. As the body of water at the center of the Cosmic Heaven, Lake Mansarovar is thought to nourish the world.

Rakshas Tal, one name for the saline lake immediately to the west of Manasarovar Tal, is considered to be "the Lake of Power and the residence of wrathful or violent gods and goddesses with devilish natures" (Lama 2002: 21). It is important to note that this lake also has many names, which reflect different spiritual orientations and meanings. Rakshas Tal, or "Demon Lake" is merely the Sanskritic name given to the lake by pilrims of the Hindu faith, but the local Tibetan name for the lake is Langak Sertso ('gold lake'). Practitioners of the ancient Tibetan religion of Bön refer to the lake as Muley Tsho ('silver lake') and believe that the Dulla Gyalmo - a manifestation of the Bön Queen of the Universe and consort to the great tutelary deity Walchen Gekhö, who reside in Mount Kailash - lives in the water's depths (Jinpa et al 2005).

And yet, while this lake is important to Bönpo, shamans, and tantric practitioners, most lay people regard the lake with caution - in large part perhaps because its water is brackish and cannot be safely consumed. The stream that flows between Manasarovar Tal and Rakshas Tal is referred to as Ganga Chhu, and the direction of its flow is interpreted as a symbolic manifestation of the triumph of wisdom over power. Mount Gurla Mandata, the companion peak to Mt. Kailash and the abode of the Bön goddess Kangkar Lamo overlooks the shores of the lake, and so it too is an important part of the mandala of the Kailash Sacred Landscape.

The upper regions of the Karnali watershed in Nepal have long been culturally and economically linked to the Kailash-Manasarovar region of Ngari prefecture of Tibet. In the past, while establishing ritual friendships and fictive kin relations traders from Nepal and Tibet used to make vows to Kailash and Manasarovar to bind them in perpetuity (Lama 2002) – a practice which highlights the connectivity between the landscapes of the Karnali region and the sacred landscapes of Kailash-Manasarovar. In the contemporary, the upper Karnali is also an important route of pilgrimage for visitors traveling to Kailash and Mansarovar – the number of pilgrims and tourists traveling through Humla has increased substantially in recent years. We hope that more people come to recognize the entirety of the Karnali River as a Sacred River Corridor.

Changing Social-Environmental Values & Water Resource Management in the Karnali Basin

Because the peoples of the Karnali basin inhabit a broad range of environmental regions and maintain a diverse array of social and cultural practices, they use and value the Karnali River in a variety of different ways. In this section, we share some preliminary observations about the ways that people interact with the Karnali River and the resources it provides, breaking down this information by physiographic region. As we describe below, as one travels downstream, the range of different ways that people use and value the river becomes more complex and more intricately related to the rhythms of life and livelihood.

The Upper Karnali Watershed: Sacred Landscapes, Harsh Environments

In the uppermost regions of the Karnali basin, people's interactions with the river are constrained by topographic and climactic factors, but people attribute great value to the many tributaries of the Karnali that provide drinking water, irrigation, and micro-hydropower for their communities. These patterns of usage are common in other high-elevation watersheds across Nepal, reflecting patterns of settlement and agricultural practices adapted to steep gradients and volatile weather – and the Upper Karnali region is infamous for challenging living conditions and chronic food insecurity.

Water Management in the Himalayan Region

People living in these regions revere the Karnali and value the water that flows from the sacred region of Mt Kailash, which is used for purification ceremonies and funerary rites - and pilgrims of different Buddhist, Hindu, and Bon faiths follow the Karnali corridor during ritual pilgrimage to Kailash. That said, few people understood that the source of the river was located up a tributary stream called the Mapcha Khabab – most thought it came from Raskhas Tal or Lake Mansarovar (discussed above). Many people told us that they feared the Karnali river due to its power and volatility of its flows, and they found it difficult to conceptualize the environmental or aesthetic values of the river. Several people told stories about people who had died during high water or trying to cross the Karnali before reliable networks of bridges were constructed; others mentioned how flash floods and high flows had eroded or destroyed their fields. Fishing in this region is also limited: as the highest location where fish have been caught is at *Kholsi*, a village with a Hindu and a Buddhist parts divided by a stream nearby Simikot. Tellingly, almost no one in the upstream regions relies on the Karnali for drinking water or uses water from the main channel for irrigation – though some people in Hilsa said that they could drink the water in the past, they are now concerned about pollution from the growing city of Purang/Taklakot above. Riverside communities typically use the smaller tributaries for these purposes and propitiate specific territorial gods responsible for springs and other drinking water sources. In recent years, increasing climactic volatility has also introduces changes in hydrologic cycles and the timing of flows, making water resource management in these areas even more challenging.

Trans-Himalayan Trade through the Karnali Corridor: Yesterday and Today

Contrary to popular belief, the Karnali region was for most of its history neither truly isolated nor truly poor. Rather, as several scholars have shown, contemporary patterns of poverty and remoteness were produced by political and economic changes that altered or severed traditional patterns of trade and practices of

brokerage between Tibet, market centers of Nepal, and India (Bishop 1990; Saxer 2017). First, the growth of Indian salt production in the mid-twentieth century disrupted the ancient salt trade by decreasing demand for Tibetan salt. When the Chinese government began regulating access to Tibet in the early 1960s, this also had significant effects on cross-border relations between the Tibetan Plateau and the valleys of the Himalayan region, leading to the deterioration of social and economic connections – weekly markets and seasonal trade fairs became more infrequent, leading to a "decline of caravan culture" (Lama 2002: 66). These shifts threatened carefully balanced subsistence economies that relied on trade (Bishop 1990) creating new patterns of deprivation and requiring new adaptations. The history of development efforts and particularly food aid programs in the Karnali have also had complex and even controversial effects on local economies.

In the current historical moment, a variety of new connections are taking shape in the Upper Karnali region, as infrastructure development and new government-sanctioned forms of trade with Tibet and China take new forms. Moving along the Karnali River, we encountered a variety of different caravans taking goods up to the roadhead to Hilsa or toward an alternative pass called the *Lapcha La* – several mule caravans in the Upper Karnali and a few goat caravans in the middle sections of the old trade route. Nepalis are selling agricultural products, textiles, herbs, and artisanal wooden bowls called *phuru* to the north, while partaking in new government-sanctioned forms of brokerage using their status as card-carrying "Nepal-China Border Citizens" (Shneiderman 2010; Saxer 2017). Our conversations with locals continually highlighted the economic primacy of the road and different forms of Sino-Nepal - mule drivers plying an older trade are operating alongside and in tandem with truck drivers and jeep drivers. At the same time, people in this region are also importing a variety of Chinese consumer goods and clothes, and some are buying a significant portion of food staples from Tibetan markets. This represents a shift in the balance of trade from earlier times when Nepali agriculture products were critical for the people of Burang, also called Taklakot by Nepalis. During our expedition through the Upper Karnali corridor, several people told us: "We used to feed the people of but now they feed us." The effects of greater Chinese market connectivity and outmigration were apparent throughout the Upper Karnali region. One man operating a small shop in a small marketplace that had sprung up along the new road in Upper Humla, commented on recent economic dependence on Chinese trade, saying said: "If they stopped us going to Purang, then we would all have to work in the fields again." In all cases, contemporary goods move via a complex network of caravans and trucks, along routes that are both new and old.

New patterns of infrastructure development throughout the Karnali region portend and promise change for a variety of differently located populations seeking economic opportunity and social mobility. As a result of increased tourism to the Kailash-Mansarovar region and the effects of the 2015 Gorkha earthquake on other Nepal-China border crossings, the Nepal-China border at Hilsa is becoming both more active and significant again. At the same time, new road networks and other transport infrastructures re-enact older patterns of exchange and transboundary connection. Amid these changes, people are hoping both for modern futures and the revival of older connections that made the Karnali region prosperous. "Rather than leading to modernity (for good or for bad), the new roads are primarily conceived of as ways back to what is remembered as prosperous trans-Himalayan exchange. These may be new roads, but what they facilitate is an old trade: brokering between neighbours." (Saxer 2017: 76)

But what kind of change will these new connections bring, and for whom? What kinds of benefits and opportunities will new roads, hydropower development, upgraded border facilities intended to facilitate tourism and high-volume trans-Himalayan trade, and other forms of infrastructure development create? As

new roads are built throughout the Karnali watershed and new administrative centers are created throughout Karnali Province, many people are relocating from their homes to new market towns, changing patterns of trade and connectivity. Meanwhile, newly elected local and provincial governments are spending the majority of local development budgets on road construction, in an attempt to make good on electoral promises to their constituencies. As road networks make their way into these landscapes, they enhance people's mobility and create new opportunities for further infrastructure development (everything from micro-hydropower to large-scale hydropower projects, for example) but also introduce new environmental risks. In the end, the major question might become: How can programs of infrastructure development be designed to ensure that negative social and environmental impacts are mitigated?

Valuing Rivers & Environmental Awareness

When asked what kind of values the river might have, many people quickly mentioned hydropower resources, which were linked to broader hopes of infrastructural connectivity and electrification – though several also questioned whether the big infrastructural plans described by local politicians would truly benefit locals. Several communities in Humla had built micro-hydropower facilities on the tributary streams and the district capital in Simikot was powered by a 500kW project built on a nearby stream. After seeing the benefits of rural electrification in remote areas, and hearing politicians and contractors talk about the regional economic benefits that large-scale hydropower could bring, many of the people we spoke to were quick to call for hydropower development on the main channel. Many said that the Karnali is currently of no benefit for them and that the people of Humla should benefit from this water that is currently flowing by 'wasted' only to benefit those downstream. In the uppermost parts of the watershed, people expressed concerns about pollution coming from the growing city of Burang (which Nepalis refer to as Taklakot) which is upstream on the Chinese. The highly-educated and worldly Rinpoche who leads the monastery at Yalbang agreed that the river is sacred, and stated that an environmental perspective is needed to balance development – but while he is an important thought leader in the region, such 'environmentally-oriented' views are not yet uncommonly held among the general population. One man living in the village of Chaugunphaya described a general lack of awareness among the population, saying that "the poor people don't know what values the river might have; only the *Sarkar* (government) knows."

During a program we organized in Simikot, a variety of different stakeholders from local government and civil society gathered to talk about the values, challenges, and opportunities related to the Karnali River. Several participants raised the prospect of hydropower development, while also admitting that further technical analysis is needed to ensure that hydropower is developed in a way that benefits the local people of Humla and encourages regional economic development. Given the scale of development that they routinely encounter on the Chinese side in Burang/Taklakot, people feel a sense of relative deprivation and criticize the central government of Nepal for neglecting their interests. Some people were surprised to hear that the Karnali River does not flow from Rakshas Tal, a brackish lake just west of the sacred Lake Mansarovar that is revered by some (especially shamans and followers of the Bon tradition) but believed to be cursed in Hindu mythology. Groups in the Sikimot area, especially youth groups and those already involved in other forms of tourism, were excited about the prospect of increasing tourism along the Karnali River - several young men indicated an interest in rafting and the idea of an outdoor sports training facility. All the participants gathered agreed that greater awareness about the multiple uses and values of the river was needed.

Religious Sites, Sacred Flows

Just below Simikot, at the village of Karpunath, we encountered the first temple of several temples located along the river bank. This small Shiva temple had been built in recent years, improving upon a shrine that was a site of prayer and ceremony for both Hindu worshippers and local shamans or *dhami* – and locals told us that on the first day of the month of Magh, or Maage Sankranti (January), hundreds of shamans and locals would gather for an all-night ceremony. A local *Khas pujari* told us that he and others collected sacred water from the Karnali to be used for purification ceremonies, and especially on *purnima, panchami* and *sombare aunsi.* While speaking about the difference between normal *paani* and Karnali *jal* that has sacred value, he demonstrated a special way of collecting *jal* from the Karnali - only cupping downstream and not upstream so as to not disrupt the river's flow. He said that even the small amount of water flowing from Kailash Manasarovar was enough to purify the majority of water that flows from the Karnali. In the same village, we met with a youth leader who had returned to his village after studying in United States to start an organization focused on improving educational opportunities for the people of this area. He spoke about the need to promote environmental awareness in the next generation, while also acknowledging that development is critical to improving the well-being of the people in his region. Like the Rinpoche from Yalbang and others we were to meet further downstream, he expressed his concern that unplanned and unregulated development would lead to a 'tragedy of the commons' similar to that he has seen with his own eyes in Kathmandu: "I don't want to see the Karnali become like the Bagmati, but I am afraid that it will...."

Ecotourism Potential

As we walked down the incredibly beautiful path that follows the river below Simikot, from Karpunath through the gorge to Sarkeghad, our team members continually commented on the scenic value of this area and the great tourism potential that this area might have for visitors seeking alternative pathways and experiences in Nepal. Locals told us that this route used to be very popular, but that business has declined with foot traffic in recent years as people are following other paths along newly built roads – and of course we can't blame them. With the exception of a few settlements like Rip and Unapani, most villages in this section of the river were not located directly on the riverside, but rather higher up, where they could not see the river itself. Talking with householders and shopkeepers in this region, almost all of them spoke of children sent to Surkhet or Kathmandu for education, indicating a larger trend to go *tala* (below) for education. While discussing the prospect of tourism along this route (en route to Rara Lake, to Saipal Himal, or just downriver) the people living in small communities interspersed along the river said that they have seen very few tourists over the years, but that they would love to see the old path revived. Perhaps efforts to promote ecotourism in this area can help local government officials and planners strike a balance between the two important goals of development and environmental conservation.

Poverty & Chronic Underdevelopment

While speaking with people throughout the Upper Karnali region, our conversations often focused on the precarity of life in this region, chronic poverty and food insecurity, and the need for development - despite the systemic development failures of the past. It is common knowledge that the Karnali runs through some of the poorest and most food scarce regions of Nepal, and a palpable sense of deprivation, both relative and absolute, is common. Many people voiced criticisms of government neglect and the extractive regimes of the past. One man in Lower Humla pointed to his grandfather saying, we have had little development in this area since his time: *"bajeko palo dheki aajako samma justaiko tystai."* Tellingly, another person we spoke to said

that this region is "treated as the stepmother" by Nepal – indicating a perceived distance from the central state and the idea of Nepal. In the village of Dulli, while most people were busy harvesting their fields, we met one older man who was bringing rice out of underground storage – he said that this practice was common in the past in places where both weather and crop yields were incredibly volatile. While a variety of NGO-led development programs have focused on Humla in recent years, the majority of these overlook these regions of Lower Humla, which remain difficult to access. As road construction programs reach closer to these areas and newly-elected local governments renew familiar pledges to uplift their constituencies, desires for greater mobility and the material comforts of *bikas* (development) are understandably common. For all these reasons, historical and contemporary, any program focused on environmental awareness or river conservation must also propose a viable program for sustainable and equitable development – and this is the kind of dialogue we hope this document can help promote.

The Middle Karnali Watershed: Shifting Mobilities, Development Politics

In the middle section of the Karnali watershed, we found that perspectives about the value of the Karnali river were changing rapidly as increased connectivity and new configurations of local governance fuel old and new desires for development. While much of this area is also underdeveloped, people expressed a greater sense that opportunities for development did exist, and people more readily expressed a connection to the river, describing its multiple values. In recent years, labor and educational migration from these areas has rapidly increased; as one man from Kalikot told us "people don't stay in the villages anymore - they are in Kathmandu or Qatar or in other places." At the same time, the systematic construction of roads throughout the river corridor is leading to the increase of a variety of pressures on the river and environmental health.

Road Construction and Environmental Health

While traveling downriver through Humla, our team re-encountered the road just below Sarkeghat – a local market hub where a group of men sat spinning wool by hand in between a variety of new health posts with NGO logos. As the Government of Nepal, the Nepal Army, and the British aid organization DFID continue working to build a new transit corridor and a corresponding network of roads that will connect more change will come to these areas. Locals expect that a road will be constructed along the entire length of the Karnali River within five to ten years, eventually connecting to the Nepal-China road that is still being extended toward Simikot. Throughout the middle regions of the Karnali, people are relocating toward roads or concentrating in the market towns growing around newly created municipal headquarters (part of a larger reconfiguration of local governance). In the large village of Tumcha, a settlement with significant agricultural lands situated on a sweeping turn of the river, people said that they only live here during the harvest season. As we moved down the half-built road, we encountered wave after wave of children and young people returning home for the festival of Dashain, reinforcing both the scale of outmigration in this area and the fact that the road facilitates a variety of kinds of coming and going.

While people definitely need roads, the current program of road construction is very worrying from the perspective of environmental governance - because unsustainable and ecologically destructive construction practices are the norm, and because routes are being plotted without due environmental consideration (see below). Some routes – such as the planned route up the gorge between Tumcha and Sarkheghad seem illogical and inefficient, designed to benefit no one but the contractors. Our repeated encounters with haphazard and environmentally destructive construction, punctuated by a few close calls with road blasting

and rockfall, indicates the need for better planning and monitoring to ensure the sustainable construction of these critical road networks in the Karnali region. Gravel and sand mining, which is also a major resource that the river provides in these areas, is also intensified with road access and the local building booms that it supports.[1] Further, in the sprawling market towns popping up along the road, awareness campaigns focused on maintaining high water quality, and the management of garbage and human waste – our team has discusses creating a pilot project in the town of Rakam, in Dailekh. Road building, gravel mining, and sewage systems should be well planned and spatially- oriented in ways that limit the overall impact of erosion on river habitat, since fisheries are an important resource in this area.

A Local Boom in Fishing

Throughout this area, people often highlighted fishing as a major value of the Karnali River, and we encountered a significant number of people fishing – mostly for *Asala* (snow trout) during the early seasonal migration. Our interviews with local fishermen indicated that the demand for fish had increased in recent years – as road development promoted greater market connectivity many people had begun fishing, expanding beyond just those traditional fishing communities. One young shopkeeper told us that he catches up to 30 kilos of fish on very good days during the high season, that he is supplying large amounts to the Army and their road engineering teams, and that he is building two houses in Surkhet by selling fish. A few days earlier, while walking back after setting his nets one night, another young man whose fathers were also fishermen lamented the decline in fish in his area, saying that the resource was being depleted due to constant fishing (not just in season), road blasting that adds sediment to the river, and heavy fishing downstream. One morning on the beach near the market town of Rakam, we saw dozens of wooden boats full of young people out fishing – with elder teenagers teaching younger children. While the majority of people seemed to be using traditional and sustainable fishing methods, we heard stories of electro-fishing and other such practices closer to the main road. As more people fish, overfishing may become a problem, especially if fish passage is blocked by large hydropower dams, limiting passage to the spawning grounds. Given the surge in fishing that we encountered, we expect that protecting aquatic species from overfishing will become a more important issue in the years to come – and so it is important to promote awareness (local legislation focused on aquatic biodiversity passed at the local level in the Middle Karnali is a great step) and to establish seasonal guidelines and regulations to help protect the fisheries and aquatic biodiversity. In the middle Karnali, we also met a few people who were engaged in aquaculture, including a college-aged young man who told us that he had recently submitted a proposal for aquaculture to his local government office. In response to these trends, we suggest that scoping studies needed. Given these trends, it may also be wise to continue promoting sustainable aquaculture programs like those that have been successful elsewhere in Nepal (with regulation to prevent the introduction of invasive species) as a means to limit pressure on wild fisheries, as market demand increases.

Irrigation & Alternative Energy

Throughout this dry region, people often spoke about the need for irrigation – though few were using the Karnali as a source of irrigation, a few spoke of the possibilities. In this area we encountered two new solar-powered pump irrigation projects built in the wake of recent elections, as well as two similar projects that

[1] In the braided channel areas along the road near Rakam, local authorities told us mining was regulated through allocations to select contractors. However, in other rivers across Nepal, sand and gravel mining is a notoriously unregulated and corrupt industry that ravages riparian areas.

had been attempted and abandoned a few years earlier, citing design problems and the lack of maintenance. While locals were keen to reference the need for electricity, they were also familiar with the challenges – telling us about a failed solar project in Mugu and an abandoned mini-hydropower project. As solar technology improves, we hope that more of these systems might be developed and effectively implemented. With some foresight and thoughtful siting, community-scale solar installations complemented by micro-hydropower can help to power mini-grids that can support regional markets and local industry. In general, promoting alternative energy planning that focuses on a diversified energy portfolio (not just large-scale hydropower) seems like an important investment in energy security for Karnali Province and other provincial governments.

Hydropower Dreams: Part 1

In the Middle Karnali, the issue of hydropower development is on the tip of everyone's tongue: in part because the long-promised 900 MW Upper Karnali Hydropower project has been a central topic of local conversation and debate for several decades, and partly because the construction of new roads is making a variety of new projects more viable. In recent years, several large-scale hydropower projects have been licensed in the middle Karnali region, both on the main channel of the Karnali (i.e. the 688 MW Betan Karnali HPP and the 426 MW Phukot Karnali HPP) and on its principal tributaries (i.e. the 160 MW Mugu Karnali HPP and the recently proposed 1902 MW Mugu Karnali Storage Hydro Electric Project). [2]

However, knowledge about the scope of proposed projects and their potential impacts proved to be highly uneven. For example, most people living near the future dam site of the Upper Karnali at the settlement of Daab were extremely savvy about land-based compensation and the design features of the project, whereas people living nearby the proposed dam site of the Phukot Karnali project at Shantighad had hardly any information at all. Inquiries with local residents led us to a single man who had gathered some basic information after a brief meeting with some officials from the Nepal Electricity Authority who had visited a year ago – he said the dam would be located just below at a narrow point in the gorge, and that just two of the settlements would be inundated. The small crowd gathered around us laughed when he joked that "this is a dusty place, and there won't be any dust after it is flooded." When we asked the Chairman of a downstream municipality who was very well-versed in the politics of the Upper Karnali HPP if he was aware of the Phukot Project being built upstream (he was not) and asked him if he was concerned about the risk of a major earthquake causing a dam failure upstream, he was less amused by the prospect of his new office (recently built on a floodplain) being underwater.

While talking about the pros and cons of the Upper Karnali HPP, one group of local leaders triangulated around a position that was both nationalist and focused on local self-determination, with one of them saying: "This Indian developer (GMR) can't push us around! Nepal should develop our own resources *(aafno shrot)* and build projects like this on our own, and quickly. Projects like this must provide benefits and facilities to local areas first, otherwise we will not allow these projects." Tellingly, under the new federalist system, local governments also desire a greater share of the benefits from natural resource development – and these issues are still being negotiated. As one youth club leader told us in Lower Humla: "Its going to be difficult to convince the big people to keep the Karnali free flowing because it's all about elections." Speaking to the prestige of bringing infrastructure, he continued: "You see, Jeevan Bahadur Shahi (one of the parliament

[2] While the Betan Karnali HPP and the Mugu Karnali HPP are licensed to Nepali developers, the Upper Karnali and Mugu Storage projects are currently being negotiated with Indian developers, and the Phukot HPP is now slated to be one of nine national-priority infrastructure projects that China will help Nepal build via Beijing's Belt & Road Initiative.

members from Humla) delivered the road. While saying, he did it. That is the standard others are looking at now. Now everyone is building roads everywhere. There is a pressure to deliver bikas (development)."
Speaking to the desire for economic opportunity, the Rinpoche upstream in Yalbang aptly summarized: "Its difficult to go against hydropower; people say 'we need to eat'." One NGO worker in Kalikot district was a bit more cynical about development projects in the region, stating simply that: *"thulo machha le sano machha khanchha"* (the big fish eat the little fish).
In the Karnali watershed and across Nepal, many Nepalis are, rightly or wrongly, excited about the potential economic benefits that hydropower development. Over the past few decades, Nepalis have become acutely and increasingly aware of the value of hydropower resources in general (Pandey 1996; Forbes 1999; Dixit & Gyawali 2010; Rest 2012; Lord 2014) as well as the recent propagation of corporate social responsibility (CSR) and benefit-sharing programs in the hydropower sector (Lord 2016; Shrestha et al 2016; Satyal et al 2018). Therefore, development planners and conservation advocates need to engage potential stakeholders in open dialogue about the potential impacts (positive and negative) of both hydropower development and river conservation efforts, and they need to foreground livelihoods and other economic issues.[3]
During our conversations about the Karnali, many people said that they wanted to see hydropower development in their area – but importantly, when asked to clarify, in many cases we often found that they were imagining a small-scale project, between 100kw to 10MW. While some people longed for the economic boost, local jobs, and perceived benefits that a large-scale hydropower might bring, some others seemed to understand that such large-scale projects primarily serve the powerful and politically-connected only - sensing development disparities, and noting recent trends of politician/contractors building houses in Surkhet or Kathmandu from other development budgets. Truly, larger projects are not needed to supply electricity to these areas; instead they are intended for the national grid or for export to other countries in South Asia. In our view, the key is coming up with a strategic basin-scale plan that considers all the different costs and benefits and strikes a balance between development and conservation that is appropriate for the Karnali region – as our proposed alternative dam of over 6,000WM from developing hydropower projects dam on the Karnali tributaries suggests. Pursuing well-sited and right-sized projects can help set a standard for sustainable hydropower development in the region, and across Nepal.

Geohazards and Disaster Preparedness

As we moved through this area, we also encountered several reminders of the fragile geology of the region. The people of Santi Bajaar, for example, have resettled at the confluence of the Paima Khola after landslides and drying springs forced them to abandon their village upstream - but they have re-established themselves on a floodplain at the outlet of a tributary that shows geological evidence of large-scale debris torrents. They have shifted away from one hazard, yet into the path of another potential geohazard, but they remain there

[3] A recently published book focused on struggles over conservation and development in the Garwhal region of northwest India, called River Dialogues (Drew 2017), highlights the complex tensions between local desires to protect Mother Ganga in the face of hydropower development that would impede the flow of the Ganges River and the everyday desires for development, increased connectivity, and new forms of livelihood that local people express. Here, after a series of protest movements involving high-profile environmental activists and a handful of natural disasters, the Indian government decided to abandon the proposed hydropower projects and create an "Eco-Corridor" in the region. Local people celebrated this victory at first, but then became frustrated when the benefits of the Eco-Corridor did not materialize as promised – tourism came in limited amounts, but conservation mandates also limited development activities in the area and people again began to feel a sense of relative deprivation. As a result, a few years after the legal decision to create the Eco-Corridor, Drew returned to her research area to find some of the women who were vocal anti-dam advocates now advocating against the "Eco-Corridor" that was created to protect Ganga, as well as new forms of pro-dam protest – where local political party members are protesting against the outside influence of environmentalists and intellectuals who they view as anti-development interlopers. Feeling neglected and frustrated with the 'fossilization' of the Garwhal region, many locals now longed for hydropower development (though small and medium scale, importantly) as well as the benefits of connectivity it may bring. A similar situation seems entirely possible in Nepal where many people do desire hydropower development (Rest 2012; Lord 2016) and accusations of being anti-development are common – and so conservation advocates must be careful to recognize the validity of local concerns about development and livelihood.

because these are the only affordable lands close to the new road, which offers business opportunities. Elsewhere in Bajura, we encountered another ramshackle community of squatters living in tin houses that had been displaced from a community on the ridgeline above the river. In several places, we tried to talk to people about the ways the risk of a large earthquake in this part of Nepal – many seismologists agree that there is a 'seismic gap' in the Far-Western region, that a 8.0+ magnitude is both immanent and now roughly five hundred years overdue. One locally elected-official commented on strange boulders perched on hillsides that seemed to be evidence of large floods in the past, and expressed concern about the need for investments in disaster preparedness and active disaster risk reduction programs throughout the Karnali region. Given a life of hardship and limited political power, many people were more fatalistic - speaking about the risks of such disasters one woman in Kalikot told us *"ke ke hune bhanna sakdaina, jehi pani aune tei paaunchha"*, or 'one can't say what will be, you get whatever comes'.

Spiritual and Cultural Values

The middle section of the Karnali watershed hosts at least two significant religious sites located directly on the banks of the Karnali river: the temple complex at Talla Dhunegshwor which includes temples to both Shiva and Bhairav, and a small temple and pilgrimage site near the village of Thirpu that marks the place where the Hindu goddess Sita's heart fell to earth. In addition to this, there are several other small shrines, caves, and other sites of prayer located at the dhoban or confluence of the Karnali and its tributaries or along the pathways that flank the river. In the districts of Dailekh and Achham, several cultural heritage sites - such as the Dullu Durbar, Panchadewal, Malla era archeological sites, and stone inscriptions that speak to the origins of *Khas-kura* (the root of contemporary Nepali language) – are located just a few kilometers from the river corridor. Considered together with the sacred landscapes, temples, monasteries, and shrines located upstream, these sites speak to the diversity of religious traditions that have existed throughout the Karnali River Corridor - providing tangible examples of the Karnali region's dynamic history and cultural heritage.

The Lower Karnali Watershed: Living with the River, Living with Floods

In the lower regions of the Karnali watershed, the lives and livelihoods of people living in riparian communities are intimately connected to the river. Traditional fishing communities of *Majhi* and *Rajhi* people depend on the river's aquatic life for subsistence and livelihood, the livelihoods of the indigenous *Tharu* and *Sonaha* people are woven together with seasonal cycles of flooding, over one hundred thousand farmers in Kalikot depend on the Karnali for irrigation systems, and many other people benefit from the biological diversity that supports tourism in the Bardiya region. In no uncertain terms, the mighty Karnali is the major force that shapes the seasonal rhythms of the landscape. In this region, people seem aware that the Karnali is both unique and valuable, if difficult landscape, a sense that something might be lost.

A Wild and Winding River

As the Karnali River winds its way through the middle hills in the district of Dailekh, it takes a massive turn that forms a unique geological feature called 'The Big Bend'. After this bend, the river makes its way through a long gorge that is popular with the international rafting community – an incredibly beautiful landscape with rich forest, interspersed with only a few settlements. The *Raute* people, Nepal's last truly nomadic indigenous group, commonly move through these forested corridors, foraging and subsistence hunting throughout the riparian landscape. While a few bridges overhead link with footpaths that extend throughout the area, which

residents told us were historically important trade routes in the past, this section of the landscape is entirely roadless. The incredible geologic formations, waterfalls, wildlife, world-class rapids, sandy beaches for camping, and picturesque riverside villages make this section of the river one of Nepal's greatest natural treasures. With this in mind, we recommend that Nepal should create river conservation legislation to preserve the environmental health and natural beauty of areas like this in Nepal – see our specific recommendations below.

Hydropower Dreams: Part 2

While exploring this section by raft, we came to the settlement nearest to the site of proposed powerhouse for the 900 MW Upper Karnali Hydropower Project. The Indian project developer GMR had leased a small plot of land for the past eight years, but people were pessimistic about the future of the proposed project. "Eight years have passed, and we don't see any other changes. They say that the project will come, but we have seen nothing." They told us that the project developer has provided some support for the construction of a local road to the main village above, but that they have heard little discussion about extending the road down to the powerhouse site. "They hired this group of security guards to watch the project facilities here after the 2015 bomb attack on the other project facilities at the dam site (in Daab), but there is nothing inside these buildings." While there was admittedly more project infrastructure at Daab, our conversations with the locals at this site indicate that perhaps the imagined hydropower future is not as close as expected here. If this is truly the case, then we ask: why not focus on developing a strategic plan for hydropower development in the Karnali Basin that allows the Karnali River to flow unbroken, in its entirety or at least in this one incredible section?

Critically, however, there is another large hydropower project that would also disrupt this pristine section of river being planned just a few kilometers downstream: the recently-licensed 688 MW Betan Karnali Hydropower Project. If constructed, this 'peaking run of the river' project would create a 50m high diversion dam just above the Seti confluence that would store about 125 million cubic meters of water. This dam would then tunnel water 7 kilometers through the Mahabharat Range, dewatering an estimated 69 km of river through some of the most productive Mahseer fish habitat in the entire Karnali river basin. Like the Upper Karnali HPP, this project takes advantage of a massive bend in the river that creates good hydraulic head with low tunneling costs – it is considered to be an easy value proposition. When we visited the proposed powerhouse site at Jamune, locals living in the 'project-affected area' had little concrete information, but told us that the feasibility study and the environmental impact assessment had already started.

While the Upper Karnali HPP has long been delayed and complicated by geopolitical issues, financial negotiations, court cases, and different forms of nationalist resistance among Nepalis (Butler 2017) the Betan Karnali HPP is being developed and financed by a high-powered consortium of Nepali institutional investors - including the national Employees Provident Fund (EPF), in partnership with the Nepal Electricity Authority. In the current political environment, this project could move ahead very quickly - indeed the project recently achieved financial closure in April 2019, and project developers have estimated that the project could be completed within five years.

Even more worrying, is the fact that project developers are now talking about reducing the Betan Karnali's project's generation capacity from 688 MW to 425 MW so as not to affect future plans for the 10,800MW Karnali Chisapani Hydropower Project that has also been proposed downstream. The Karnali Chisapani HPP – which was proposed many years ago, but which seemed to be abandoned – would be the largest project in South Asia. By building a massive dam at pinch point in the gorge just above Chisapani, it would inundate and

displace tens of thousands of people, flooding the Karnali River Valley all the way up to the Seti Confluence, and drastically reduce flows throughout the Karnali delta in the Bardiya region, disrupting riverine connectivity and damaging habitat for species like the Golden Mahseer and the Gangetic River Dolphin that are already endangered in Nepal. In short, this dam would be environmentally devastating and require resettlement and relocation on a scale never before seen in Nepal. Why would the Government of Nepal consider this project, when dozens of other hydropower projects are already under construction that, once completed, will provide more power than Nepal can possibly consume? The call to Nepalis to sacrifice their lands on behalf of a nation struggling with energy scarcity and crippling blackouts no longer applies. So why would a massive and incredibly destructive project like this be needed, and who would actually benefit from it?

With all these hydropower schemes being considered in the Karnali Basin, many people just want to see something built, after years of waiting. But is this emotional response really wise? Can river conservation advocates convince government officials in Karnali Province and Kathmandu to conduct a strategic and cumulative impact assessment in the Karnali region? Can Nepal come up with an alternative plan to generate hydropower in the Karnali Basin – such as the one proposed in this report, where an estimated 6,000 MW can be generated by building dams on the tributaries alone – that can help conserve this pristine stretch of river? Or is it already too late?

Valuable Fisheries under Pressure

The lower section of the Karnali is one of the most productive fisheries in all of Nepal, and it is also currently one of the healthiest, in terms of water quality and river connectivity. Throughout the lower Karnali, we encountered people of all ages fishing – setting nets from the shore, poling upriver by boat, using traditional and modern methods, subsistence fishing and fishing for markets. In the *Majhi* and *Rajhi* villages above the Chisapani gorge, where fishing is their traditional source of livelihood, dozens of people were working along the riverbanks every morning and evening. Our freshwater ecologist was glad to report that water quality remained very high throughout the lower basin, and fish habitat remained largely intact.

However, when we spoke to the locals in these communities, they all described a gradual decline in the wild catch, which they attributed to fishing pressures and problems with breeding upstream. Many of the elder fishermen spoke of massive fish that they caught in the past, and then immediately said "but we don't find fish like that here anymore." Most people stated that overfishing was a risk – that the number of people fishing had increased drastically, that people fishing for markets fished throughout the year, rather than at specific times, and that some people were using illegal methods like electrofishing, dynamite, and poison. Seated outside his home, designed in the unique vernacular of the Rajhi communities, one old man described a fish species that he hasn't seen in a long time. A few people also commented on the need to create and enforce fishing regulations evenly, saying that "if we fish less here, they will fish more upstream." Overall, we found that thoughtful regulations, seasonal restrictions, and coordination are required to preserve the health of these fisheries.

Creating specific protected areas and promoting sport fishing or angling is also one strategy to promote sustainable fishing practice and promote regulated ecotourism opportunities linked to fishing. During the expedition, our team camped at the confluence of the Karnali and the West Seti river for two nights, during the festival of Dashain. While here, we talked to a variety of local people, including one man who lived just across the confluence who frequently worked as a fishing guide for foreign and Nepali tourists who come to the area. When our team members proposed the idea of creating a Mahseer Conservancy that would stretch

10km upstream and downstream from the Karnali-Seti confluence, he was visibly excited, but he also reminded us that regulation is also needed in other places, and that "fewer Mahseer are coming here now than before." One man with a dark sense of humor in the *Magar village* of Jamune who was aware of plans for the Betan Karnali HPP joked: "If they build the dam then we will catch a lot of fish here once, because where will they go?" All of these comments point to the need to scientifically assess the many different impacts that put pressure on aquatic populations in the Karnali, and the need to create a comprehensive fisheries management plan in the Karnali watershed.

Irrigation Systems

Irrigation is one of the most important uses of the Karnali in the lower regions. However, while soils in the region are quite fertile overall, many small villages on the stream terraces along the continue to struggle to meet their needs during the dry season with pump irrigation due to a lack of power supply. In the Terai, just south of the point where the river emerges from its final gorge at Chisapani, a portion of the Karnali's flow is partially diverted to serve three major integrated irrigation systems – the Rani, Jamara and Kulariya irrigation systems. For over one hundred years, these systems were traditionally constructed, maintained, and managed by farmers by farmers from the indigenous *Tharu* community. Every year, during the dry season, thousands of farmers would work to rebuild the complicated diversions systems on the main channel of the Karnali needed to water their fields – a massive collective undertaking – only to have these structures washed away during the monsoon. In recent years, the Government of Nepal and the World Bank has initiated the two-phase "Modernization of Rani Jamara Kulariya Irrigation Scheme Project" which seeks to build permanent diversion structures and upgrade the canal system so as to gaurantee water delivery, improve system operations, and increase local resilience to drought – the system will still be managed collectively by a local Water Users Association. Phase One was completed in 2017, and Phase Two is soon to be underway. Collectively, these systems divert a significant percentage of the river's flow to irrigate over 14,300 hectares of land, serving about 150,000 people in Kailali District (World Bank 2018). Several other smaller community-scale farmer-managed irrigation systems also depend on the Karnali River and the expected seasonal variations in flows. If dams built upstream or other diversion projects (such as the Bheri-Babai Diversion which will reduce the flow of the Bheri river, the Karnali's largest tributary) reduce the flow or timing of flows during the dry season, thousands of people's livelihoods will be affected.

Living with Floods

In the Lower Karnali region, floods are a fact of life – giving and taking life and land, shaping local economies, providing a variety of ecosystem services, creating unique habitats and livelihood opportunities. The river rises swollen with the monsoon, flash floods are common in the dry tributaries, and major flooding events that caused significant damage have occurred in 2040, 2063, and 2071 BS (1983, 2006, 2014 CE, respectively). In the *Rajhi* villages on the banks of the river in the meandering plains above the Chisapani Gorge, people described the damage inflicted by the 2040 floods, saying "the river came all the way up to those hills" pointing several kilometers behind us.

In the Bardiya region of the plains, the Karnali River spills out into a broad delta - a constantly shifting landscape landscape inhabited by tens of thousands of people who are subject to the full force of the Karnali's hydrologic cycles. floods are a common occurrence. The communities living in this region, especially the indigenous *Tharu* and *Sonaha* groups that inhabit the Bardiya delta, must cope with and adapt to the intense flood conditions that typically occur 3-4 times per year. Over the years, the government and

local communities have built a variety of embankments, levees, and other 'river-training infrastructures', while a variety of NGOs have helped to develop flood warning systems and initiate programs focused on increasing the 'resilience' of communities living in the area. While these measures have helped some people, they cannot fully prevent floods, as the river will inevitable rise or changes course, defeating these efforts at containment. Similarly contemporary attempts to control flooding with engineering or promote resilience in the face of future events often take little account of the historical and structural roots of vulnerability and exposure (Gladfelter 2017). In Bardiya, people's relationship to the river, their vulnerability to floods, and their capacity to 'be resilient' is also shaped by past government policies of mass resettlement, clearing forest areas, and the creation of Bardiya National Park, and the shifting policies of various environmental managers that limit traditional livelihood activities like fishing.

Several scholars who have examined the flooding in South Asia have found that floods have only recently become understood as 'disasters' – the result of a situation where seasonal changes in the hydrological cycle that previously supported agriculture productivity have been reinterpreted as hazards to be managed and exacerbated by various planning failures, attempts to regulate land, and efforts to constrain flows with in-stream infrastructures that intensify flooding events when they fail (Dixit 1999; D'Souza 2006; Gladfelter 2017; Cortesi 2018). Throughout the main channel of the Karnali river near Tikapur, local governments and NGOs have invested heavily in the construction of embankments, levees, gabion walls to protect against floods. Though many people in the region attribute these interventions for the decrease in flood damages over the last 3-4 years, others say it is only a matter of time before the river rises and overtakes these structures. As elsewhere in Nepal, transboundary water management also plays a factor: several locals complained about the Kailashpur barrage downstream over the Indian border, which is often closed to protect Indian lands, causing the river to backflow: intensifying short-term inundation in Nepal and increasing sediment deposition on the Nepal side, which raises the level of the river over the long-term.

Writing about life on Rajapur Island in the Bardiya region of the Lower Karnali basin, a landform situated in the middle of the braided channel that was itself created from the deposition of sediment during past flood events, Sierra Gladfelter (2017) suggests that: "Over time, the nature of floods and peoples' relationships to them have changed as the island's most precarious residents increasingly face disasters exacerbated by development patterns and infrastructure, at the same time that they have been structurally dispossessed of alternative ways of living with the river" (p.76). For example, the *Sonaha* people, whose traditional livelihoods depends on gold mining, also benefit each round of floods brings a new pulse of gold deposition. *Sonaha* people have adapted to floods in part by constructing houses with raised platforms and then remove the temporary walls of the lower level, allowing the flood to pass through. During our expedition, one *Sonaha* woman said very clearly: *"Baadhi aayeko thik, gharma na pasos, sun pani paine, machha pani paine."* (It's okay if the flood comes, may it not enter the house, gold is available, as is fish"). This quote demonstrates the ways that people conceptualize floods differently, as well the ways that riverine communities had shaped their ways of living to adapt to seasonal variations in river flows, including floods.

Ecotourism and Environmental Ethics

The pulsing flow of the Karnali supports an incredible wealth of biodiversity in the Bardiya river delta and within Bardiya National Park – the largest and most diverse conservation area in the plains of Nepal. In this way, the Karnali, which spreads into a complex network of braided channels (including the Gheruwa which delineates the edge of the National Park) helps create a thriving ecosystem that supports a variety of rare and endangered species – from river dolphins and tigers to river otters and migratory birds. The health of

these ecosystems already supports a booming ecotourism sector in the Bardiya region, which supports local livelihoods that are both directly related and ancillary to conservation efforts. In short, the Karnali has a great deal of different ecological and aesthetic or scenic values in the Bardiya Delta.

However, because the benefits of tourism are not always evenly distributed, and because conservation programs can also limit access and constrain the livelihood of communities living within or on the edges of conservation areas, other alternative forms of livelihood must also be considered and promoted. In the context of Bardiya, it must be acknowledged that these seemingly "wild" landscapes are also inhabited, particularly by the indigenous *Tharu* and *Sonaha* people who have rights that must be respected. Local communities who value the river in different ways must be consulted and meaningfully engaged in discussions about sharing the benefits of environmental conservation programs. [4]

Some of these issues surfaced during discussions about dolphin conservation in the Bardiya region of the lower Karnali basin – the Gangetic river dolphin is critically endangered in Nepal, with only 48 dolphins remaining across the country, most in the Lower Karnali basin. The Mohana River is a 'dolphin area' part of the year, because the dolphins come with babies when the river is in flood stage, and this brings tourism and economic opportunities to communities living along the Mohana River on a seasonal basis. However, if the area is officially declared a dolphin sanctuary and access or activities is limited, then some people might lose their livelihoods, especially when the dolphins are not present and tourism is low. Therefore, conservation initiatives in this area must also that accounts for temporal variations in dolphin distribution and flow as well as livelihoods – perhaps creating more fine-grained fishing regulations that shift on a sub-seasonal basis. Educational programs focused on riparian communities are also needed, to improve the efficacy of conservation programs and to help locals understand the potential impacts of upstream hydropower projects. As dolphin conservation expert Sarah Levine (2015) has suggested, while looking at the Mohana and Karnali delta: "It is more vital than ever that those with riparian rights to their shared basins are given the proper knowledge regarding the sanctity and utility of their water." To this end, one exciting idea recently emerged during the Paani Program's conversations with the *Tharu* communities: how about creating a scholarship for children from the area to study fisheries science? Only situated and long-term dialogue with locals can resolve frictions over issues of livelihood in communities living near or within conservation areas. Lastly, we would like to point out that patterns of tourism are changing, and that a significant environmental ethic is slowly growing with Nepal. While visiting Bardiya National Park at the end of our expedition down the Karnali we encountered a surge of Nepalis visiting the park during their Dashain holidays, and we could see a growing interest in environmental issues and appreciation for 'wild and scenic' places emerging in the younger generation of Nepali society. Recent reports on Nepal's tourism sector have indicated that Nepali tourists are making up a significant and rapidly expanding portion of tourist revenues – and at least during our visit to Bardiya, there were more Nepalis than any other kind of tourist. At the same time, many young Nepalis are formally and informally promoting environmental values on social media, through sharing stories about their trekking, rafting, and climbing experiences. In this way, hundreds if not thousands of Nepalis, are already doing the important work of traveling in their own country and raising environmental awareness. We believe that encouraging Nepali tourism and recreation is both a promising economic vector for promoting local economic growth and a viable way to cultivate an environmental ethic in Nepal.

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[4] Research in Nepal and around the world has suggested, so-called 'fortress conservation' that evicts or displaces local communities living in or near conservation areas is inappropriate – recent controversy over the ways that security forces treat locals living near Chitwan National Park are just the most recent shocking example (Ghale 2018a). Ongoing contestations and recent events in Nepal, such as local protests over governance and revenue sharing in the Annapurna Conservation Area (ACAP) of Nepal (Baral & Stern 2010; Croes 2013; Shrestha 2018) indicate that questions of benefit-sharing are central in local decision-making and that ongoing local consultation is critical to the success of any conservation project.

Envisioning Sustainable Development

The Karnali region and especially the Karnali River corridor has much to offer Nepal's development that is currently not being highlighted by either Nepal tourism or Nepal's economic outlook. The intact cultural diversity found from upper Humla to the Terai is unparalleled. The ecological zones that one can cross over short distances can bring bird, wildlife and native plant interest groups flocking to the Karnali Region. In fact, the harshness of the environment itself makes the area appealing. And finally, the Karnali is Nepal's last and most pristine free-flowing river. That brings a notoriety to the Region that no one else can claim. An intact protected river system can be as valuable for tourism as Everest is to the Khumbu Region, the Annapurna and Dauligiri Range is to central Nepal. Marketing the Karnali River for its scenic and water sport adventure values makes the region a tourist destination.

As Nepal turns to federalism and each province seeks to negotiate its own development path, local leaders in the Karnali river basin can work together to implement smart development choices. This is a moment to frame a new history for Nepal. One of development and environmental conservation. The following sections of this document were developed to explore a variety of options for smart development in the Karnali Region. Smart development, guided by insightful politicians brings prosperity to all, even marginalized groups, within the basin while protecting the environment for both current and future generations. Development in a rapid and haphazard manner, without regard to environmental factors, brings prosperity to a few and ruins the environment reducing economic opportunities for the many while stripping future generations of the chance of a healthy prosperous life.

There are many values to protect in the Karnali region, including the diversity of ecological zones, cultural zones, the river and its beauty and its turbulent whitewater, the fragile hillside slopes and stream side terraces that provide for agricultural products and the religious heritage of Shiva's journey along the Karnali with Pavrati making it a pilgrimage heritage corridor. At the same time, there are many threats. Hydropower threatens to truncate the flow of rivers while providing electricity to other areas of Nepal, India and Bangledesh, sand mining threatens river flows and aquatic habitats, irrigation diversions threaten both stream and sediment flows.

We present information that promotes smart development and includes, first, the provision of a strategic, well-constructed road system that is guaranteed to provide access 12 moths of the year. If a road doesn't provide access 12 months of the year, it is not a road. The techniques for proper road construction are codified in Nepal's road construction standards, however, local decisions makers are pressured to build the longest road possible with their budget rather than taking the time to build proper roads that may take longer to reach their destination. Local decision makes need to be held accountable for following standard road construction practices.

In this section, we also talk about hydropower resources and the potential for developing over 6,000MW of electricity in tributary streams before impacting the flow of water, sediment and aquatic species in the mainstem of the Karnali. We present alternative energy systems that can be immediately implemented and provide for sovereignty to the area with solar, wind and micro-hydro projects. At the same time, we recognize that it is impossible to talk about alternatives to hydropower development, without also discussing the need to promote local livelihoods and to design an alternative benefit-sharing plan.

We propose that concurrently skills are developed within communities throughout the Karnali corridor to provide for ecotourism along with development of community lodges and improvement and marketing of multiple trekking routes to spread economic opportunities throughout the basin. This includes a pilgrimage corridor from Kailash to the Ganges and to Lumbini. Ecotourism opportunities must serve a variety of clients from the backpacker trekking set, willing to camp and who want to interact with local communities in a remote, un-roaded experience to those who travel on busses and expect clean, well-constructed hotels. We highlight the opportunities for an increase in water-based tourism and the need to train local guides, start local rafting companies and provide boaters with food, lodging and cultural experiences as they float down river. We highlight the many products already being produced throughout the Karnali basin and suggest development of cooperatives, reliable markets to purchase the goods manufactured by small cottage industries in communities throughout the basin.

Finally, we address governance opportunities that highlight conservation and protection of key stream sections for aquatic species and for their high value scenic, recreational, cultural and resource values. We present fishing and sand mining regulations intended to promote sustainable aquatic resources into the future and the need for transboundary water governance discussions with India and China. Restoration needs are highlighted and the many intact forest resources of the Karnali that can be used as reference libraries for restoration of other areas of Nepal. Lastly, we talk about research needs and the many key elements of society and the environment which need to be better understood before rushing to develop this unique area of Nepal.

Sustainable Road Construction

Road access is a crucial part of development. A national road system is currently being constructed into the Karnali River watershed. A strategically designed, well-constructed and maintained road system provides year-round access to markets, health care, and will bring tourists into the area. Roads constructed in the wrong place or with poor techniques fail to serve their purposes, cost more to reconstruct in the future and damage the land and rivers through which they travel. Road construction in the mountains of Nepal is not a technical issue but a political one. Existing laws and standards could lead to sound road construction. Is there the political will to enforce the laws?

Mapping unstable areas helps engineers avoid or mitigate problems, so that roads can stay open. The map below shows the suitability of road construction in the Karnali Corridor for existing (red) and planned (purple) roads. Roads are least suitable in the red areas, moderately suitable in the yellow areas and highly suitable, with little mitigation required, in the green areas. Chronically unstable areas, flood prone areas, and areas of rock outcrop and scree are unsuitable for roads. Funders and engineers can adjust road locations for all planned roads to avoid unstable areas and maintain options to establish protected river corridors with no roads.

There is considerable opportunity for local politicians to make decisions on enforcing road standards so that roads are safer and provide for year-round access to rural areas.
-DEVELOP AND ENFORCE A MASTER ROAD PLAN-
Don't allow bulldozers to go anywhere with poor design and construction techniques.

To maintain the essence of "old Nepal" keep roads to one side of the river or well above the river and allow road-free trekking trails to be maintained on the other. This allows visitors to view the river unencumbered by development activities.

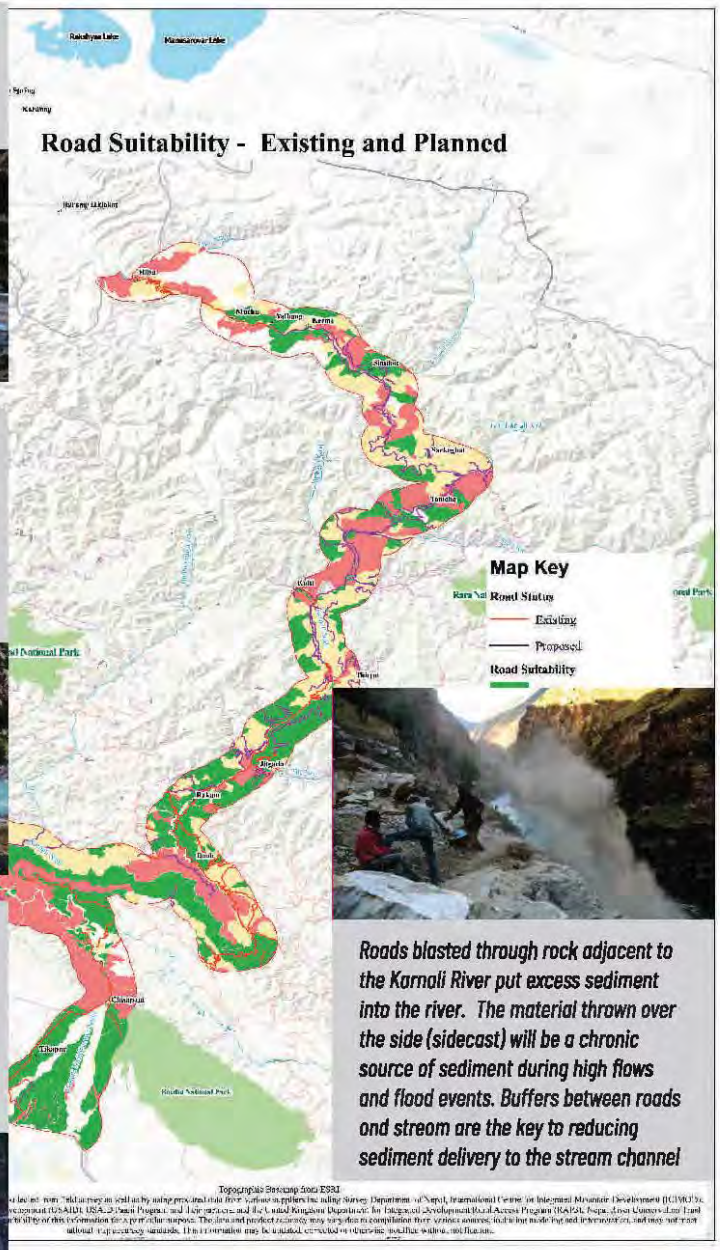
Roads constructed in unconsolidated sediments will constantly unravel blocking roads with debris.

A bridge abutment constructed in unstable glacial till is at risk of failure during high flows.

Colluvial slopes and those prone to debris torrents constantly fail onto the road bed. Methods to handle this constant erosion in these landforms needs to be designed into road construction techniques.

Narrow roads constructed on the contour at less than 10-12% grades minimize the height of the cutbank, and the amount of material sidecast and will have minimal erosion if not constructed through landslide terrain.

Roads constructed on horizontal or bedding planes slaping into the hill are inherently stable. Bedding planes matching the slope of the land are unstable, especially if undercut by road construction.



Roads blasted through rock adjacent to the Karnali River put excess sediment into the river. The material thrown over the side (sidecast) will be a chronic source of sediment during high flows and flood events. Buffers between roads and stream are the key to reducing sediment delivery to the stream channel

Tipping and swayed trees are a sign of deep seated earthflows. Excavating the toe of this area for a road can destabilize the slope Avoid these areas or mitigate with drainage and engineer buttresses.

Where a landslide has already occurred is where a landslide will occur again. Be aware! Know your landscape and design accordingly.

Developing this road will take away the scenic qualities of this area, remove historic trails and access few houses. A road over the top will avoid these development conflicts.

Best Practices for Ecologically Designed Roads

Construct low gradient (,10-12%) roads without stacked switchbacks.
Disconnect road drainage from streams.
Avoid stream diversions down road surface.
Avoid causing erosion or landslides by concentrating flows downslope.
Avoid increasing sediment load to streams.
Ensure culverts are sized to handle peak flows.

Strategic Hydropower Development and Cumulative Impact Assessment

All mainstem river systems in Nepal already have hydropower development on them. The Karnali is the last free-flowing river system in Nepal. Nepal currently has an installed hydropower generation capacity of 1,027MW, with another 983 MW expected to come into operation by 2020 (NEA 2019). This is more than enough to meet Nepal's electricity demand.
Is there a need to build the large-scale dams that would block the Karnali and impact its unique and globally important environmental resources? Or are there other more strategic options?

As development progresses, informed decisions need to be made that protect the people, culture and natural resources of the Karnali into the future. Short-term land use decisions that foreclose future options or result in irreversible impacts on shared environmental resources should be carefully considered before they are implemented - these decisions can change the fate of the Karnali forever.
The map below shows all the planned hydropower projects within the Karnali basin. Our assessment suggests that strategically choosing to construct hydropower projects in tributary streams rather than on the main channel of the Karnali will provide sufficient electricity supply for local economic development, generate employment opportunities and revenue, while also maintaining the flow and function of the Karnali.

HYDROPOWER POTENTIAL

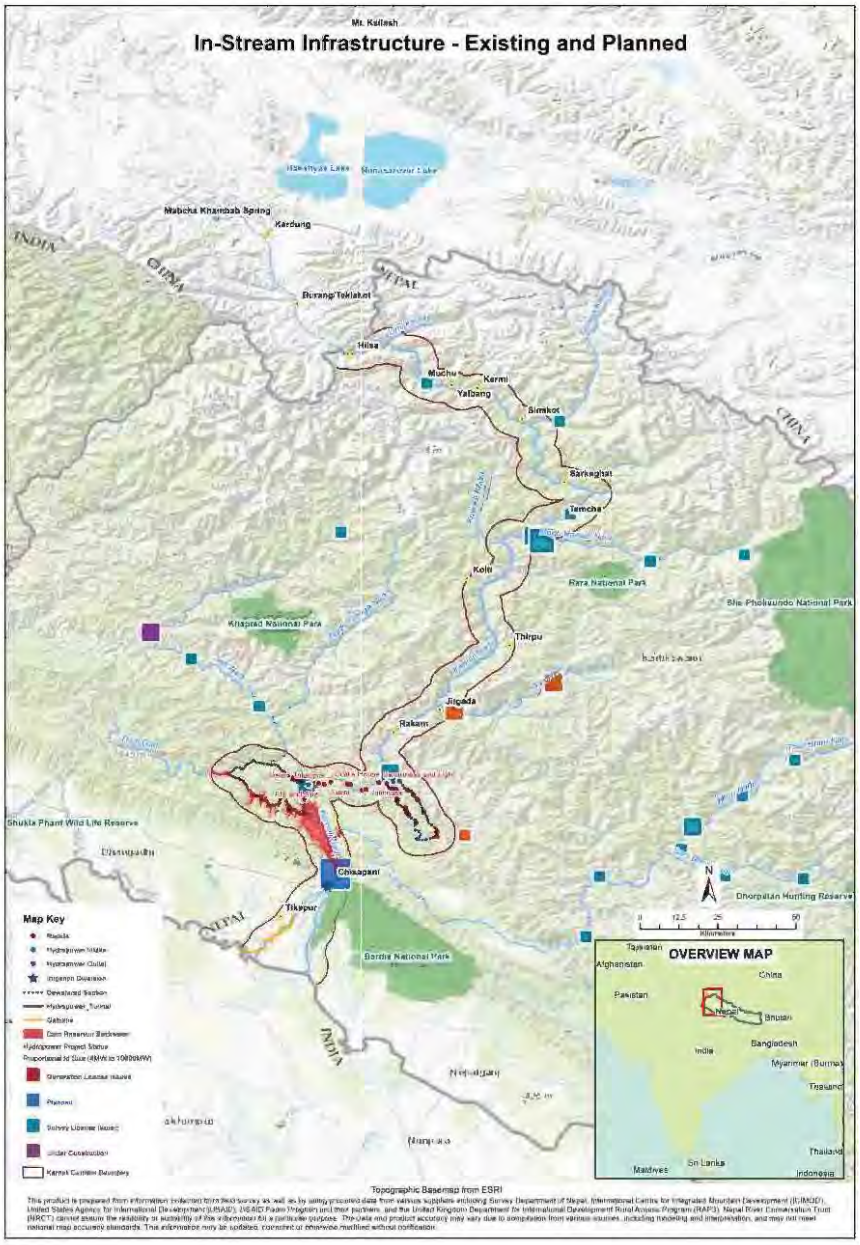
Mainstem Karnali	= 13,384 MW
Tributary Streams	= 6,510 MW
Total Planned	= 19,894 MW

At least one-third of planned hydropower development in the Karnali basin is on tributaries.
This amount (~6,000MW) is six times the current national capacity. Is this not enough?

Both the Upper Karnali Hydropower Project and Betan Karnali HPP will dewater key Mahseer rearing habitat and truncate migration routes of these endangered fish.

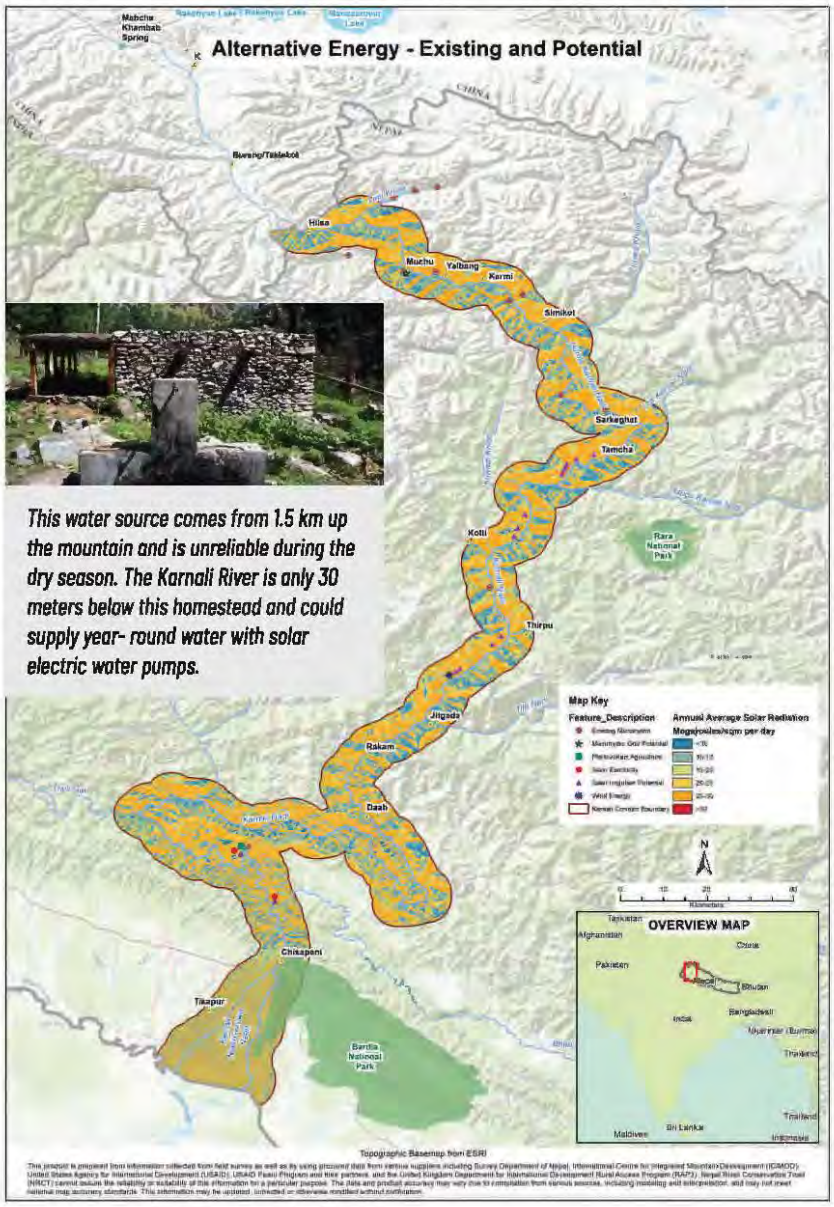
Many hydropower companies across the globe are finding that if adequate measures to protect aquatic species are implemented with hydropower construction, the design and operating costs to maintain environmental requirements are not economically feasible.

The Chisapani Multipurpose project will backwater this entire red area upstream of the Seti Khola confluence impacting hundreds of kilometers of key Mahseer rearing habitat, truncating the upper reaches of Ganges River Dolphin habitat and flooding out world class whitewater rapids.



Alternative Energy: A Diversified Energy Portfolio

In order to diversify sources of electricity and provide for energy sovereignty in the region, we prepared the map below of the solar potential of the Karnali River Corridor. The west side of the river from Tamche to below Rakam has the highest solar potential. In addition, existing micro-hydropower development of small, steep tributary streams supplies nighttime electricity to many communities in the upper Humla area. Individual and micro-hydro power grids could be developed to enhance electricity in remote areas. Wind potential too can add to the energy sovereignty of the Karnali corridor.



This water source comes from 1.5 km up the mountain and is unreliable during the dry season. The Karnali River is only 30 meters below this homestead and could supply year- round water with solar electric water pumps.

Throughout the Karnali, ancient stream terraces and alluvial and debris fans are perched far above the current level of the Karnali River. They can be added to the agricultural base with solar pumped irrigation.

The dry landscape (just above Tamcha to below Rakam) provides few water sources. Solar pumping of water from the mainstem of the Karnali river to elevated terraces will enhance agricultural productivity, aid in food security, help improve livelihoods, and provide a source of income for local farmers.

Wind energy: Every afternoon, strong winds travel up valley. Small windmills could also power pumps from the Karnali to supplement irrigation or provide electricity for local communities. Further study is needed.

High value vegetable crops can be grown under solar panels. Thinking holistically, this produce could supply community lodges built along the river.

Agrivoltaicsis co-developing the same area of land for both solar photovoltaic power as well as for agriculture.

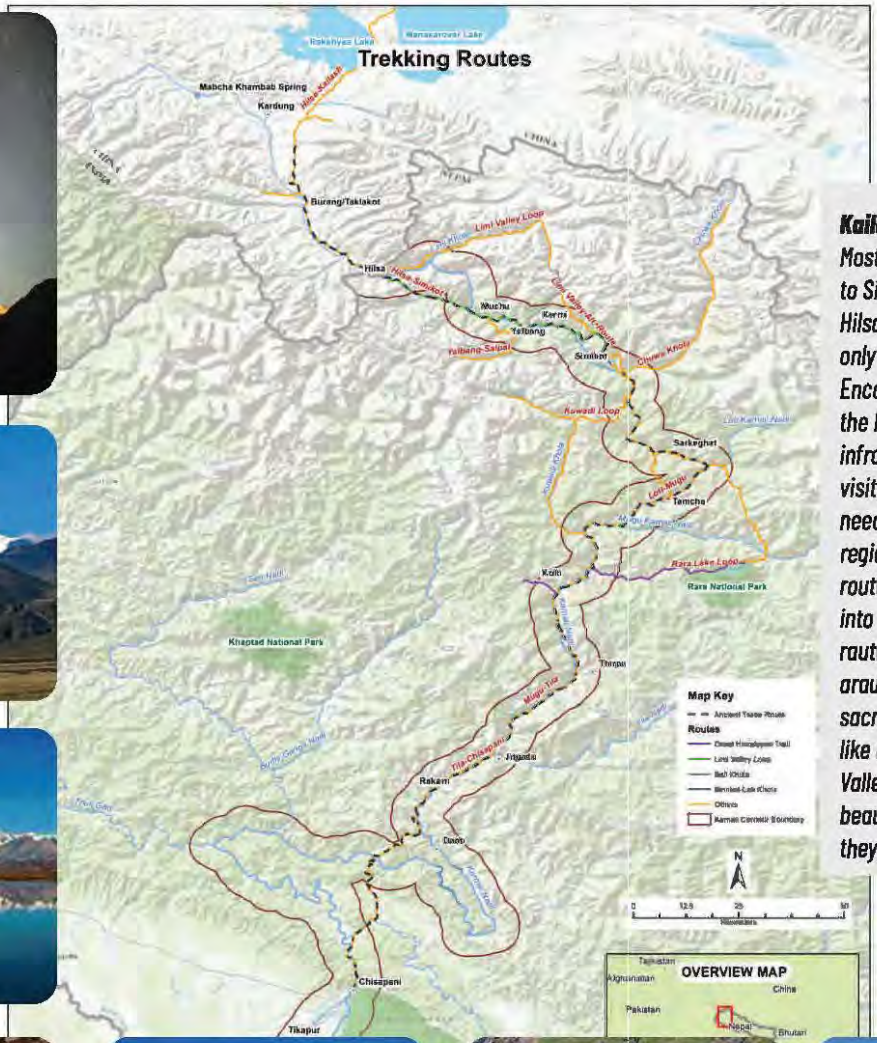
***Agrivoltaics** in arid landscapes, like the middle section of the Karnali, increases solar panel efficiency (solar panels don't do well in high temperatures) while providing a microclimate to grow plants. As the plants transpire, they cool the panels, condensation is captured by the panels and returned to the soil for more efficient water use.*

Ecotourism

The Karnali could be the next destination area of Nepal. Engaging local communities in development and creating infrastructure that invite tourists into this remote area of Nepal opens options that are no longer available to tourists in other parts of the country. Whereas the long-distance trekking routes of the Annapurna's are now are accessed by roads and see many user conflicts, and the Everest Region is clogged with visitors, the Karnali could be developed to allow for separate uses within the Karnali River Corridor. By the maintaining the unique cultural heritage, providing river views and access from trails, creating day and multi-day loop trail options and highlighting the historic trade routes and cultures between Tibet and India, the Karnali offers unique possibilities not found in other areas of Nepal. Ecotourism that highlights the Karnali River from trekking trails combined with water-based recreation options and access to locally grown organic foods and locally produced products brings economic opportunities to the area that currently do not exist.

Branding the Karnali Sacred River Corridor

Just as the Everest region in eastern Nepal, the Annapurna and Dhaulagiri mountains of central Nepal, the temples of Kathmandu valley and the jungles of Chitwan are known to travelers across the world, the ***Karnali Sacred River Corridor*** *could be established as a trademark and marketed as a destination for pilgrims, trekkers, culture seekers, and whitewater enthusiasts*



Kailash to Lumbini

Most tourists to Mt.Kailash fly to Simikot and helicopter to Hilsa, spending money with only a few corporate entities. Encouraging longer stays in the Karnali region with better infrastructure to support visitors will bring a much-needed economy to the region. The ancient trade route could be transformed into a modern pilgrimage raute, inviting tourist from around the globe to visit sacred Buddhist landmarks like Mt. Kailash, the Limi Valley and Lumbini along the beautiful Karnali corridor as they do.

Both infrastructure and training are needed throughout the Karnali to encourage and invite an ecotourism industry into the area. The most important aspect of this is to gain public support and local commitment to supporting a tourist economy for the long-term. Local champions need to be found who will lead this effort.

Ecotourism Training Centers

Development of training centers to improve local understanding of tourist needs and desires can be developed in Yalbang, Rakum and Tikapur. Training would provide business skills, health and sanitation requirements, meal preparation methods with ways to engage local farmers in the sale of organic produce, lodging requirements, and hospitality information. All of these skills are necessary to kick-start and maintain a vibrant tourist economy in the area.

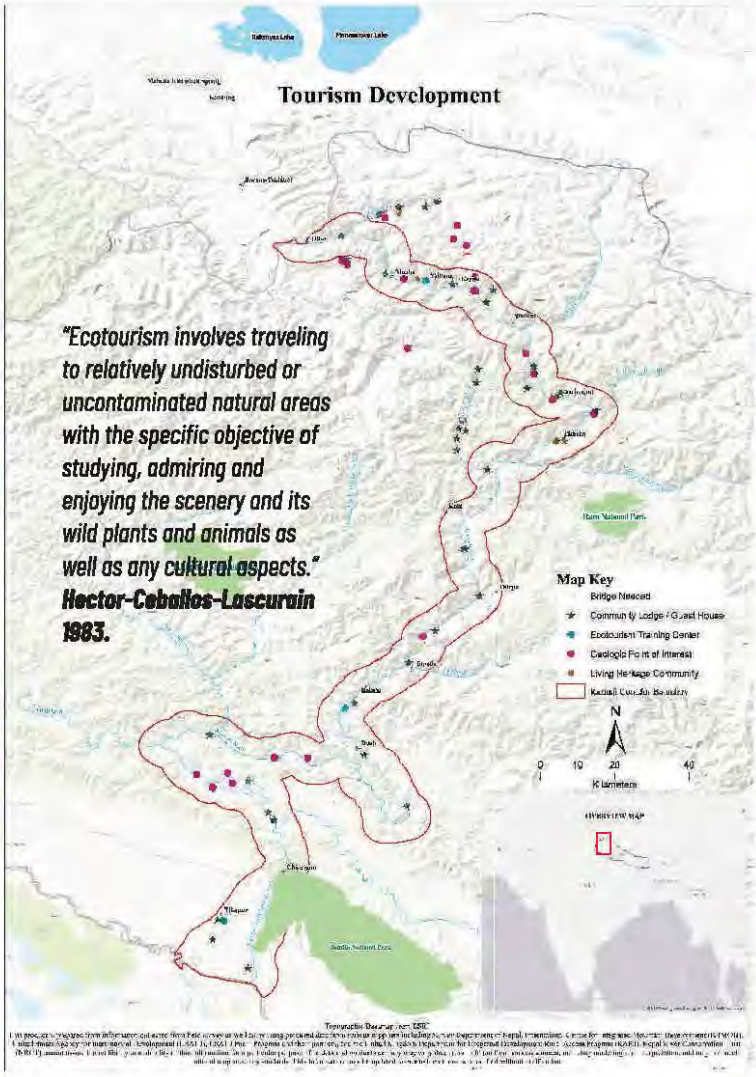
Community Lodges

Lodges need to be strategically placed within a day's walk of each other along the entire route of the Karnali River and side trekking routes. Community lodges would be built and maintained by community groups using local cultural architectural designs with the comfort features that tourists desire. All funds raised from rental of rooms and restaurant fees would be returned to the community with priority given to improving local school systems. Students could be engaged in operations of the facility.

Trails need to have glimpses of and access to the river.

Protect and maintain historic trails.

Encourage trekkers and boaters to stop at local communities for food drink, lodging and engage in cultural programs.



"Ecotourism involves traveling to relatively undisturbed or uncontaminated natural areas with the specific objective of studying, admiring and enjoying the scenery and its wild plants and animals as well as any cultural aspects." ***Hector-Ceballos-Lascurain 1983.***

Develop hot springs atLimi valley (2), Kermi, Karpunath and Urapani

Interpreting unique geology and highlighting geologic points of interests helps tourists understand the environment they are traveling through.

Paddling or even helping to construct a native dugout canoe would be a highlight of any trip. Training locals to be fishing guides would bring income to local economies.

Engaging with locals rather than quickly passing by on a river would provide meaning to the journey. Providing home cooked meals and local crafts engages tourists into learning more about the local culture.

Wildlife viewing, birding, fishing add enjoyment to a visitor's experience and make them advocates for protection of the areas biodiversity when they return home.

Water-Based Recreation

The Karnali is ranked in the top ten of world class white water rivers! It has the potential to attract a large tourist economy that is focused on the Karnali's whitewater adventures. The map below shows sections of the Karnali river that are suitable for kayaking, rafting or both. For advanced kayakers, the upper Karnali is an experience not to be missed. For novice and intermediate kayakers and rafters, the lower Karnali can be marketed for its challenging whitewater, broad white sandy beaches and clear starry nights.

Currently only Kathmandu-based rafting companies benefit from the spectacular Karnali whitewater. However, local communities can benefit from water-based tourism by supplying lodging, food and drinks if there is infrastructure to support the industry. We proposed, along with other ecotourism training, to promote a raft guide training center for local residents interested in becoming guides and starting businesses

The Karnali Class IV and V rapids, challenges even skilled kayakers.

White sandy beaches that rival those of vast oceans provide serene rafting campsites. Couple this with local cultural performances provides a way to connect boaters with the local community.

Encourage trekkers and boaters to stop at local communities for food drink, lodging and engage in cultural programs.

Single and multi-day trips will reach a diverse audience and will attract more local income.

Training locals to be raft guides and to start rafting / kayaking businesses is key to improving local economies.

Fishing in this section is sure to be rewarding.

The upper section of the Karnali provide a lifetime adventure for advanced kayakers and packrafts.

There is nothing like the peacefulness one gets early in the morning on a river trip.

Cliff-jumping, swimming and hiking are all side trip activities that can expand the enjoyment of multi-day rafting trips.

The Siwalik Hills offers wide-open vistas and phenomenal geology, a stark contrast to the deep, narrow canyons of the Mahabhart Range upstream. Local communities use the river for fishing and swimming offering numerous opportunities to interact with boaters.

An easy paddle through the Terai with warm weather, morning fog and a chance to glimpse wild elephants, tigers, rhinos, and spotted deer, endangered fresh water dolphin, and ancient gharial crocodiles makes this section an attractive, tranquil float.

Cottage Industry Development

Developing cottage industries with support and commitment from locals adds value to the products being produced throughout the Karnali River corridor. Success depends on marketing and finding reliable markets. The ability to produce and deliver products depends on a reliable transportation system, one that is open all year and can bring tourists in and export products. Both enhanced food security and livelihoods will result from extra cash on hand. People cannot appreciate their local environment and the beauty around them until their basic needs are satisfied. The map below shows some key places in the watershed where cottage industry development could be pursued by local development groups. Setting up cooperatives throughout the Karnali River Corridor, would help to share the workload and expand the availability of product making a dependable supply chain possible. Here are a few ideas of the types of cottage industries that would be supported that we learned about from locals during the expedition.

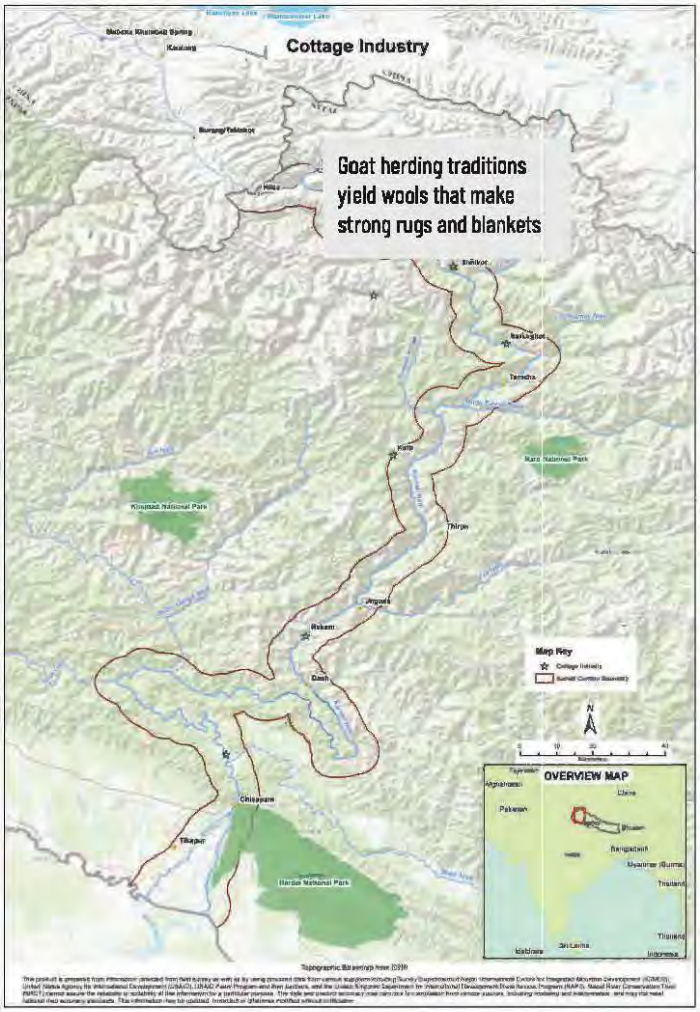
Yarsagumba harvest is lucrative but needs to be regulated and sustainably managed.

Fruit and Nuts (apples, apricots, berries, walnuts, hazelnuts) -fresh, dried, distilled, or processed into jams could be sold to tourists locally and exported.

Spring water could be treated and exported

The incredible variety of environments in the Karnali corridor produce a wide variety of plant species that can be used as spices, medicines or dyes.

LOCAL ORGANIC HONEY! A Kermi specialty



Maintain yak herding culture - produce milk, cheese, wool and a variety of spun, knitted, or woven wool products.

The unique climate of Kolti area is perfect for olives, Olive oil is already produced. Olives, stuffed with a variety of herbs and garlic could become a Kolti signature product.

Travel the Historic Trade Route with goats as your porter. A perfect marketing niche!

A regulated and sustainable harvest of sand, gravel and cobble can keep many employed locally.

Restoration Opportunities

The map below highlights several areas throughout the watershed where environmental restoration practices would improve water quality conditions.

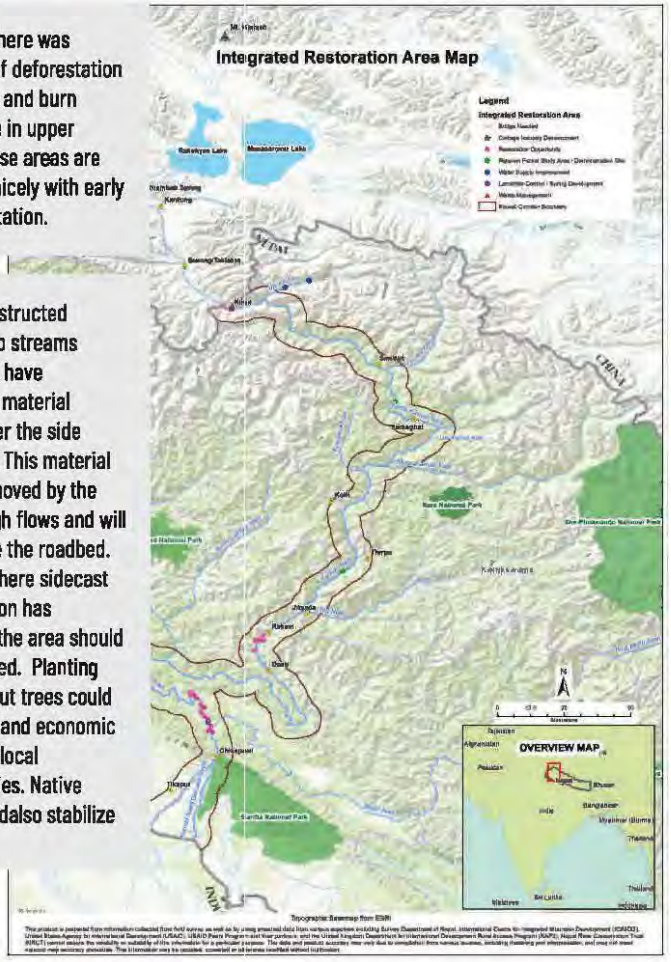
A Model Integrated Watershed Management Plan could be developed and implemented with input from the Rakum community. This area is on the main Karnali Highway and could serve as an education center for other communities in the Karnali Corridor.
Ideas (to be vetted with the community) include: reforesting riparian along streams, hardening native surface roads, showers and clothes washing stations along streams, constructed wetland for filtering water back to stream, aquaculture, garbage management, covered drainage system disconnected from stream, agroforestry on terraces, farmer managed irrigation system (solar pumps), rainwater capture, and landslide stabilization programs.

Hilsa is the base for many pilgrimages from Nepal to Kailash. The village lacks proper sanitation and garbage management. Garbage is thrown on the banks of the Karnali tobe taken away with high flows.

The sacred spring at Hilsa is atthe base of an active massive landslide. Access to the spring and the spring itself are uninviting. Piping the water to a place in town will avoid impacts from future landslide activity and allow the community to create a more spiritual place for pilgrimsto bathe and gather the waters.

Although there was evidence of deforestation from slash and burn agriculture in upper Humla, those areas are restoring nicely with early seral vegetation.

Roads constructed adjacent to streams should not have excavated material thrown over the side (sidecast). This material will be removed by the river in high flows and will destabilize the roadbed. In areas where sidecast construction has occurred, the area should be stabilized. Planting fruit and nut trees could help bring and economic activity to local communities. Native trees wouldalso stabilize the site.



The wide glacial streams in the Limi Valley need bridges for both truck and human traffic to safely cross and to avoid petroleum products from leaking into these pristine waters.

In many areas along the Karnali River Corridor, riparian forest vegetation is intact, these areas can be used as examples of healthy riparian areas. The tree species, number and spacing can serve as models of any reforestation effort.

The wide river valley above the Bherri Khola confluence has multiple opportunities for riparian reforestation. There is an excellent intact forest that can be used as a model on the alluvial fan across from Gaum Ghat.

An Enhanced Terai Forest Conservation Zone on the opposite side of the Karnali from Bardiya NP would provide critical habitat for wild elephants, tigers and rhinoceros and have better long-term flooding protection than gabion.

Like the successful Community Forest Management groups throughout Nepal, Community River Management Groups could be established along the Karnali. Each group would be responsible for management of a specific section of the river and would work with other groups to establish and enforce guidelines for stream system protection and aquatic species conservation.

Conservation and Environmental Governance for a Prosperous Future

Successful policy starts with a vision of the local leadership and by-in from local communities. Starting a conversation about Karnali River conservation and protection of its aquatic resources to benefit the people of the Karnali for the long term would be a positive step for the future of the area. In the following sections, we provide a series of strategic recommendations focused on river conservation and improving environmental governance in the Karnali River Corridor.

River Conservation Legislation: 'Wild and Scenic' River Corridors in the Karnali River

This section identifies and describes five sections of the Karnali River that we propose should be considered for formal classification via river conservation legislation in Nepal. Simply put, these sections of the Karnali have significant environmental and social values equivalent to other "Wild and Scenic Rivers" in the United States and other high-value protected rivers around the world. These recommendations are based on our empirical data and observations during the 2018 NRCT Karnali Scientific Expedition, and reflect our review of international best practices, as detailed above. The summary below is intended to provide a brief preview of some of these findings, focusing on the five sections of the Karnali River that have 'outstanding and remarkable values' that we believe should be protected. It is our hope that the following preliminary recommendations can be used to initiate further dialogue, data collection, and consultation about and within the Karnali basin.

International Examples of River Conservation Legislation

Over the last few decades, a variety of different laws have been enacted across the globe in an attempt to protect some of the last remaining free-flowing rivers from dams and development – in the United States, Canada, Australia, Ecuador, Colombia, New Zealand, and India. In general, these cases reflect an increasing awareness about the importance of river systems worldwide, and the need to manage water resources and riverine landscapes in ways that balance development and conservation goals. In each country, river conservation legislation has emerged in response to threats to the environmental health of rivers, and in some cases in response to concerns about the loss of cultural heritage that might accompany river degradation. we then consider the ways these cases might be pertinent to river conservation efforts in Nepal.

Based on the findings of our expedition, parallel research and scholarship on riverine health in other basins across Nepal, and a review of international modalities for river conservation that have been enacted, we believe that the time has come to consider enacting river conservation in Nepal. We also believe that the Karnali Basin is the best place to start – to introduce river conservation bills at the local, provincial, and central levels of government. In short, the Karnali River is rich in ecological, cultural, and scenic resources – it embodies the sense of "wild and scenic" that has guided river protection efforts in other countries around the world. Why shouldn't Nepal also protect its most valuable river resources?

For a detailed review of international river conservation legislation and recommendations about the process of introducing river conservation legislation in Nepal please see the companion report produced by NRCT titled "Strategic Considerations for River Conservation Legislation in Nepal."

A Guide to the Recommendations

For each of the proposed sections, we include:

- An overall map showing the location of each of the proposed sections
- Suggested classification/designation of each section e.g. "Wild", "Recreation", "Scenic" (as defined below; other terms may be used in the future)
- Brief descriptions of the "outstandingly remarkable values" (ORVs) in each section
- Individual Google Earth image of each section with on-site photos showing the character of the river and the surrounding landscape through that section.
- Key Opportunities and Risks for each section

Defining Terms

The recommendations highlighted in these sections are based on the following working definitions, which were created in the context of river conservation legislation in other countries – principally the U.S. Wild & Scenic River Act, but also the other countries reviewed in "Strategic Considerations for River Conservation Legislation in Nepal." With these precedents in mind, we are using with the following terms and designations as working definitions.

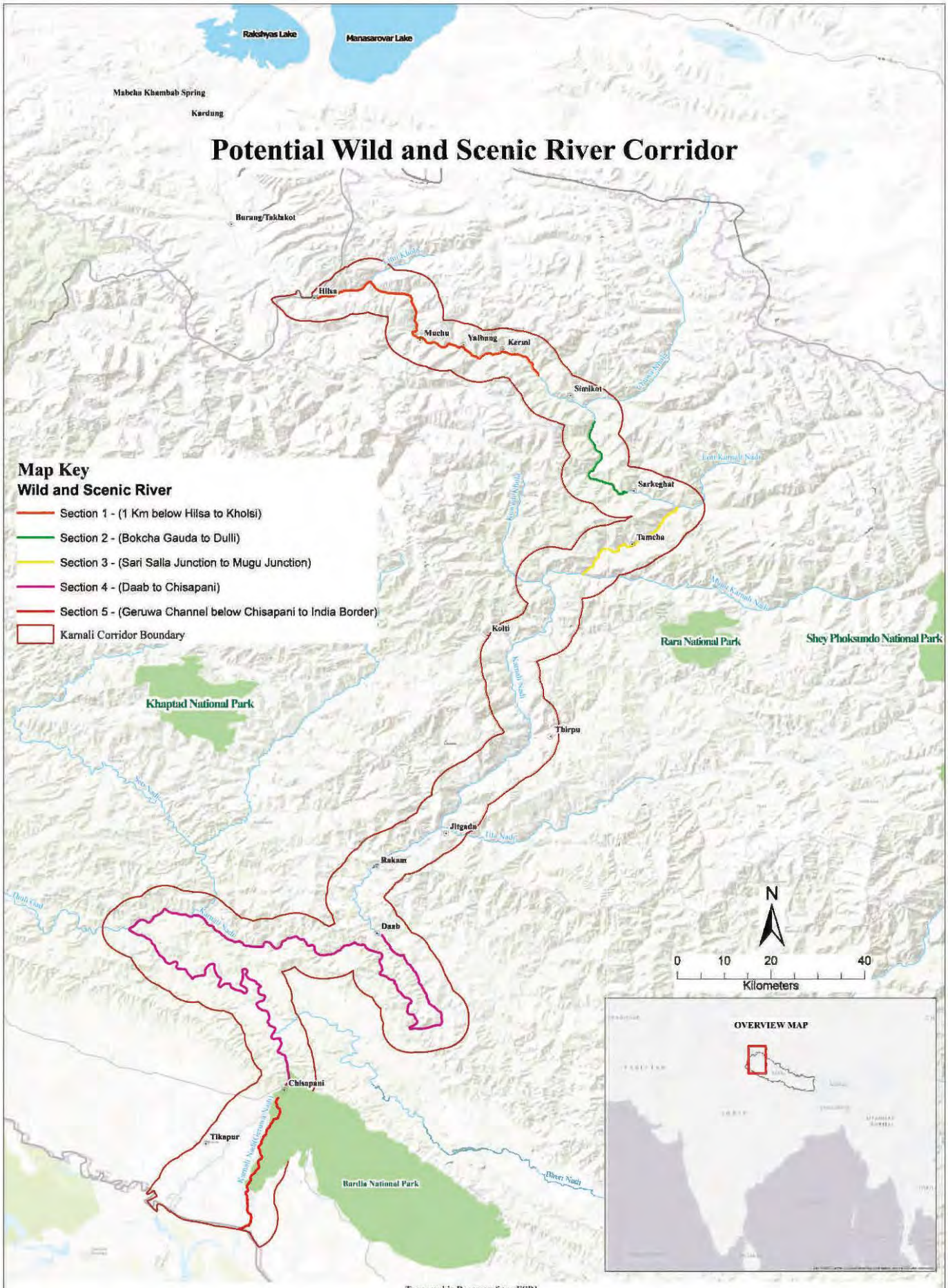
Wild River Areas – understood as those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially undeveloped and waters unpolluted.

Scenic River Areas – Those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely undeveloped, but accessible in places by roads.

Recreational River Areas – Those rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past.

"Free-flowing" as applied to any river or section of a river, means existing or flowing in natural condition without impoundment, diversion, straightening, rip-rapping, or other modification of the waterway.

Outstanding and Remarkable Value (ORVs) are organized in terms of geology, wildlife, fisheries, recreation, scenic, cultural, and historical values.



Topographic Basemap from ESRI

This product is prepared from information collected from field survey as well as by using procured data from various suppliers including Survey Department of Nepal, International Centre for Integrated Mountain Development (ICIMOD), United States Agency for International Development (USAID), USAID Paani Program and their partners, and the United Kingdom Department for Integrated Development Rural Access Program (RAP3). Nepal River Conservation Trust (NRCT) cannot assure the realibility or suitability of this information for a particular purpose. The data and product accuracy may vary due to compilation from various sources, including modeling and interpretation, and may not meet national map accuracy sandards. This information may be updated, corrected or otherwise modified without notification.

Proposed Wild and Scenic River Section 1: Hilsa to Kholsi

Designation:

Wild and Scenic: Starting from 1km below Hilsa to Tumkot is Wild / From Tumkot to Kholsi is both Wild and Scenic.

Free-flowing nature – This section is entirely free-flowing.

Outstanding and Remarkable Values:

Geology –Karnali dips into a deep gorge of granite just after the Limi Khola confluence – an area with 2500 ft deep cliffs bordering the river. At Tumkot, the river opens into glacial terrain, with glacial moraines dominant until just after Munchu. A confined river cuts through tectonic mountains with a few narrow gorges just below Kermi.

Wildlife – The upper gorges of the Karnali River in this section harbor endemic snow leopard, blue sheep, musk deer, langur monkeys and red panda. The Buddhist religion protects wildlife from hunting pressures although poaching does occur.

Fisheries – Fish occurrence in this area is unknown due to the lack of information from the surrounding Buddhist communities who don't fish. Kholsi marks the beginning of documented fish habitat and the Snow Trout up to 2kg in size are caught near Kholsi.

Recreation – Shiva's Gorge (just below Limi Khola) is for experienced kayakers only as there is little opportunity for rescue. Below the gorge, the river remains confined supporting experienced kayakers only.

Scenic – This section of the Karnali River has high scenic quality from the river itself, however, it is not accessible through Shiva's Gorge. Below Shiva's gorge the river is entirely accessible through a stream adjacent trail system and much of it is connected by a road that is above the river and out of sight of both boaters and trekkers.

Cultural – Currently, use of the river in this area is solely for disposal of bodies before or after cremation. People fear the violence of the river during floods and the loss of their loved ones. The Buddhist religion prohibits fishing in this section.

Historical - Below Tumkot, the trail following the river is the ancient trade route from Tibet to the Terai where

sheep and yak wool and meat were traded for salt from India.

Conservation Measures in Place: No protective measures currently exist.

Threats: The road through this area is already bulldozed into the landscape is its location is high on the hillslopes above the river. It crosses the river at Tumkot and much construction debris ha rolled off the hillslope into the river marring the visual quality.

Key opportunities include continuing to separate future road locations from the river corridor, waste management along the river, especially at Hilsa and Tumkot/Muchu, marketing this area for expert kayaker destinations, developing day trips in slower sections below Yalbang and Kermi and training locals as kayaking guides.

Proposed Wild and Scenic River Section 2: Bokcha Gauda to Dulli

Designation:

Wild and Scenic: This section is the essence of a wild river. The only access is by trails and the river trail is overgrown winding through cliffy areas as well as terraces hillsides.

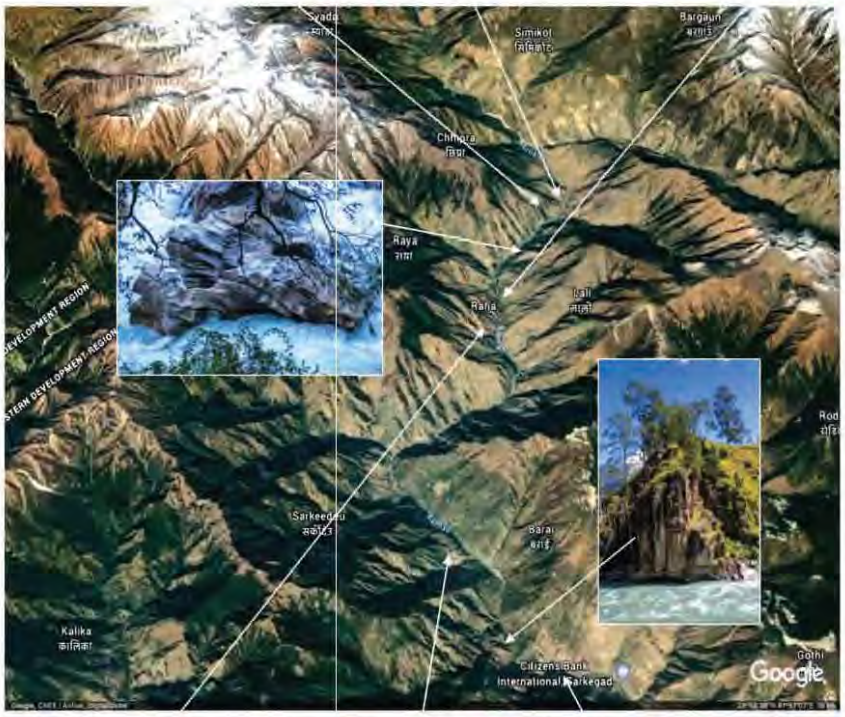
Free-Flowing nature: This section is entirely free-flowing.

Outstanding and Remarkable Values:

Geology – This section cuts through steep rocky terrain with rockfall dominating the hillslopes. Once in the river, these house-sized banded dolomitic rocks are carved into spectacular sculptures by the force of the river. After the gorge, this section continues through steep rocky terrain with rock out crop and rockfall dominating the hillslopes.

Fisheries - Snow Trout are found in this section

Recreation - Multiple Class V and VI whitewater areas abound in the upper portion of this section. It is too technical for most kayakers and not suitable for rafting.



Scenic – The surrounding hillslopes alternate between agricultural lands and associated villages on S and E facing slopes and precipitous cliffs dominated by exposed rock on the N and W facing slopes make this a dramatic landscape to trek through. The river trail offers multiple opportunities for scenic view point of the river and the surrounding landscape. The river cascades over house-sized boulders creating mesmerizing waterfalls and tumultuous cascades interspersed with quite backwater areas

and the first beaches encountered south of the Chinese border. Isolated swimming holes invite trekkers to cool off.

Cultural **–** Many people revere the Karnali as a river that flows from the sacred Kailash landscape, but they also fear the violence of the river during floods and the loss of their loved ones. Due to the steep canyon walls, most of the villages are perched on the hillsides. Toward the lower part of this section, several small villages are encountered. Dulli is an idyllic village that should be regarded as a cultural heritage site.

Historical **-** the trail following the river is the ancient trade route from Tibet to the Terai where sheep and yak wool and meat were traded for salt from India.

Conservation Measures in Place: No protective measures currently exist.

Threats: The road currently does not go through this area and the lack of road enhances the wild quality of this dramatic river section. Sections of road are being constructed below Sarkeghat which eliminates that section for W&SR designation. Those roads should be constructed above the river corridor to access villages above Sarkeghat.

Key opportunities include marketing this section as a destination for river tourism. Development would include improving the river trail and working with locals to create community lodges to accommodate tourists. Multiple loop trekking routes could be connected that include passage through this area including up an over the Kawadi to Rip or Rara Lake through this section to Simikot. Road construction guidelines should specify locations that do not interfere with the wild quality of the river in this section. The communities are much higher on the landscape and roads should also be out of the river corridor to access those communities.

Proposed Wild and Scenic River Section 3 - Loti Khola to Mugu Karnali Nadi

Designation:

Wild and Scenic: The beginning of this section is the essence of a wild river.

Free-flowing nature – This section is entirely free-flowing.

Outstanding and Remarkable Values:

Geology **–** This section begins in a spectacular gorge of nearly vertical metamorphic rocks. The rock layers are tilted straight upwards at 90 degrees to the way they were laid down as sediments. The sinuosity of the river here is a reminder that the Karnali once flowed across the landscape prior to uplift of the mountains and kept downcutting as the Himalayan mountains were uplifted.

Wildlife **–** Few wildlife species were noted in this dry section

Fisheries - Snow Trout dominate the catch of local fishermen. Sale of this fish provides economic opportunity to individuals living nearby the river.

Recreation **–** This is perhaps the best section of the river for adventure kayaking. It supports many Class IV and V+ rapids to challenge thrill seeking kayakers.

Scenic **–** The Karnali takes a hard turn river left at Sali Sala and the landscape, especially the south facing slopes become much drier with cactus, exposed rock outcrop, and grasses dominating. Few villages are found along the river. Those that do gather around the mouths of perennial streams that depend on precipitation much higher in the hills.

Cultural **–** Many people fish in this section and also gather firewood that is brought down during storm events. As the side tributaries and springs dry out, people obtain their drinking water from the mainstem of the Karnali.

Historical - the trail following the river is the ancient trade route from Tibet to the Terai where sheep and yak wool and meat were traded for salt from India.

Conservation Measures in Place - No protective measures currently exist.

Threats: Road construction currently is being done at the Loti Khola junction on the North side of the river. The road from there to Sarkegat is low on the landscape, following the river and is already failing due to sidecast in places close to the river. The road takes that section, Loti Khola to Dulli out of consideration for Wild and Scenic River status. However, with proper construction techniques (i.e. minimizing landslides and sidecast into the river, constructing the road well above the river, the Wild and Scenic nature of the area could be reconsidered. The trail could be moved to the other side to separate the two uses. A road continuing down from Loti Khola along this cliffy section, where few villages are encountered would ruin the wild nature of this beautiful, fragile landscape, and threaten the scenic quality as well.

Key opportunities include keeping road construction well above the river corridor and marketing this section of river, historic trail and unique ecosystems for trekking loops. Training locals on ecotourism, production of local, organic food for tourists and providing day rafting/kayaking trips would all enhance economic opportunities along this section.

Proposed Wild and Scenic River Section 4: Daab to Chisapani

Designation:

Wild and Scenic / Wild, Scenic and Recreational: This entire stretch could be considered wild limited only to trail access but it is so scenic, it must be included as scenic as well. In addition this section provides world-class rafting and kayaking opportunities.

Free-Flowing Nature: this section of river is entirely free flowing

Outstanding and Remarkable Values:

Geology: This proposed Wild and Scenic River section contains some of the most interesting geology in Nepal. The Mahabharat Range rose after the Karnali was well entrenched on the landscape. The mountain uplift blocked the N-S route of the river turning the Karnali on an E-W trajectory, as the river turned, it

dropped sediment and created the vast farmlands near Rakum as a result. Faults within the Mahabharat range expose towers of smooth bedding planes of pure black shale. With sections of purple and black shale exposed at the river's edge as well. Waterfalls cascade off harder rock surfaces directly into the Karnali. Groundwater seeping through the occasional limestone outcrops create unique ecosystems of their own harboring ferns and mosses amongst the constant mist as the water falls into the Karnali. Rockfall into the river create a variety of rapids that keep both kayakers and rafters alert and thrilled at the adventure of passing through. As the Karnali turns into the final leg of the Z just past the Thuli Gad confluence, the landscape widens out into the faulted, cemented sedimets of the Siwalik Range. The red bands of cemented sediments create a spectacular landscape of pinnacles around almost every corner as the Karnali meanders wildly across the softer sediments of the Siwalik hills.

After the Bherri, harder sandstones of the lower Siwalik hills create a deep canyon that ends at Chisapani.

Wildlife **-** A variety of birds call from the forested landscape as one rides down the river. *Rhesus macaque* monkeys play in the canopy of the jungle occasionally coming down to the river to bask on the sunny beaches.

Fisheries **-** This section has a productive fishery with, the freshwater eel, the giant catfish, and the endangered Mahseer throughout. The Fresh Water Dolphin finds habitat in the canyon below the Bheri River confluence.

Recreation **-**The Karnali through this section is known as one of the top 10 white-water rivers in the world. The tourism potential and economic opportunities associated with this float are already significant and could be cultivated further – a follow-up study and valuation is needed. In addition, remote fly-fishing camps and specific fly fishing float trips would add economic value to this section of river.

Scenic **-** The Mahabharat range, being inaccessible, has one of the most in-tact sub-tropical forest landscapes in all of Nepal. Occasionally farms are carved out of old river terraces or the softer rocks of the Siwalik Hills. Both of these features in addition to the unique geologic landforms create a scenic wonderland throughout this entire section of river.

Cultural – Riverside villages inhabited by traditional fishing groups such as the Rajhi people abound in the lower part of this river section. The nomadic Raute people often inhabit this relatively unsettled section of the river and use its resources. The riverside temple at Dungeshwor and several Malla era cultural heritage sites of archeological importance are located near Dullu, in the upper part of this proposed section.
Historical -Several historic bridges connect trails used by the ancient trade caravans travelling from Tibet to India through this section of the Karnali, which cuts through the Mahabharat Range.
Conservation Measures in Place: No protective measures currently exist. In addition to Wild and Scenic River designation, our team is also proposing the creation of a Mahseer Conservation Area 16km above and below the Seti River confluence.
Threats: There are plans for three hydropower dams and one irrigation withdrawal that would negatively affect social and environmental values in this section of the Karnali River.
I. The long-planned Upper Karnali Hydropower Project (900 MW) would tunnel through the Mahabarat Range just below Daab for a short 2km long tunnel thereby gaining river power by shortening the distance of flow and creating a significant head to create electricity. The Upper Karnali Hydropower project would significantly reduce flows for 55 km of the rivercourse for 8 months of the year, and block or alter migration of the endangered Mahseer – even if the legally mandated 10% minimum environmental flows are maintained, this may not prove sufficient for some species. Sediment would also back up behind the dam, flooding and destabilizing hillslopes further upstream in the Middle Hills physiographic region. GMR, the Indian development company is currently seeking financing for the project.
ii. The proposed Betan Karnali Hydropower Project (688 MW) would tunnel water through the Mahabharat into the Siwalik Range just above the Seti River Confluence through to just below the Jamune community. If constructed, this dam would dewater 69 km of river through some of the most productive Mahseer fish habitat in the entire Karnali River basin. The reduced flows downstream of this dam, even during the monsoon flows, would allow the high sediment loads transported in both the Seti and the Thuli Gad rivers to block the mainstem of the Karnali making it impossible for fish passage and to run the river with kayaks or rafts. There is considerable questions about the stability of the tunnel through the Siwalik Hills.
iii. Irrigation withdrawals from the Bheri-Bhabai Multipurpose Project, which would divert at least 10% of the flow of the Bheri River to the Babai River system will also impact the flow of the Karnali River down to the Indian border. Data provided by IWMI indicates that 35% of the Karnali River's flow (on average) comes from the Bheri River. The alteration of the timing and amount of water flow would threaten freshwater dolphin habitat and other wildlife in Bardiya National Park and throughout the Terai alluvial fan.
iv. The Chisipani Multipurpose Hydropower Project (~10,800 MW) is planned as a full spanning, reservoir-type dam that will displace thousands of people. It will back up the river to a mean elevation of 370m with a maximum of 420m (SAARCenergy.org 2018) which will back up water flow in the Karnali 92-122 km above Chisapani or 6-36km past the Seti River confluence. Habitat for freshwater dolphin, Giant catfish and the Golden Mahseer would be eliminated. Five of the eight (62.5%) named rapids on the Karnali, the rapids that make the Karnali a world class river, would be flooded out below "Jailhouse Rapids" as well as 37.5% of the other rapids in the main rafting section of the river. This dam will permanently alter the sediment regime of the Terai and the productive farmland that local communities depend upon. Coupled with the existing irrigation outtake just below Chisapani, this dam will also alter the hydrologic regime of the alluvial fan.
Key opportunities: We must expand public perceptions of this section of the river, from a single purpose (hydropower) toward a broader recognition of multiple alternative uses and values. This section of the Karnali is considered one of the top ten whitewater rafting rivers in the world. However, currently only rafting

companies from Kathmandu take advantage of the whitewater opportunities: they bring clients, all boating and camping equipment, and food stocks with them from the city and pass through the area without generating any local economic gains. Local communities could be trained as whitewater guides and greatly enhance the rafting experience by establishing local or community lodges, supplying local ethnic food and drink and providing local cultural entertainment. In addition, side canyon hikes or historic trade route hikes could add value to the rafting adventures. The province could collect fees for use of the river, establish regulations of use including how to handle human waste and garbage.

The province could also capitalize on the critical habitat of the endangered Golden Masheer through this section. Establishing remote fly fishing resorts that cater to elite fishermen who want to fish for trophy Masheer and support the conservation effort would enhance local economies. Beyond fishing season, these lodges could be used as a base for jungle and cultural tours, birding and wildlife viewing treks, etc. Combining rafting, fishing and wildlife viewing could make this section of the Karnali a destination for a variety of clients. Also, because this area is open and accessible for tourists during the winter season when upper Humla is under snow, this area could be an alternative tourist economy for the Karnali Province.

Proposed Wild and Scenic River Section 5: Geruwa Channel to the Indian Border

Designation:

Scenic:

The flow in this section of river has been altered so that it does not fit into Wild status.

Free-Flowing Nature: This section as an altered flow and sediment regime.

Outstanding and Remarkable Values:

Geology – This section is entirely in the Terai physiographic region. It occupies the eastern channel of the Karnali across the massive debris fan that is deposited below Chisapani and extends 35 km to the Indian border with a triangular shaped fan that is 22 km across at the bottom.

Wildlife – This section of river forms the boundary of Bardiya National Park, where over 53 mammals, many of them are wetland dependent can be found along the Geruwa Channel. The one-horned rhinoceros, wild elephant, Bengal tiger and swamp deer are just some examples of wetland dependent mammals. Over 250 bird species, including the wetland dependent

Bengal florican and Sarus crane, can also be found along the riparian forests and grasslands of the Geruwa channel.

Aquatic Species – Freshwater dolphin use this area during higher flows, their habitat may have been eliminated by the altered flow regime. The endangered Gharial is found in the backwater swamps and channels

Recreation – This is a quiet section of river and if streamflow levels allow could be accessed by raft or canoe. Bird watching and wildlife viewing opportunities abound.

Scenic – Bardiya is the largest national park in the Terai. It is a beautiful unspoiled land with in-tact sub-tropical and tropical forests of sal, teak and other tropical hardwood species. Grasslands seasonally rejuvenated by the flows and flooding of the Karnali River can be viewed in all stages of development.

Cultural – Many people fish in this section, gather boulders, sand and gravel and pan for gold. Traditional agricultural practices and unique houses built by the local *Tharu* and *Sonaha* people also add cultural value to this area.

Historical – Prior to draining of wetlands and mosquito control, the *Tharu* were the only people who could withstand the potential for malarial infection in this area.

Conservation Measures in Place: The Geruwa river is the boundary of Bardiya National Park, but the river itself has no protective measures in place – and the section below the southwest boundary of the park is still in need of protection.

Threats: Alteration of stream flow timing and diminished flow volume are the biggest threats to the Geruwa channel and the habitat it provides.

Key Opportunities include consideration of environmental flows that allow for aquatic species health and natural stream processes that cut new channels, leave backwater channels and revive grasslands. Concurrently, development of boating opportunities to view wildlife and providing access to cultural opportunities would enhance the boating experience. Training locals to engage with the boating community by leading guided trips, providing traditional dugout canoes and providing community lodges or homestays would bring a much-needed economic opportunity to this area.

Other Areas Considered for River Conservation, But not Included in our Recommendations

From Mugu Confluence to Tila Confluence

This section of the Karnali River was considered but not selected for inclusion in the Wild and Scenic River protection strategy. Between the Mugu and Khatyad Khola (from Rara National Park) the army is currently blasting a road template into the cliffs of hard quartzite rocks which border the Karnali River. This blasting indiscriminately dumps tons of rock and sediment directly into the Karnali River and detracts from the scenic quality and separation of road and trail systems. In addition, a road template has been constructed all the way from Kunda Khola below Kolti down to Jite Bazaar many times switch-backing up hillsides causing multiple cascading landslides. Motorcycles can currently use the road most of the way. Access for cars and trucks is not quite feasible although it will open soon. Although it is not yet in use, the road has captured the river trail in many places and 'sidecast' construction techniques have resulted in rock and soil debris being thrown over the edge of the road, scaring hillslopes, occasionally causing landslides and many times putting significant loads of sediment into the Karnali River itself.

From Tila Confluence to Daab (Proposed Upper Karnali HPP Dam Site)

This section of river was eliminated from consideration for the Wild and Scenic protection strategy due to proximity of National Highway (Karnali Highway) and because of the wide depositional area above and below Rakam. The stream flow in this section is gentle with few rapids. It could be a good recreational section for beginning boaters and for training guides in water rescue techniques. While we not recommend full protected status for this area, NRCT will make a series of other recommendation for sustainable development focused on this area in future.

Natural sediment deposition above the Mahabharat Range near Rokum, Nepal(Google Earth). This sediment provides good spawning habitat for fishes.

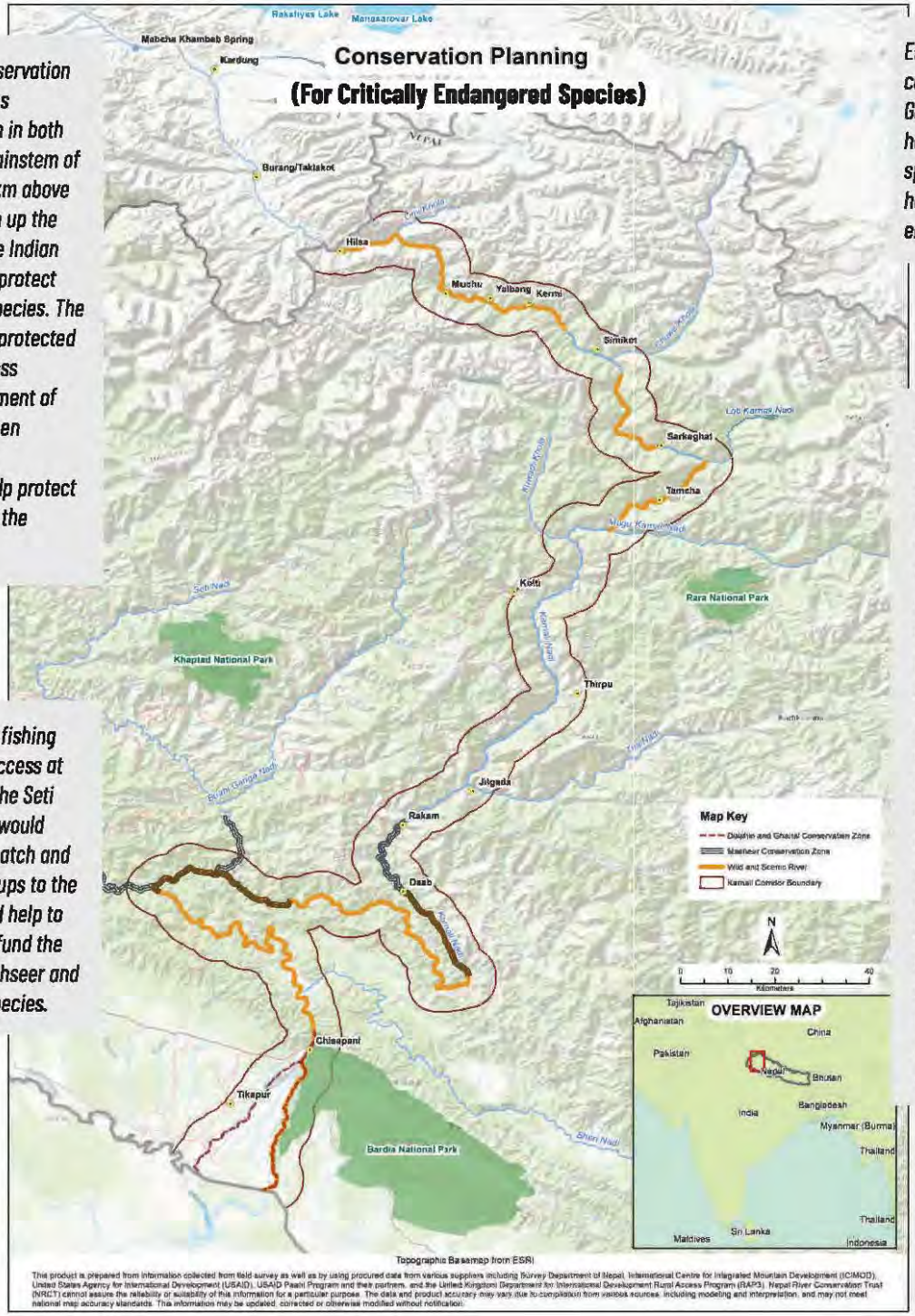
Creating Mahseer, Ganges River Dolphin, Gharial Conservation Areas

Protected areas for aquatic species have had great success throughout the world in restoration of populations and have helped communities to regain vibrant fishing industries. Throughout the Karnali people claimed that the number and size of fish they catch now is greatly reduced from the past. Pressures from over fishing, fishing techniques and loss of habitat have been identified as causes.

The map below shows the places that we propose to designate protected corridors. Conservation zones for a few key species which are currently on the ICUN red list for endangered species are highlighted. This includes the Golden Mahseer, Ganges River Dolphin, and Gharial. A protected corridor would limit taking of these species except through catch and release techniques. Protection would also limit pollutants and alterations of stream flows, sediments and aquatic species habitats.

Establishing a conservation zone for the Ganges Freshwater Dolphin in both the Geruwa and mainstem of the Karnali River 1km above Chisapani and 4km up the Mohana river to the Indian border will help to protect this endangered species. The species is already protected by law in India. Cross boundary management of the species and open passage between populations will help protect genetic viability of the species.

A high-end remote fishing lodge (helicopter access at the confluence of the Seti and Karnali Rivers would bring world-class catch and release fishing groups to the Karnali. They would help to both promote and fund the conservation of Mahseer and other iconic fish species.



Establishing a conservation zone for Golden Mahseer will help protect spawning and rearing habitat for this endangered species.

Gharial is a critically endangered crocodilian species found below 750 meters in slow water areas of the Geruwa, mainstem Karnali and Mohana channels withing the Karnali River Corridor. Habitat loss, pollution and over hunting for traditional medicine have led to population declines. Establishment of a conservation zone would increase chances of survival.

Fishing Regulations

A number of existing laws and policies protect and regulate aquatic species in Nepal. Enforcement of existing laws is imperative if populations are to be protected. Some Aquatic Biodiversity Related Acts, Policies, Strategies, and Regulatory Framework in Nepal are as follows:

1. Aquatic Animal Protection Act, 1960
2. National Conservation Strategy, 1988
3. Nepal Environmental Policy and Action Plan, 1993
4. Water Resources Act, 1992
5. Electricity Act, 1992
6. Water Resources Regulations, 1993
7. Environment Protection Act and Regulation, 1997
8. Drinking Water Regulation, 1998
9. Water Resource Strategy, 2002
10. Nepal Biodiversity Strategy, 2002
11. Sustainable Development Agenda for Nepal, 2003
12. National Agricultural Policy, 2004
13. Science and Technology Policy, 2005
14. Nepal Biodiversity Strategy Implementation Plan, 2006
15. Tourism Policy, 2009
16. Industrial Policy, 2011
17. National Wetlands Policy, 2012
18. Irrigation Policy, 2013
19. Nepal National Biodiversity Strategy and Action Plan, 2014-2020

Education: Provide Information to People About

- The endangered fish species in the Karnali and how they can help to recover populations.
- A few key fish species and their life cycles and help people understand the importance of maintaining a variety of connected habitats for protection of the entire fish life cycle.
- The difference between endemic fish (found only in the Karnali), native fish (fish indigenous to this area) non-native fish (fish introduced from another area) and invasive fish (those introduced species that take over habitats or prey on native fish and decimate their populations). Start this education in the primary schools.
- How protecting habitats is so much more effective than trying to restore, rehabilitate or mitigate after they have been degraded. Time and again aquatic habitat loss is irreplaceable and to try to recover it is incredibly expensive. In the United States, aquatic ecologists are finding that dam removal may be the only truly successful restoration of aquatic habitat.

General Regulation: With the number of people fishing, especially in the Lower Karnali, through the Siwalik Hills and Dunn valleys and in the Terai, fishing regulations would help to maintain viable fish populations. Until much more information is known about fish populations and their life cycles, implementation of conservative fishing regulations is needed.

1. Fishing

a. Do not use poison, explosive materials or electric current for fishing purposes.
b. Do not kill fish species listed as "endangered" or "critically endangered" by IUCN Red List Status.
c. Regulate daily catch limit and size of fish kept. This needs to be determined for each species.
d. Do not use "Mahajaal", use small fishing nets.
e. Do not fish when fish are spawning.

2. Water Quality and Quantity

a. Do not release organic or chemical compounds that will exceed the parameters limit determined by "Nepal Water Quality Guidelines for the Protection of Aquatic Ecosystem".
b. Do not divert all the water from streams and release the amount of water needed to maintain base flow in the river.

3. Infrastructure Development

a. Perform baseline aquatic organism surveys and provide a complete species list before the construction of any developmental infrastructures in water resources. Understand all aquatic species life cycles including migrations patterns and timing as well as spawning and rearing habitat requirements. Adjust infrastructure designs to facilitate protection of fish species and their life cycles.
b. Construct functional aquatic species passage (i.e. fish, dolphin, gharial).

Transboundary Water Governance

China

China already has two small hydropower dams on the Karnali. Nepal should be concerned about timing and amount of sediment released as it has the potential to erode streambanks downstream. Residents in Hilsa have expressed concern about the potential of floods from above, one man told us: "It took two decades to build these two buildings, but it wont take a minute to destroy them if there is a big flood or dam bursts upstream." Others in Hilsa and other parts of Humla noted that since the Chinese have developed large towns like Purang/Taklakot upstream, human waste has polluted the waters of the Karnali. They are no longer able to get water from the river and suffer due to the low precipitation and lack of tributary stream flow in the area.

India

The Girijapuri barrage in India slows river flow and backwaters Karnali flows into Nepal during monsoon, causes the deposition of sediment. This affects irrigation canals in the Terai causing flooding in places where flooding has not occurred in the past. Dam release timings could be negotiated to eliminate this problem. Agreeing on minimal in-stream water flows and maintenance of a minimum 2.5-meter water depth level necessary to maintain dolphins and fish species will help each country plan for amount and timing of water diversions. Although the Ganges Freshwater Dolphin can pass over the dam in high water, there is currently no fish passage at the barrage. Isolation of populations limits genetic transfer and long-term viability of aquatic species. Working together to provide passage of various aquatic species around the barrage would greatly contribute to aquatic species conservation.

Additional Research Needs: Improving Socio-Environmental Data

- Understand fish life cycles, where they spawn and rear their young, when and how far they migrate and potential shift due to climate change
- Understand how aquatic habitats and aquatic community assemblage change with alterations of stream flow timing and volume and sediment regimes.
- Conduct a social-scientific study focused on shifting livelihoods and fish consumption patterns in the Karnali basin.

Conclusions and Next Steps

Key Scientific Findings of the Karnali Expedition

On Valuing River Rersources

- The Karnali is Nepal's last and most pristine free-flowing river. It needs to be protected and celebrated as a key asset of the region that can help to bring prosperity to a wide-ranging group of residents – if a balance between development and conservation can be achieved.
- The diversity of ecological zones found in the Karnali provides a natural resource library that can be used as an ecological reference site for the restoration of degraded sites in the Karnali and other areas of Nepal.
- Currently, the values of the Karnali River are generally misunderstood or overlooked – the river is often viewed in one-dimensional terms, as a source of hydropower, neglecting other uses of water resources and the range of ecosystem services that the river provides.
- There is a need for environmental education and awareness programs that can help people across Nepal to understand the ecological value of the Karnali River. We hope that such programs can help everyone - from the citizens of the Karnali region and local political leaders, to the government officials and policymakers in Kathmandu - to recognize the critical importance and value of environmental health in the Karnali region, and to see a new vision for the Karnali as the icon of the area.
- Designating a Karnali "Sacred River Corridor" would draw pilgrims and trekkers to the entire river corridor capitalizing on and building upon tourism in the Upper Humla/Kailash region. Religious tourism, cultural tourism, ecotourism, and world class rafting would be the signatures of the Karnali Sacred River Corridor re-establishing and re-purposing historic trade routes. The Karnali Sacred River Corridor concept, if marketed well, can bring prosperity to the Karnali region.

River Conservation Legislation is Needed in Nepal

- Based on the findings of our 2018 Expedition, research conducted in other watersheds across Nepal, and a review of international examples of river conservation legislation, we argue that the time has come to introduce river conservation legislation at the local, provincial, and national levels in Nepal. [For a detailed review of international river conservation legislation and recommendations about the process of introducing river conservation legislation in Nepal please see the companion report produced by NRCT titled "Strategic Considerations for River Conservation Legislation in Nepal."] Why shouldn't Nepal also conserve and protect its most valuable rivers?
- In this report, we have highlighted five "River Conservation Sections" of the Karnali River that we recommend should be conserved and protected, based on their unique and outstanding environmental, cultural, and scenic values. Legal designation of these river sections as "protected area" could also help to promote ecotourism and create an international "niche" for the Karnali region.

On Protecting Aquatic Species

- Conservation Zones for critically endangered aquatic species are identified and need to be designated into law. Regulated fishing will help conserve the populations for long-term use by locals.
- We propose creating a "Mahseer Conservancy" from Rakam to 16km below the Thuli Gad Confluence and 10km up the Seti Khola. This conservation area could be a world class research area for Masheer and support development of a remote (helicopter or boat-in) high-value catch and release fishing business. Golden Mahseer habitat in the mainstem of the Karnali below the Tila confluence is the cornerstone of this species existence. Current hydropower development proposals, if developed, would threaten this species existence.
- Snow trout are ubiquitous throughout the Karnali River basin. Fishing regulations, including catch and size limits should be adapted to protect this specie's populations. Hydropower development in the upper tributaries would affect the least percentage of the habitat.
- Freshwater Dolphin currently use the mainstem of the Karnali 2km above Chisapani to the border. Habitat loss has occurred in the Geruwa channel already due to flow alterations and changes in mainstem Karnali flows, river training projects in the Karnali channel could further reduce habitat by altering channel depth. The Mohana River currently supports rearing habitat for the dolphin. The Kailashpuri barrage in India truncates migration of the dolphin during low flows and may threaten genetic viability of the existing Nepal populations.
- In our report we have also highlighted several areas throughout the watershed where environmental restoration practices would improve water quality conditions and help protect or improve in-stream habitat to promote aquatic biodiversity.

Strategic and Sustainable Hydropower Development is Possible

- The Government of Nepal has issued licenses to construct large-scale dams on every large river in Nepal, and hydropower projects are currently being constructed on all of them, except the Karnali. Therefore, the Karnali will soon be the last major free-flowing river in Nepal.
- Currently, several large-scale hydropower projects are planned on the main channel of the Karnali River: including the national-priority 900 MW Upper Karnali Project, the 688 MW Betan Karnali HPP, and the 426 MW Phukot Karnali HPP. The massive and long-promised 10,800 MW Chisapani Storage Project, while currently dormant, is also a possibility. These large-scale dams would have significant impacts on aquatic life, river connectivity, sediment regimes and thermal regimes; by flooding or dewatering sections of the river, these projects would also dislocate livelihoods and require the resettlement and relocation of 'project-affected people
- As Nepali water scholars like Dipak Gyawali and Ajaya Dixit have said for decades now: there is a difference between 'good dams' and 'bad dams' – and it is critical that policymakers learn to distinguish between the two. As the national power generation capacity increases and the memory of energy scarcity and recent blackouts begins to fade, it is becoming clear that Nepal does not truly need all of the dams that are currently licensed, and that the export market for electricity might not be as lucrative as previously expected. As Nepal's energy landscape shifts, a new plan for hydropower development that considers ALL of the costs and benefits, as well as the cumulative impacts of intensive hydropower development, is critically needed – and this requires a new kind of strategic thinking and planning.
- Identifying high-value rivers and river sections for conservation requires a strategic perspective that

considers water resource management issues at the basin and national scale. Strategic and cumulative impact assessment of water and energy infrastructure is sorely needed in Nepal, especially given the density of hydropower development licenses that have already been issued and the number of planned hydropower projects distributed throughout the many watersheds of Nepal. Currently cumulative impacts are poorly understood (by publics and policymakers) and coordinated and strategic decision making about the management of water resources is minimal.

- Cumulative impact assessment and coordination between different ministries, planning agencies, and regulators is sorely needed to ensure the efficient use of resources and to prevent the accumulation of negative impacts in Nepal's watersheds. This recommendation extends beyond river conservation in Nepal and connects to broader issues of environmental degradation and environmental governance that many developing countries in Asia (such as Myanmar and Cambodia) are currently facing.
- We recommend that the Karnali region pursue an alternative and sustainable model of hydropower development for the Karnali Basin that generates more than 6,000 MW of hydroelectric generation capacity (License issued till 2019) using the tributaries of the river system, while leaving the main channel of the Karnali unobstructed. Strategic hydropower development plan that prioritizes development on the tributaries can provide more than 6,000 MW of power generation - guaranteeing energy security within Karnali Province and across Nepal, while leaving the most ecologically valuable sections of the Karnali River undammed.
- During our consultations, some political leaders in Karnali Province also expressed an interest in focusing first on the development of tributary stream hydropower opportunities – so as to bring economic development to the area while protecting the river and the multiple opportunities that it could support. We recommend that Karnali Province take the lead in developing a "Sustainable Hydropower Plan" for the parts of the Karnali watershed within its provincial boundaries – setting an example for strategic watershed thinking that other provinces in Nepal could learn from.
- Other forms of alternative energy should also be developed in the Karnali Basin to enhance energy security and energy sovereignty. This can be achieved through utilizing solar and wind energy technologies, and by strategic energy planning that creates mini-grids supported by small-scale hydropower development in the upper tributary streams. This kind of energy development will provide sustainable energy for the area without damaging the aquatic resources, and recreational values found in the mainstem of the Karnali.

Current Patterns of Road Construction are Environmentally Destructive and Unsafe

- Roads are key to development and well placed, well-constructed, roads will preserve the character and beauty of the landscape and river while providing for enhanced economic opportunities. Poorly constructed roads do not serve their intended purpose are dangerous and are harmful to both terrestrial and aquatic environments. It is critical to enforce existing standard road construction best management practices.
- A master plan for sustainable road development should be developed prior to further road construction in the area. Hopefully using the dataset used to generate the Landtype Association Map above, which evaluates the entire Karnali River Corridor for road suitability. Improved policies and monitoring programs are needed to ensure compliance with best practices of construction that minimize the environmental damage of roads.
- Regions with signatures of past landslides should be recognized and buttressed during road construction

– especially areas with softer rocks (schists, especially areas of mica schist). These areas are also subject to debris torrents during storm events and design of roads should accommodate debris flow activity either with low water fords or dips to confine the flow in the channels and not allow it to be captured by the road. Rockfall and tumble would be concerns for safety during and following road construction in areas like the narrow river canyon just below the Loti Karnali confluence.

On Conservation Efforts and Local Livelihoods

- Conservation efforts and programs throughout the Karnali River Corridor must take local desires for economic development seriously and include and meaningfully engage local stakeholders in long-term processes of consultation.
- Environmental perspectives are easily dismissed in South Asia by political leaders focused on short-term development goals – and in some cases, people in conservation areas are mobilizing to remove environmental protections that are now perceived as limiting development opportunities (Drew 2017). These issues can be resolved through meaningful and long-term dialogue with local stakeholders. Conservation efforts do not have to be opposed to development!
- These considerations are particularly important in the Karnali region – an area characterized as one of the poorest regions of Nepal that has been politically and economically marginalized for decades, and a place where development failures have only increased a very real sense of deprivation. People living throughout the Karnali Corridor will rightfully demand to know what kinds of livelihood opportunities will accompany conservation programs, and how locals will benefit from programs focused on sustainable environmental management and river conservation.
- River conservation legislation in other countries has also been careful to accommodate some forms of development in protected areas – and Nepali river conservation advocates should also work to ensure that conservation programs are not overly burdensome on communities who have legitimate needs and real desires for development. To be clear: local people should be allowed to utilize the river for conservation friendly activities such as sustainable fishing and eco-tourism programs, even within conservation corridors.
- To ensure that local livelihoods and local socio-economic issues are meaningfully considered in the Karnali River Corridor Management Framework– planners and conservation advocates should work directly with local stakeholders to develop innovative and place-based livelihood opportunities, livelihood enhancement initiatives, and training programs. Encouraging tourism is one common possibility throughout the watershed and an important vector for local and regional development, but many other kinds of livelihood/economic opportunities are possible. Establishing cottage industries with dependable markets will diversify employment opportunities in the area and protect existing native crafts and lifestyles. Locally-driven dialogue is needed to imagine, design, and implement these initiatives.

Understanding Geomorphology and Geohazards

- The landscape of the Karnali River Corridor contains both highly stable hillslopes and extremely fragile areas vulnerable to landslides, earthflow, debris torrents and rockfall. Understanding this variability can help inform development options, help provide resilience to climate change and reduce the risk of disasters.
- Because the Far-Western region of Nepal is an estimated five hundred years overdue for an 8.0+ magnitude earthquake (Bilham et al 2003) – disaster risk reduction and disaster management programs

are critical throughout the Karnali River Corridor, and plans for large-scale infrastructure development need to take these geological realities into account.

- Most villages and subsequently terracing of lands for agriculture have developed around ancient earthflows on the hills above the stream channel. Each of these areas has been delineated on the Landtype Association map. These earthflows vary in their current rates of movement. Some areas have very active landsliding while others appear stable. Large earthquake events could re-activate movement of these areas. Road construction through these areas should be sure not to undercut the footslope of these large deep-seated landslides nor add weight or water to the headscarp areas. Local mapping of stability prior to road system design should be required
- If the Karnali mainstem flow were reduced below the level that currently moves the high rates of sediment produced in those streams, then sediments produced in the Seti, Thuli Gad, and tributaries below the Thuli Gad to the Bherri Khola would move into the mainstem of the Karnali during monsoons and effectively dewater the Karnali (by forcing the stream underground through the sediments). The confluence of the Seti and Karnali has a sediment load that nearly crosses the mainstem under natural conditions.

Hydrologic Findings

- The portions of the riparian landscape that are suitable for agriculture should be protected. More land could be brought into agricultural production with solar powered irrigation from the mainstem of the Karnali River.
- The Bheri contributes more flow to the Karnali than any other tributary stream (32%). The Bheri is a critical source of flow to the lower Karnali and to the Bardiya area and wildlife, aquatic and agricultural resources found there. Alteration of this flow with cross-basin transfer of water would have severe implications for the Karnali and the landscape below Chisapani. The Rani-Jumara-Kulariya irrigation project would also be affected by Bheri River flow alterations and in itself has similar implications for the sustainable.
- Agricultural lands along the river depend on ancient river terraces and alluvial fans deposited from landslide acrivity higher in the hills. Without side tributaries for irrigation, many of these landforms are not used for agriculture (see Landtype Association mapping). Solar pumping of irrigation water from the mainstem of the Karnali would expand the amount of arable land in the watershed and become a recognized ecosystem service provided by the Karnali.
- The Mugu Karnali is also an important source of flow and sediment to the remainder of the river system – damming this river would have negative impacts downstream, causing erosion that could damage agricultural lands and local infrastructures.
- Currently much of the mainstem of the Karnali and tributary streams support aquatic organisms that indicate low pollution of water resources. Areas with higher populations and more agricultural development show reduced water quality. Watershed management education should be introduced as development in the Karnali continues to expand.

The Karnali has Massive Ecotourism Potential

- The landscape of the Karnali River basin is incredibly beautiful and extremely dynamic, and it has the ability to attract a high-volume of tourists. In the future, the Karnali River Corridor could become a major asset in Nepal's tourism industry, like Mt. Everest or Chitwan National Park.

- Because the beauty of this region centers around the Karnali River, programs should be developed to promote tourism throughout the Karnali River Corridor. If the recommendations about river conservation and strategic planning are designated they could help establish the Karnali River as Nepal's first protected river system, which will help draw tourists to the area – especially tourists are searching for new and 'off-the-beaten track experiences'. The touristic and scenic value of the Karnali region will only increase if and when other watersheds across Nepal are degraded by indiscriminate hydropower development.
- "Aquatourism" can be a significant resource throughout the Karnali Basin, as we develop and market new multi and single day rafting routes and other forms of water-based tourism (i.e. canyoning). New models of river-based ecotourism are needed; ensuring that visitors stay longer in the area and engage with locals through cultural programs and by buying local organic foods will enhance experiences of the tourists and livelihoods of the local people. Establishing ecotourism and boat guide training centers provide rare professional opportunities for locals. Design self-contained solar powered eco-lodges that can be locally constructed and dismantled and moved as needed as local entrepreneurs build their own lodges/homestays. Develop a Raft Guide Training Center at Rakam – schedule reconnaissance trips to develop new rafting routes.
- Diversifying the tourist base will bring more prosperity to a wider contingent of the population. Nepali tourism is growing, and becoming a major percentage of the tourism sector! Why not preserve Nepal's greatest river for Nepalese?

Immediate Next Steps

Gather Local champions to Commit to the Following

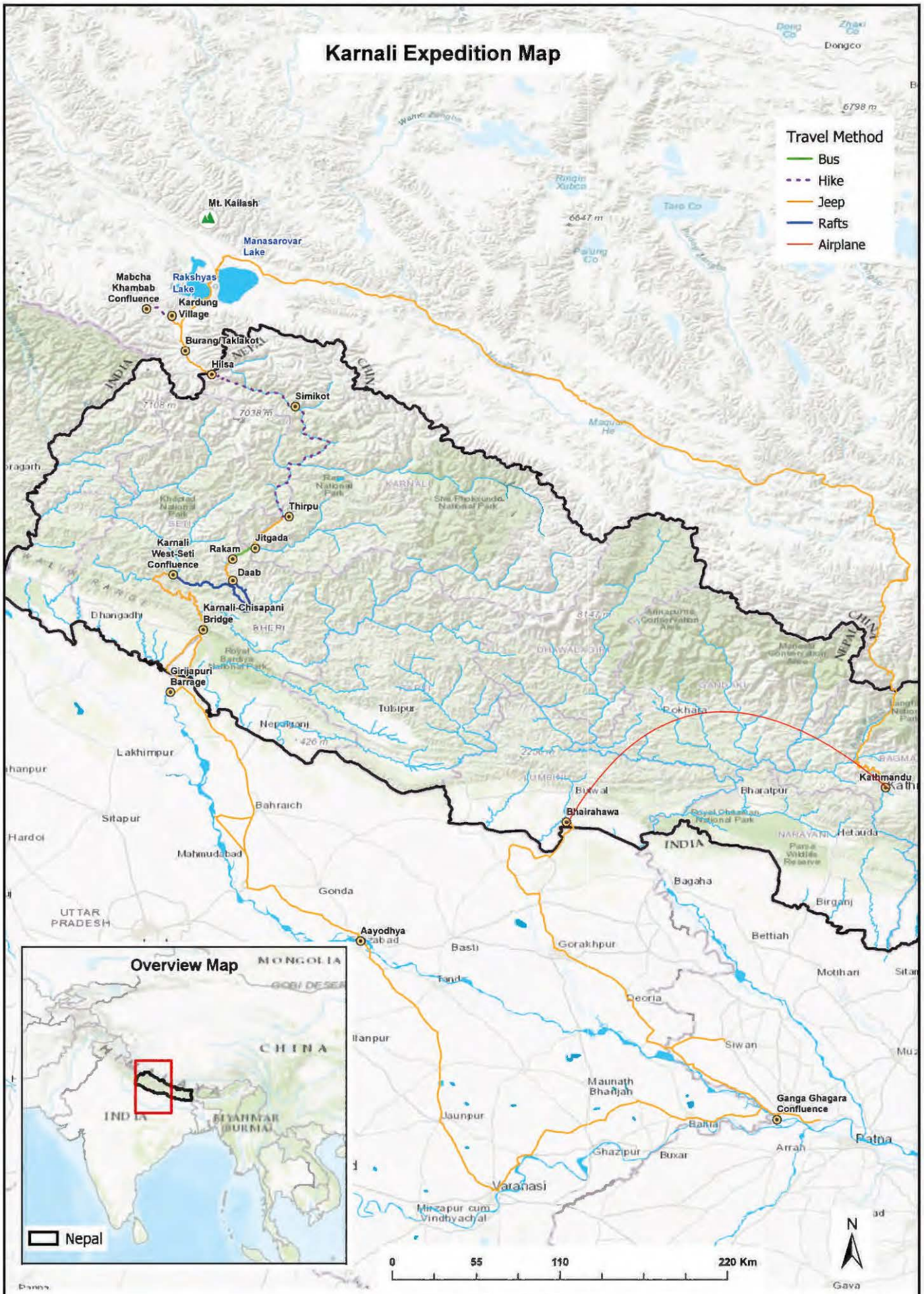
- Decide to market the Karnali as a Sacred River Corridor - market the Karnali Rivers unique character and pristine free-flowing nature on the local, national and international level.
- Discuss the possibility of introducing river conservation legislation in Nepal - at the local, provincial, and national scale. Use a participatory approach to legislation and planning to determine which sections of the river will be protected and what that means for the future.
- Create a strategic plan for sustainable hydropower development in the Karnali basin based on a cumulative impact assessment – taking into account the possibility that ~6,000 megawatts of electricity can be generated by developing hydropower on the tributaries, leaving the main channel of the Karnali undammed.
- Design and implement a Road Master Plan that protects environmental and river quality – a commitment to constructing good roads could make the Karnali region a model for the nation.
- Establish and enforce Mahseer and Ganges River Dolphin Conservation Zones.
- Develop an Ecotourism Training Center – first at Rakam, then in other parts of the watershed.
- Establish a Watershed Management Demonstration Area in Rakam.

Dialogue about all of these issues and proposed programs will generate greater awareness of environmental issues among locals and provincial level governments, while also helping make them aware of their capacity to affect legislative change and encouraging new forms of dialogue and civil society debates. Ongoing dialogue also helps to promote an active civil society that can work to ensure that river conservation is actually implemented.

In closing, we choose to end this report on a cautiously optimistic note – balancing the possibility of unsustainable development that would bring about environmental degradation with the promise of a growing environmental ethic, perhaps even a movement, in Nepal. The question is not just how these forces will interact, but when and where? And, most importantly, who exactly will make efforts to support these two divergent causes, or perhaps mediate between them to lead Nepal down a middle path? For all these reasons, it is imperative that river protection advocates begin promoting dialogue and spreading awareness: to pre-empt the wave of hydropower projects slated to come and to encourage sound decision-making for the long-term future of Nepal and its citizens. In short, they need to act now, before it is too late.

ANNEX
Maps Used in the Framework

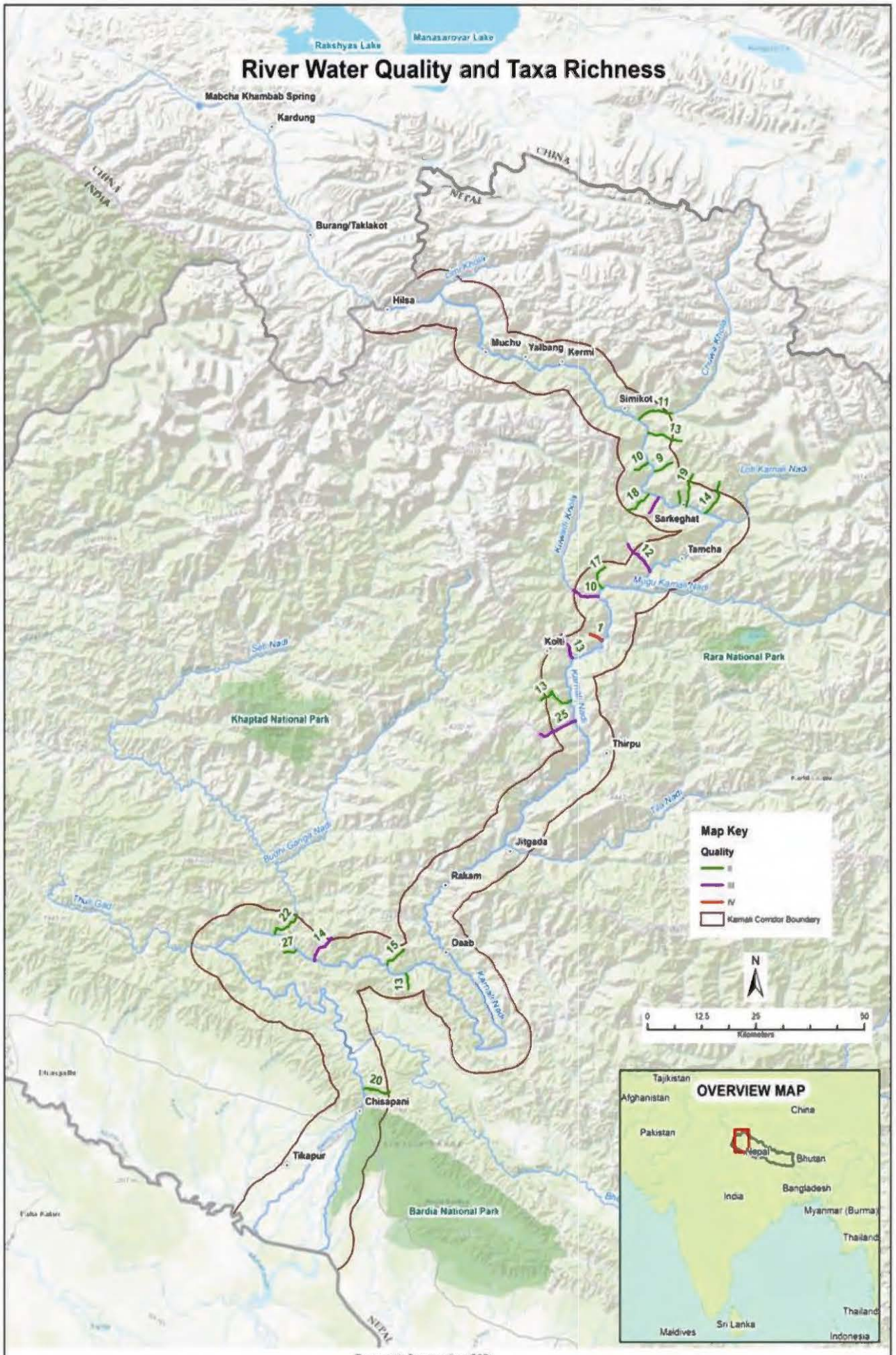
Karnali Expedition Map



Topographic Basemap from ESRI

Disclaimer: This product is prepared from information collected from field survey as well as by using procured data from various suppliers including Survey Department of Nepal, ICIMOD and USAID. National River Conservation Trust cannot assume the reliability or suitability of this information for a particular purpose. The data and product accuracy may vary due to compilation from various sources, including modeling and interpretation, and may not meet National Map Accuracy Standards. This information may be updated, corrected or otherwise modified without notification.

River Water Quality and Taxa Richness



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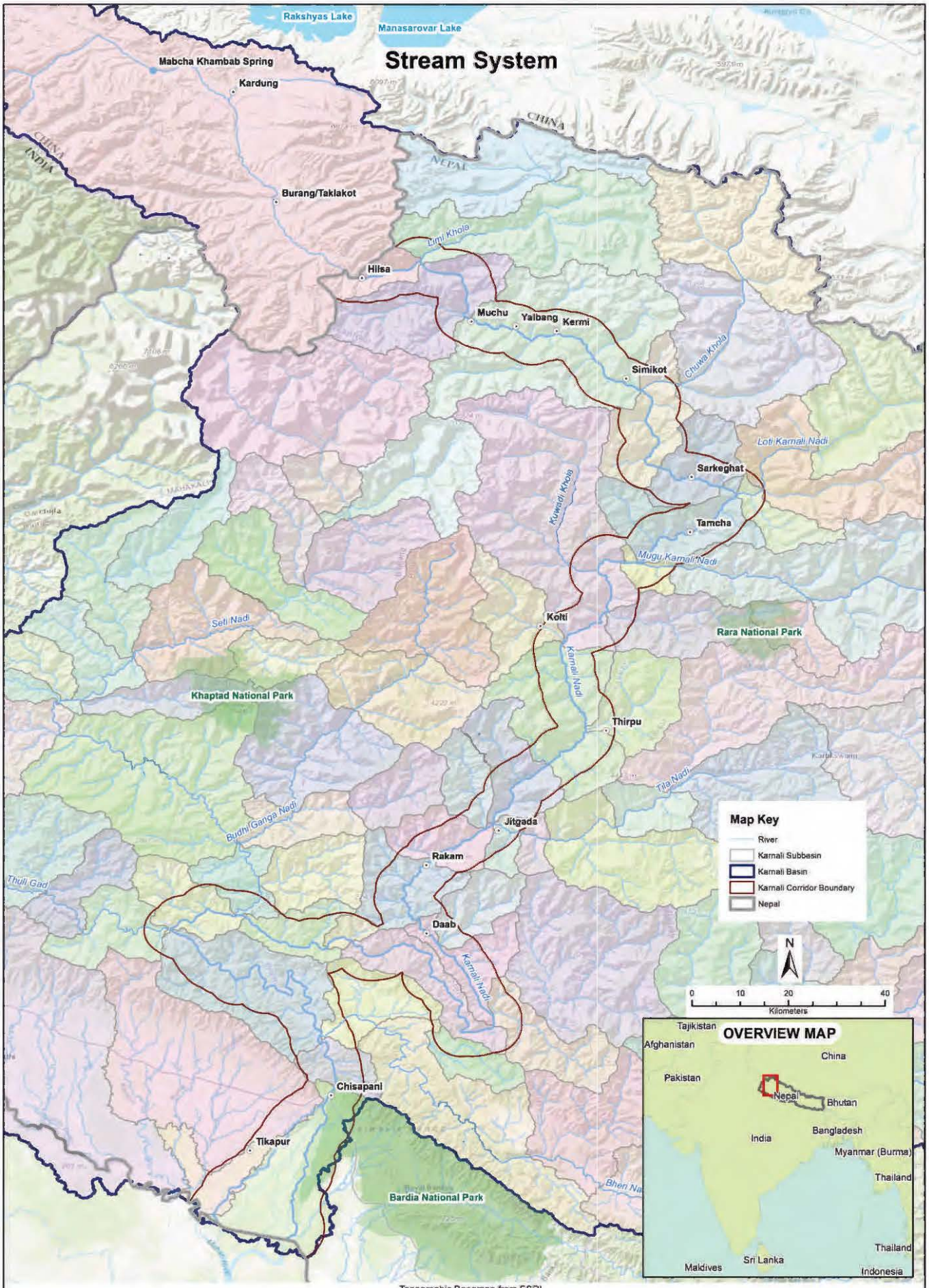

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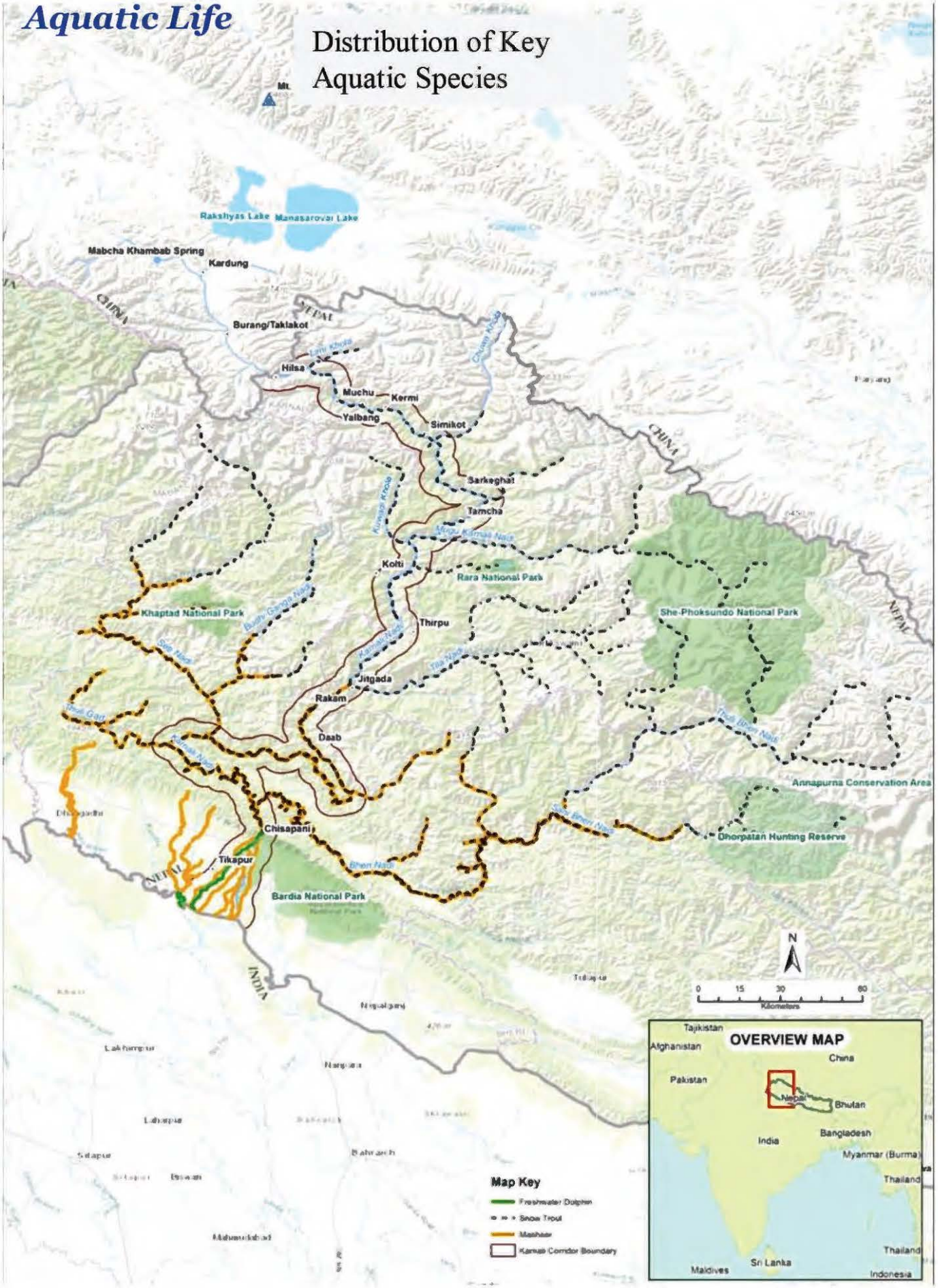
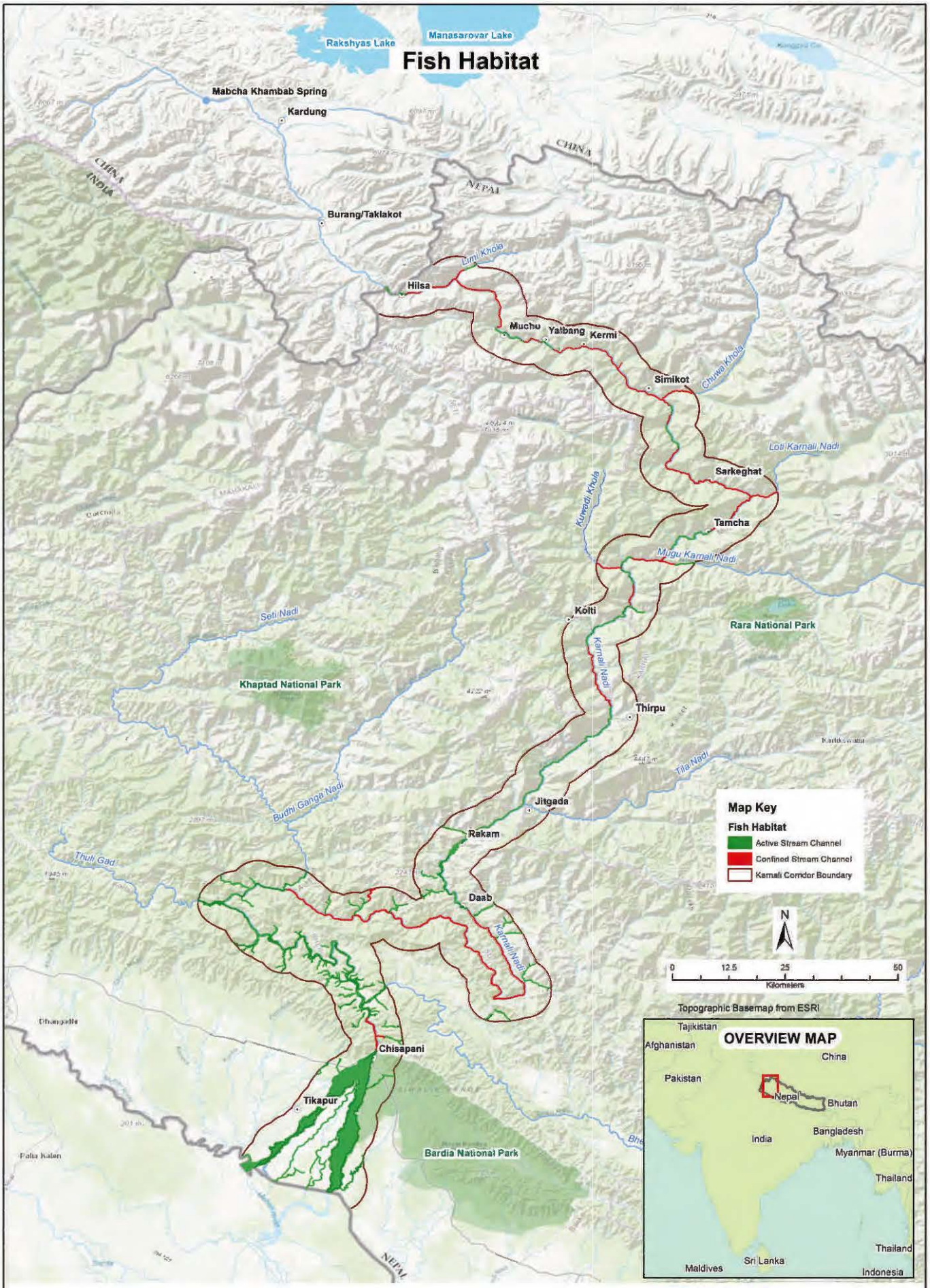
Aquatic Life

Distribution of Key Aquatic Species





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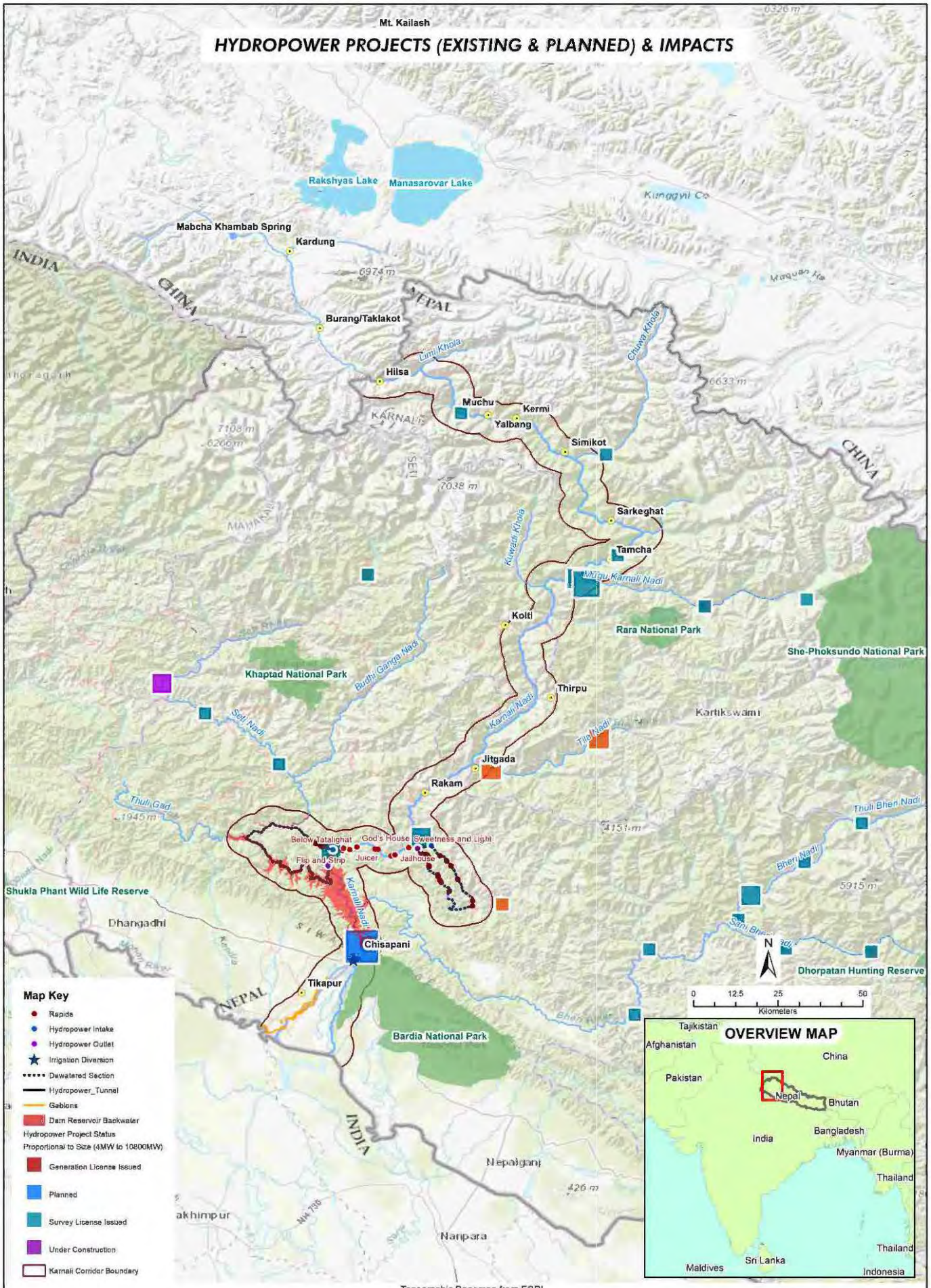
HYDROPOWER PROJECTS (EXISTING & PLANNED) & IMPACTS



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In-Stream Infrastructure - Existing and Planned

Topographic Basemap from ESRI

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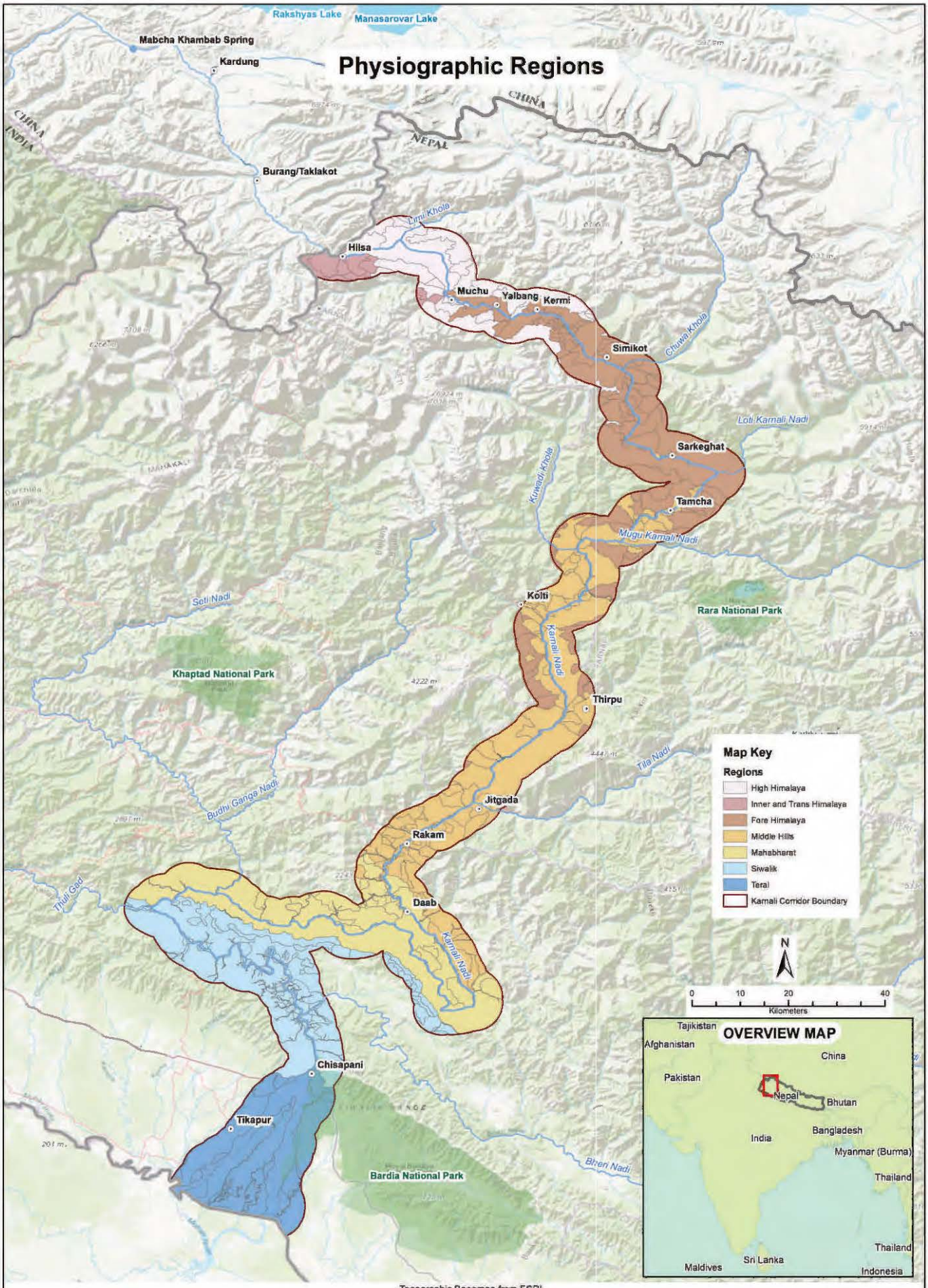

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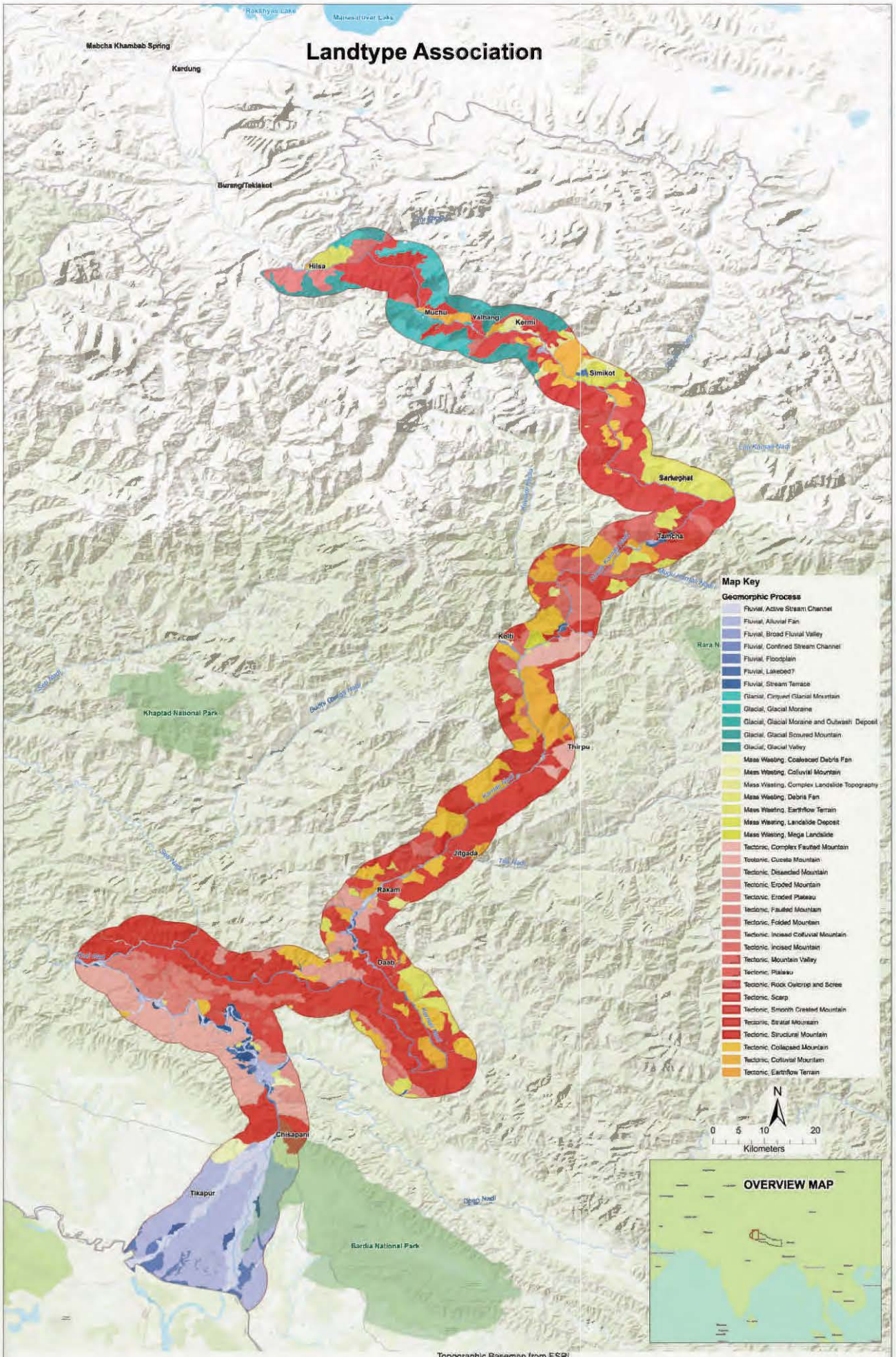
Landtype Association



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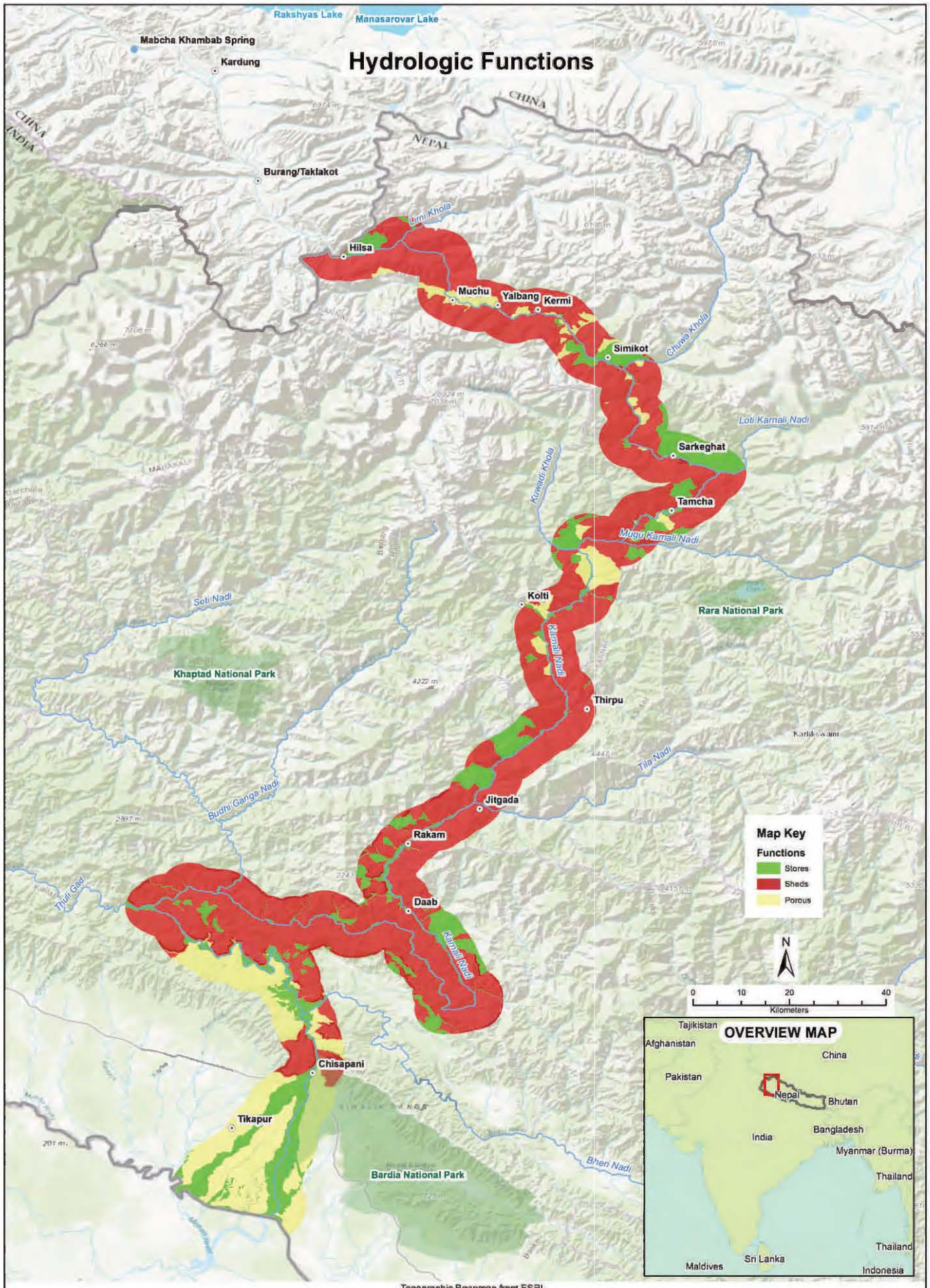

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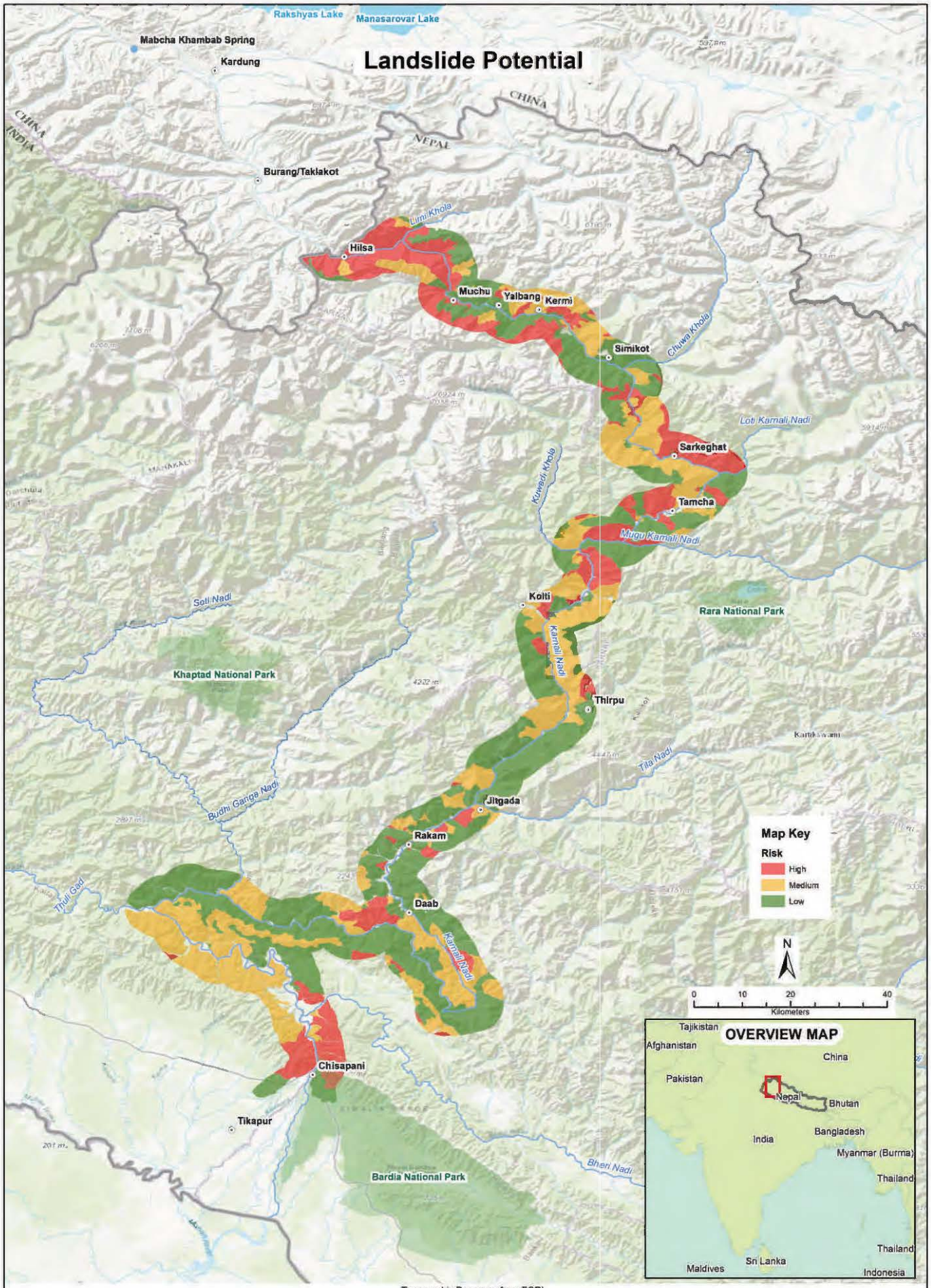

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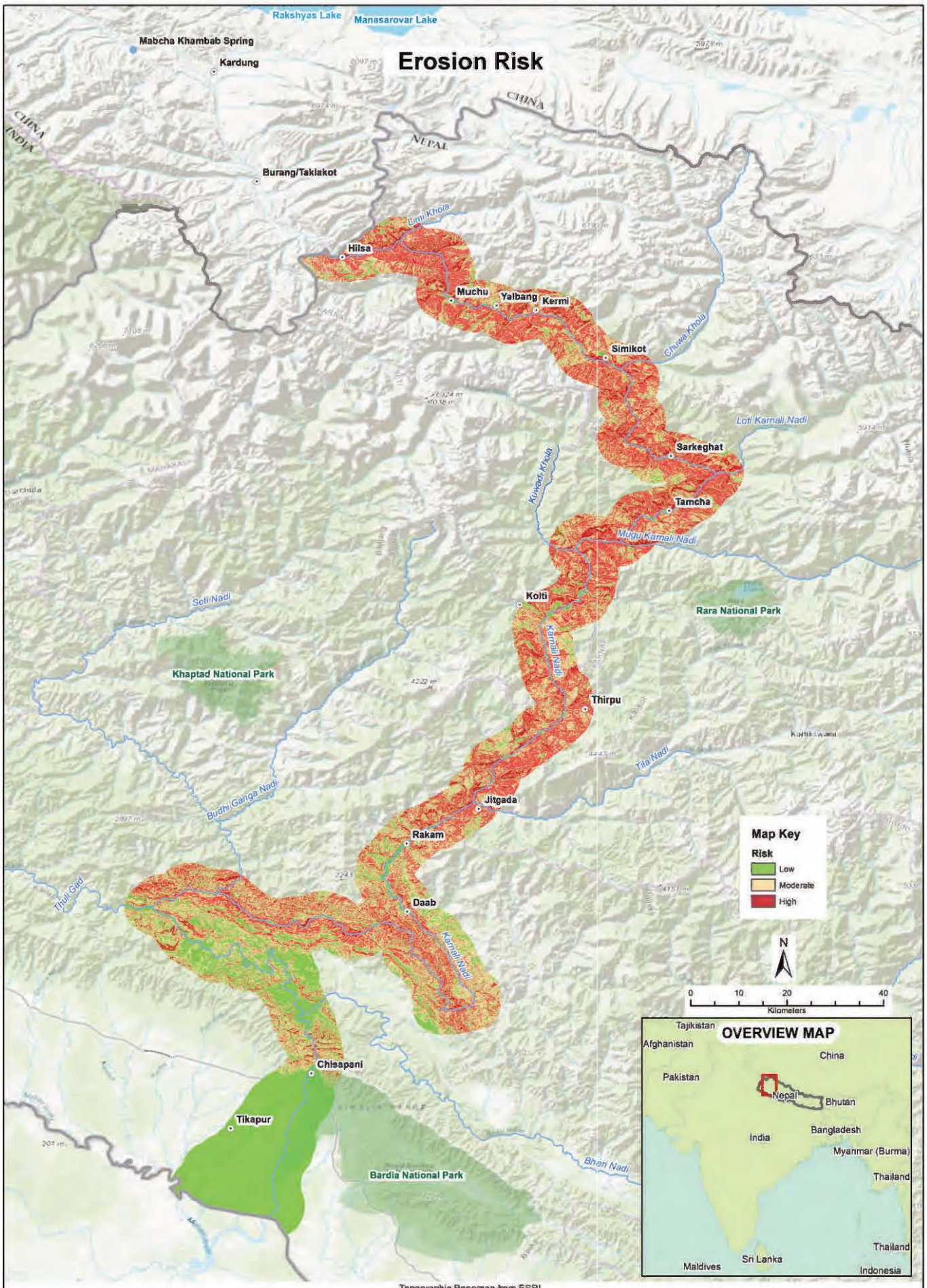

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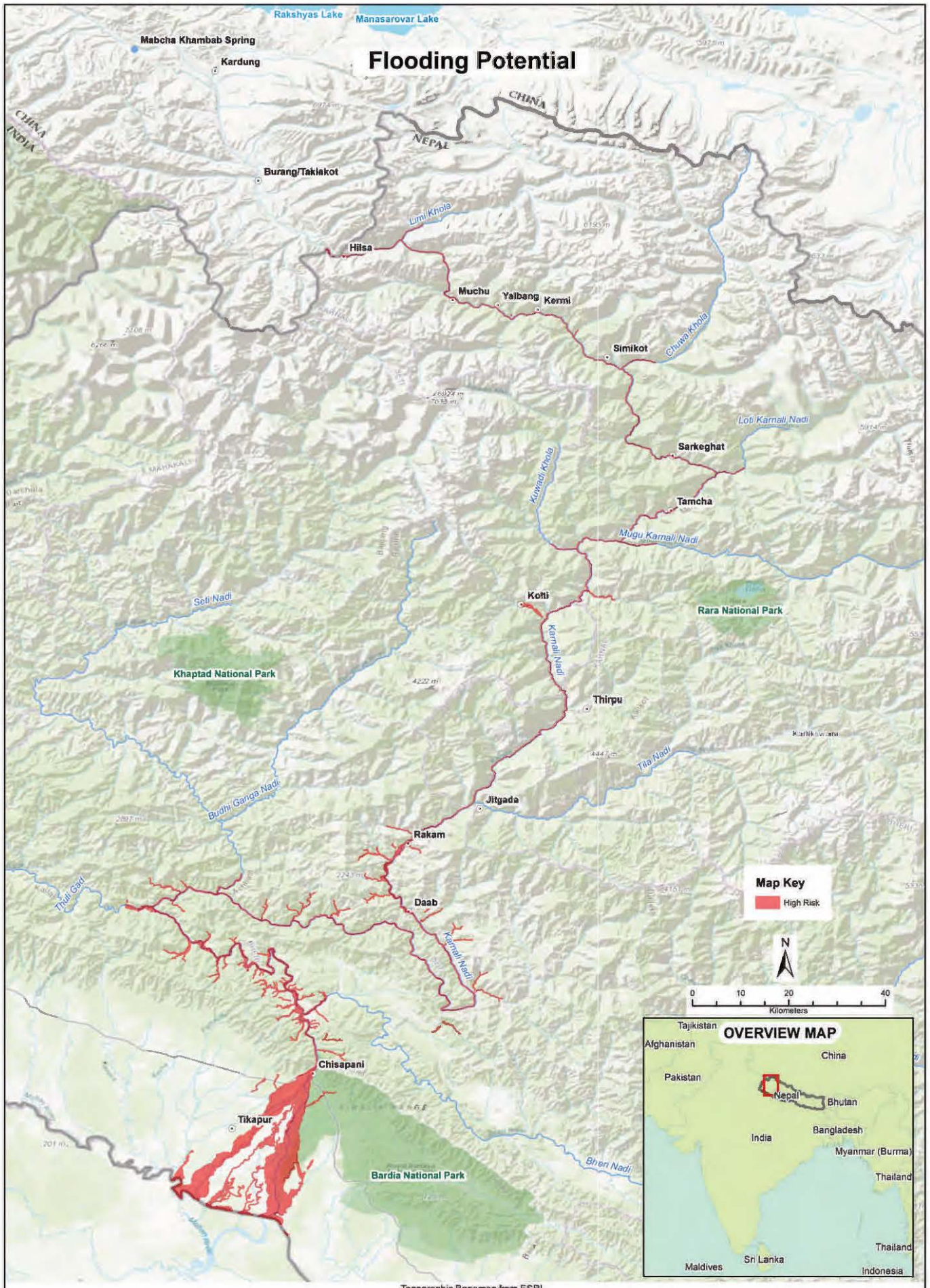

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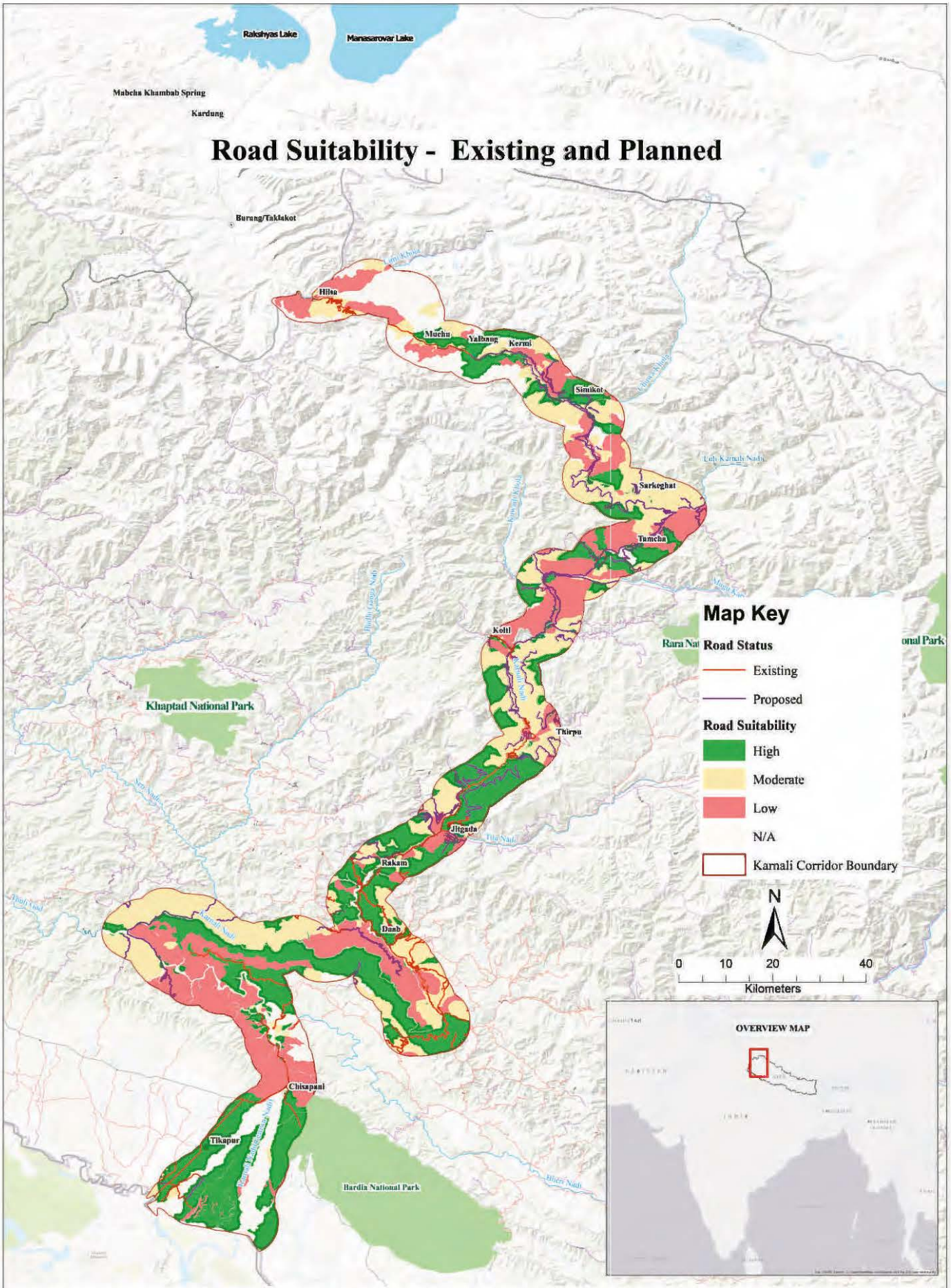
Road Suitability - Existing and Planned



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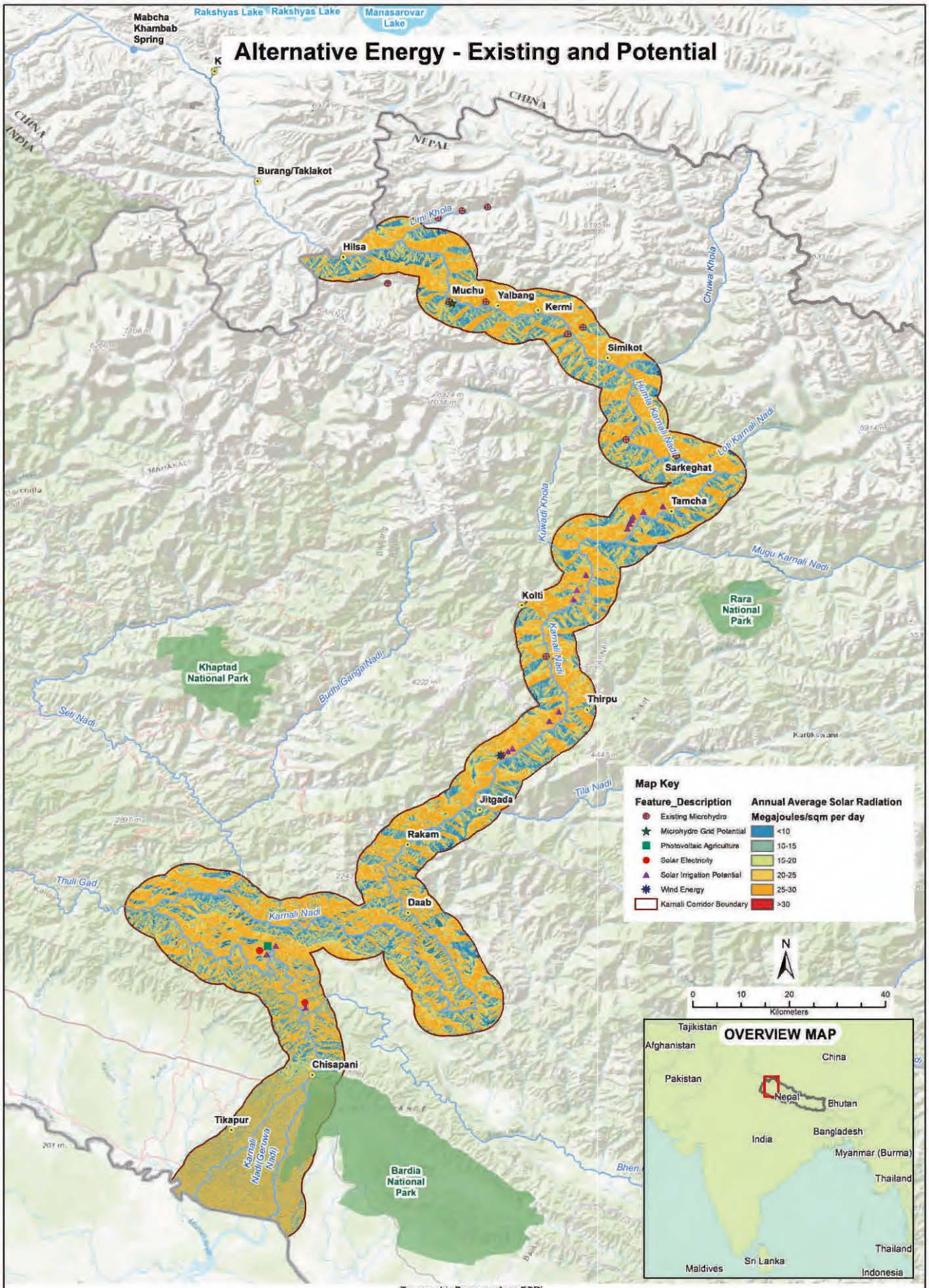

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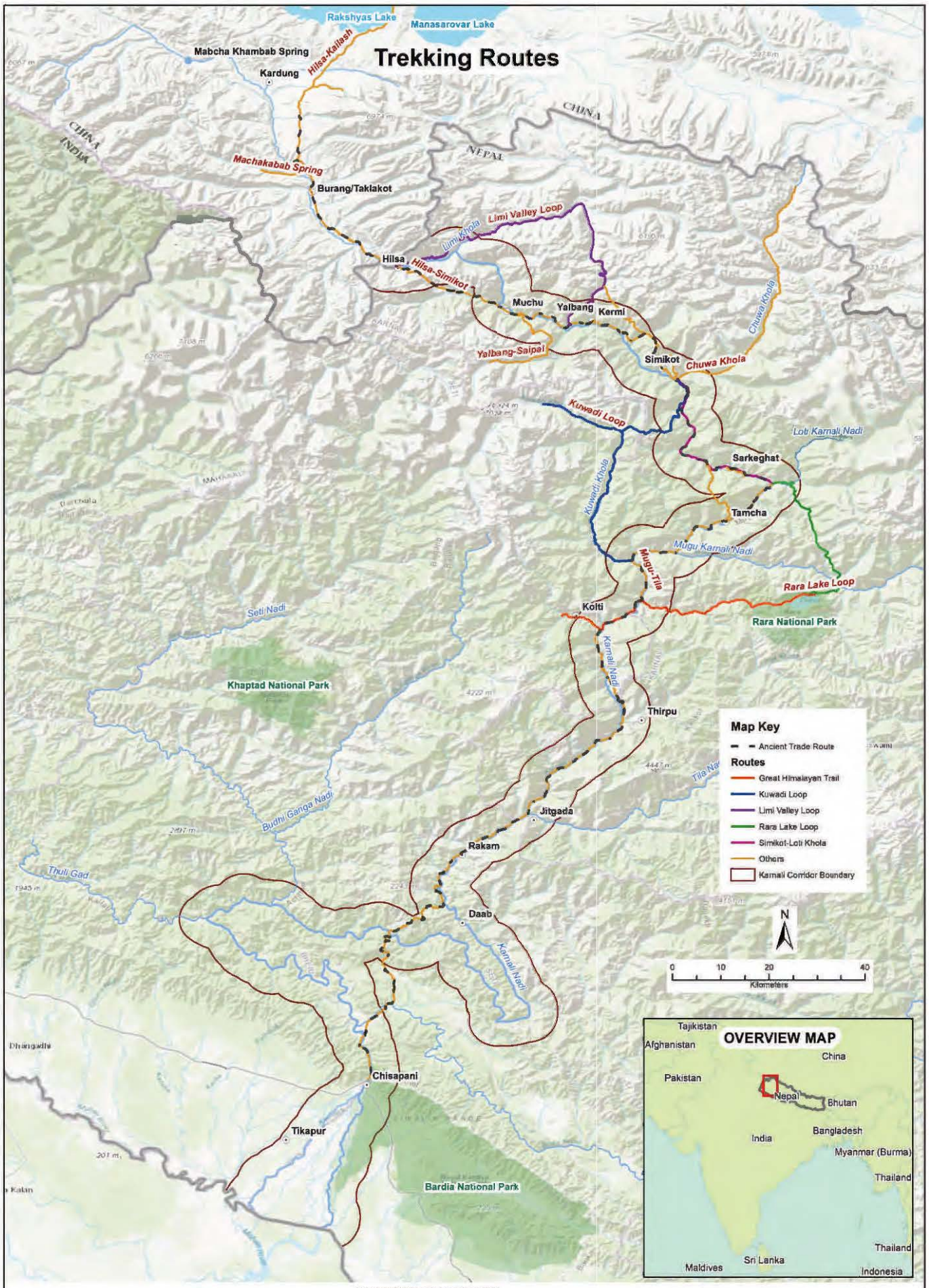

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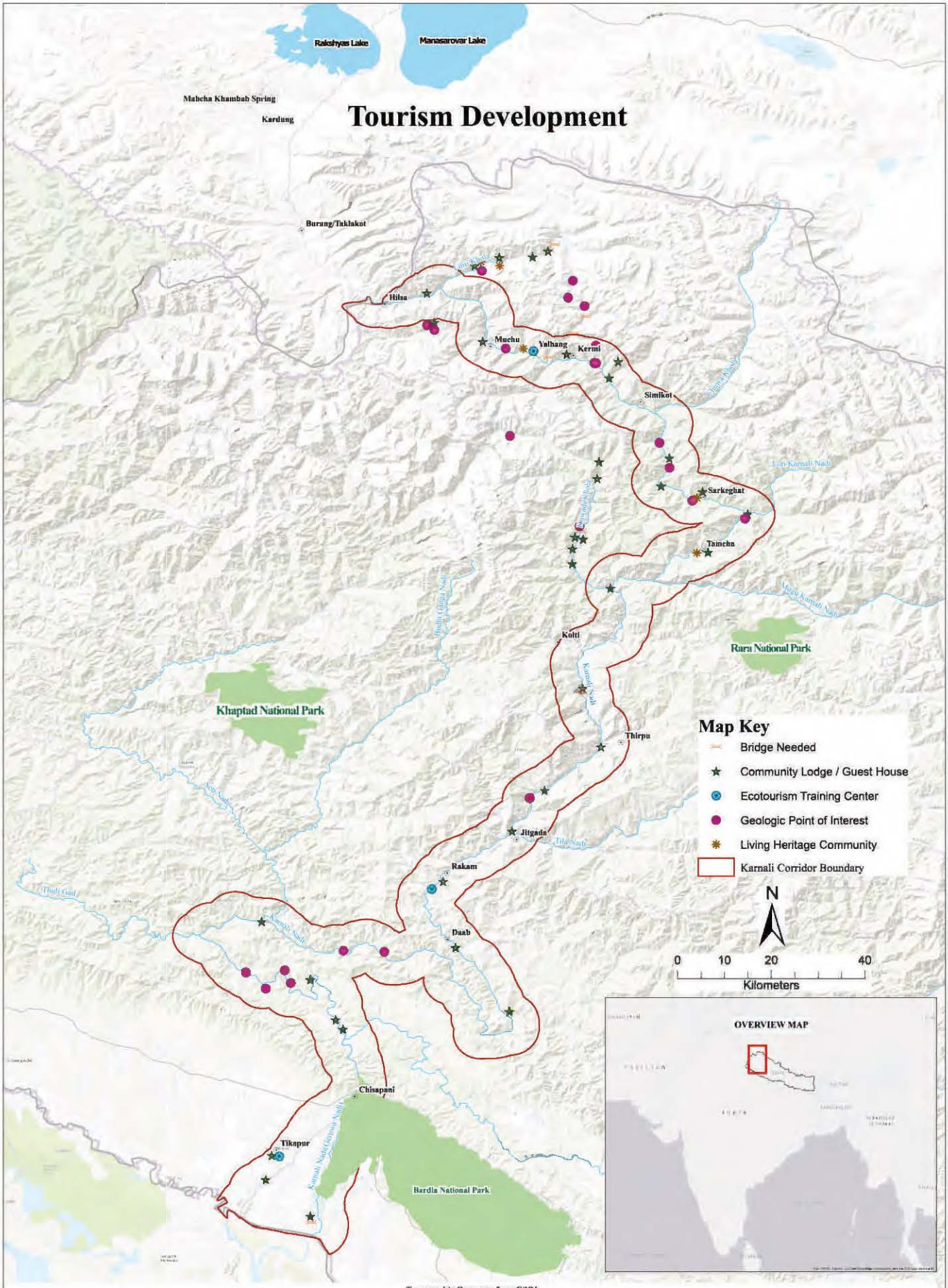
Tourism Development



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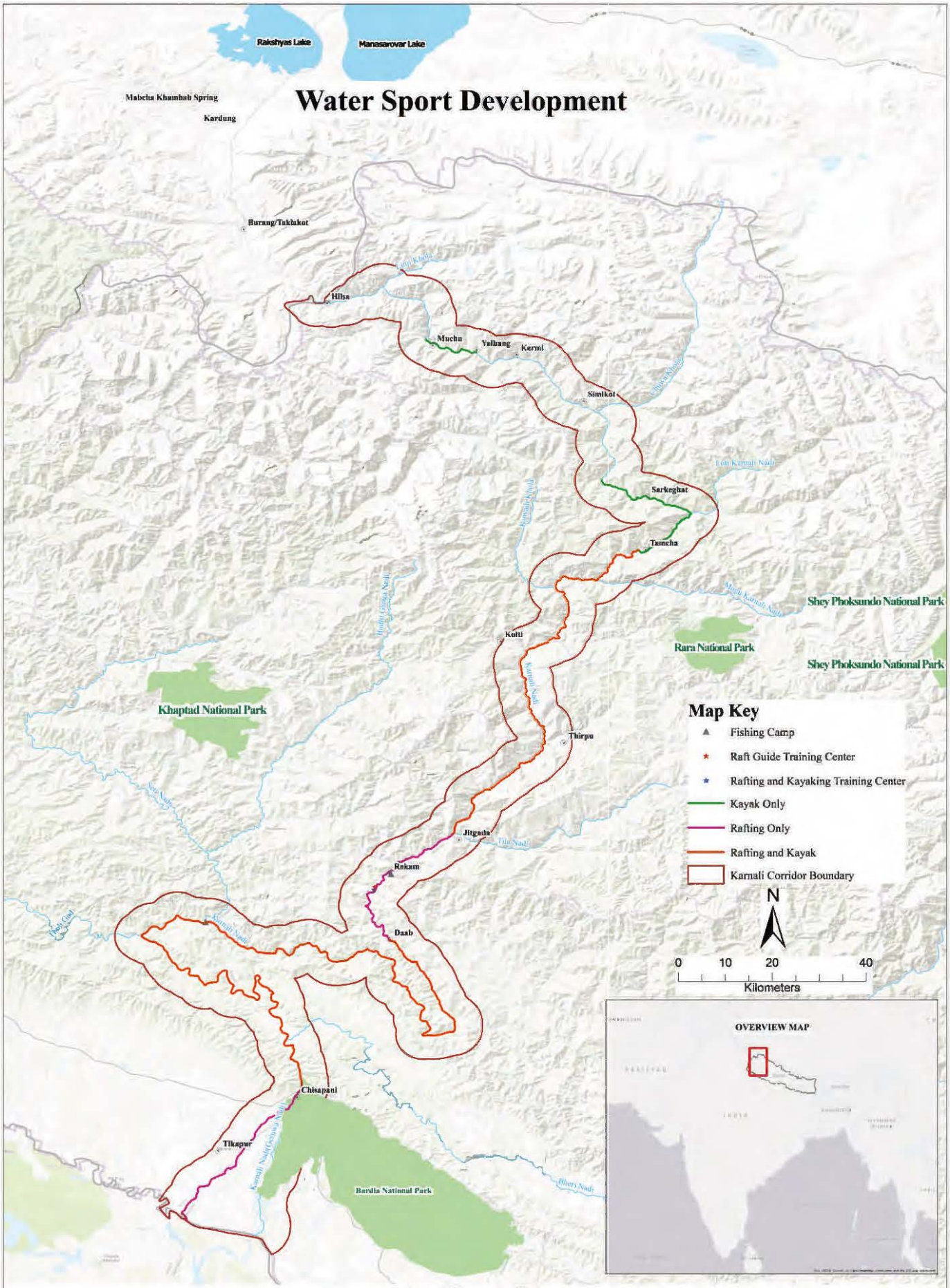
Water Sport Development



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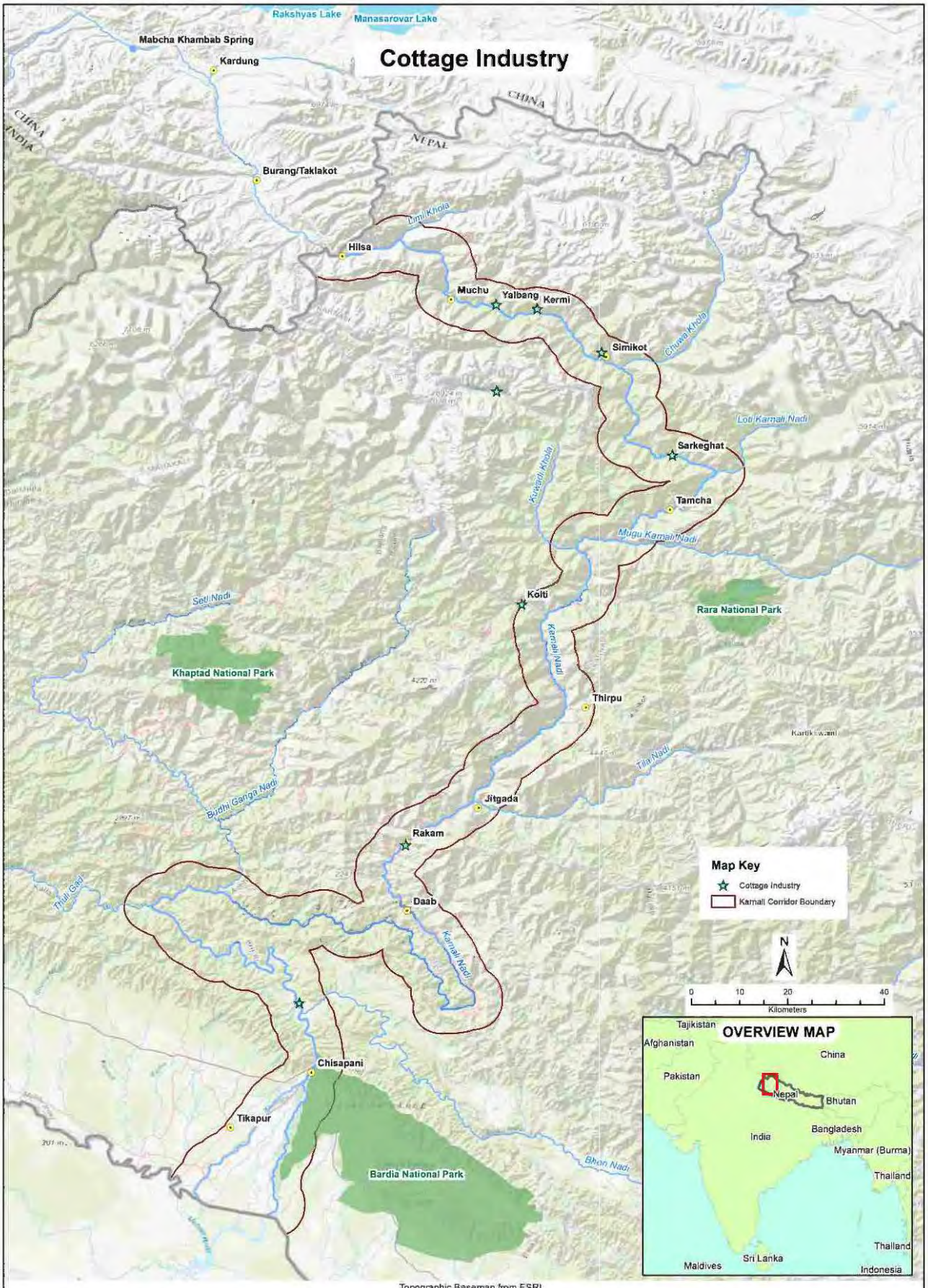

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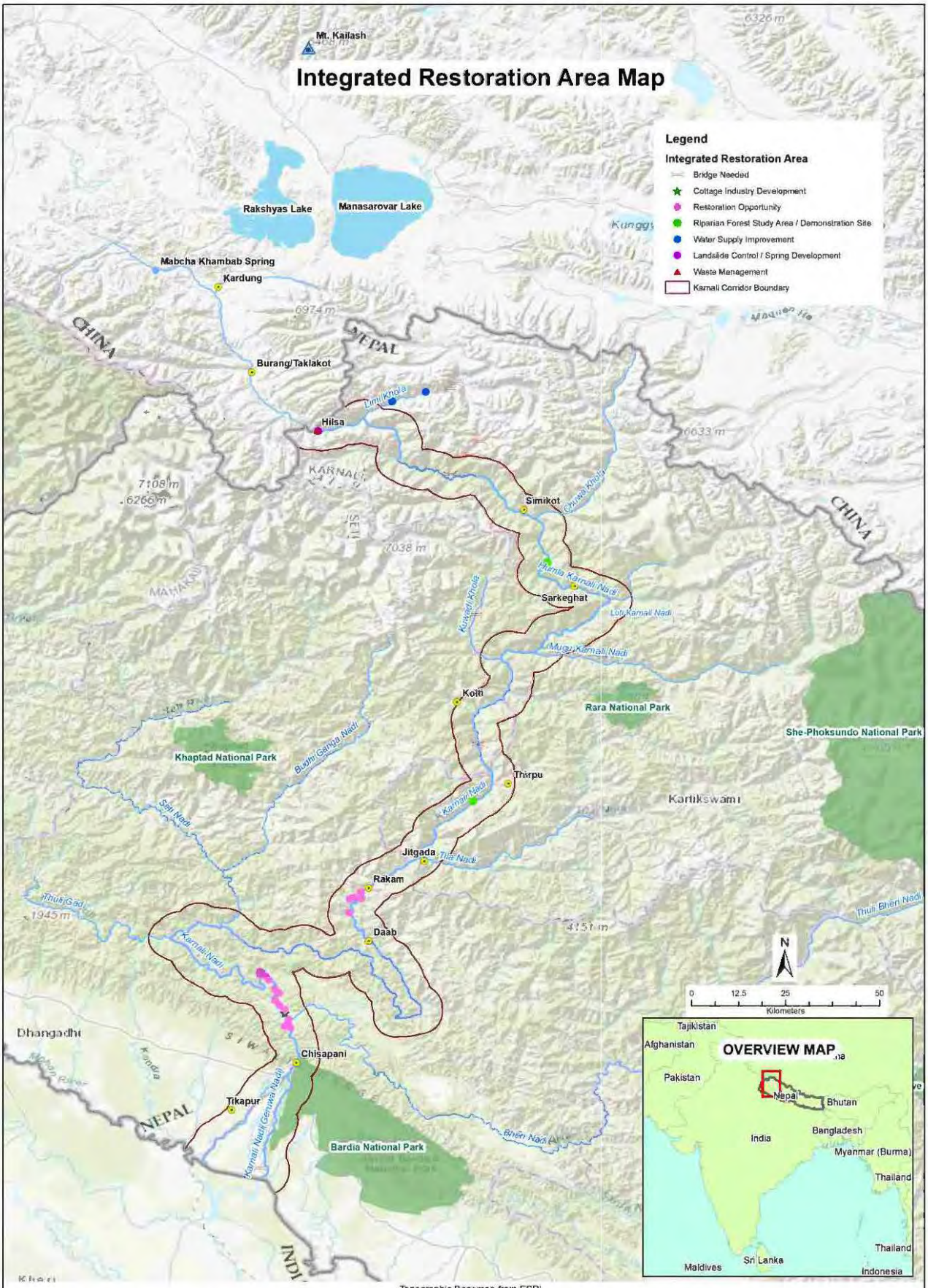

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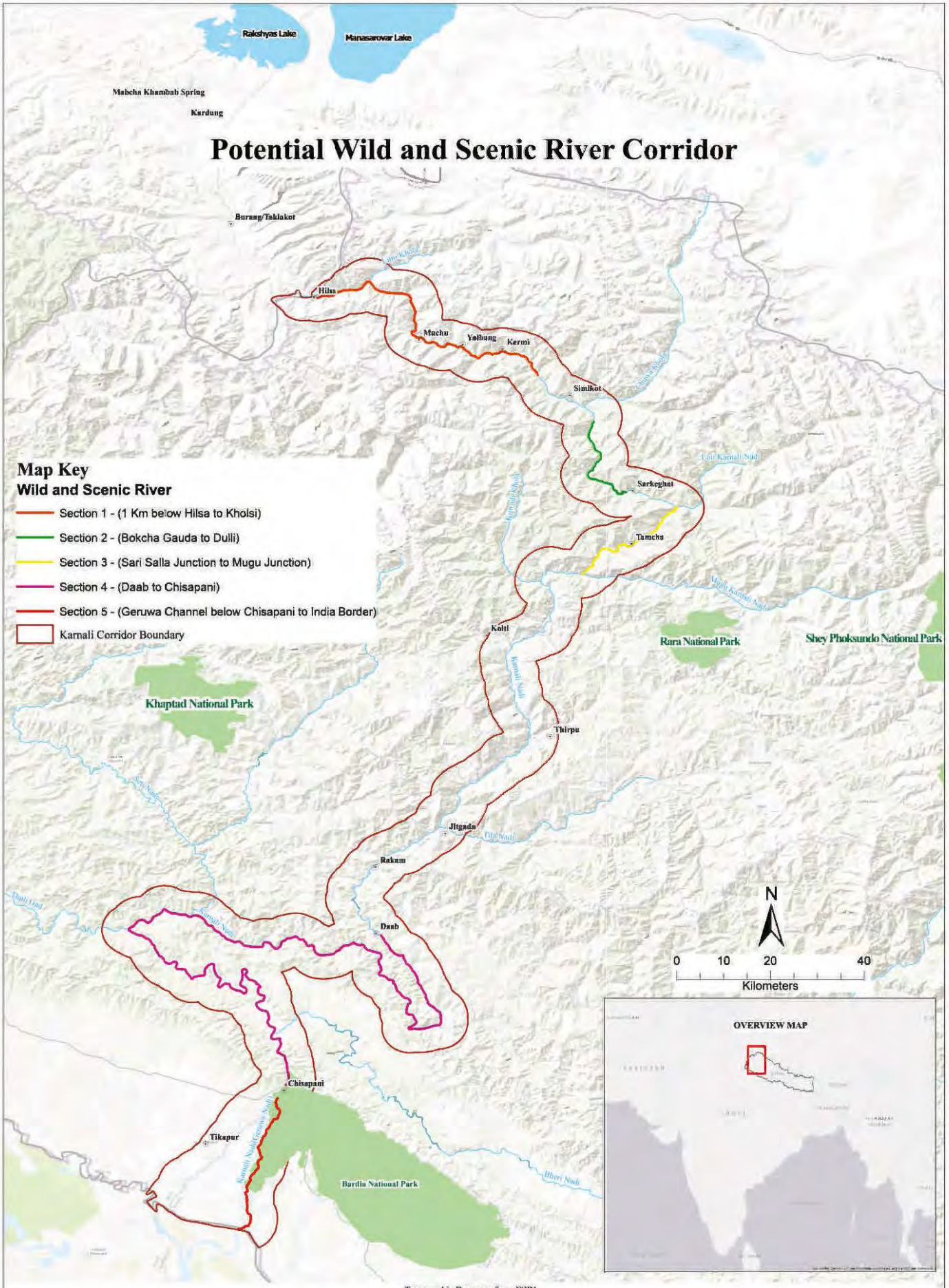
Potential Wild and Scenic River Corridor



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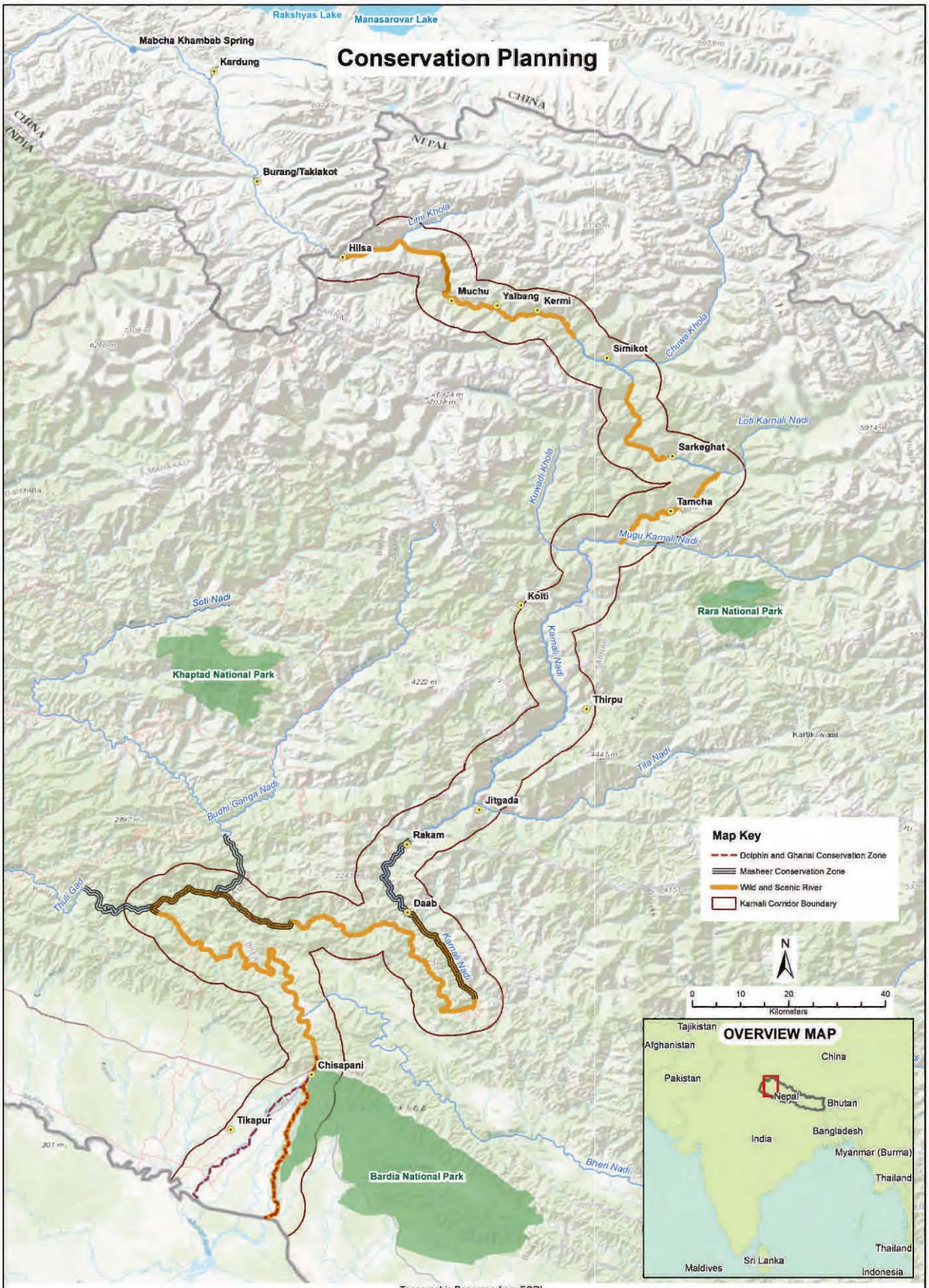

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