



TRANSFORMING RIVER BASIN MANAGEMENT

Stories from the Koshi Basin

ICIMOD

FOR MOUNTAINS AND PEOPLE

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About ICIMOD

The International Centre for Integrated Mountain Development, ICIMOD, is a regional knowledge development and learning centre serving the eight regional member countries of the Hindu Kush Himalayas – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan – and based in Kathmandu, Nepal. Globalization and climate change have an increasing influence on the stability of fragile mountain ecosystems and the livelihoods of mountain people. ICIMOD aims to assist mountain people to understand these changes, adapt to them, and make the most of new opportunities, while addressing upstream-downstream issues. We support regional transboundary programmes through partnerships with regional partner institutions, facilitate the exchange of experience, and serve as a regional knowledge hub. We strengthen networking among regional and global centres of excellence. Overall, we are working to develop an economically and environmentally sound mountain ecosystem to improve the living standards of mountain populations and to sustain vital ecosystem services for the billions of people living downstream – now, and for the future.



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Stories from the Koshi Basin

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Please find Koshi Basin Programme website at www.icimod.org/kbp

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Foreword

The following collection of stories represents an introduction to the people and places benefiting from the work of ICIMOD's Koshi Basin Programme. The programme focuses its work in the Koshi River basin, an area that extends from the hills of the Tibetan Plateau, through the mountains and hills of Nepal, down to the expansive plains of the Indian state of Bihar. What connects this region together is water: The Koshi River and its tributaries cut to the heart of life in both the upstream and downstream communities that live along them. Here, water is the source of both life and death – it provides food and energy, but also incites floods, landslides, and, in its absence, drought.

The projects documented in this book illustrate innovations and partnerships that are enhancing water management in the transboundary basin so that water may be used effectively as a sustainable resource for local socioeconomic development. If water is well managed, damage as a result of water-induced disasters may also be mitigated. Projects range from community-level trainings on flood early warning systems to the rejuvenation of local springs and ponds. Significantly, these projects promote regional collaboration between China, India, and Nepal. Along rivers, a positive effect in one place often translates to a positive effect in another, including those across national boundaries.

As the projects take shape and evolve, the stories that are produced from them also serve as the backbone for future work under the Koshi Basin Programme. Through these stories, we are able to understand what worked well, what needs more work, and what may be a further opportunity, frequently through the eyes of the individuals who directly experienced them. Ultimately, these stories are not only an introduction to the programme, but also a way to share the knowledge we have gained around the Koshi basin's most pertinent issues, in the hopes that through wider understanding, change can continue to happen in very real ways.

David Molden

Director General, ICIMOD





When It Comes to Water

A project in Nepal's middle hills works to
address problems of water scarcity



In Tinpiple, a village in Kavre District approximately one and a half hours by car outside of Kathmandu, Nepal, a group of adolescent girls gathered around a tap that connected to a natural spring. They washed their hair, collected water in plastic and metal jars, and gossiped among themselves. Coming to springs like this one is a daily chore for many of the girls in Tinpiple, as many families in the village rely on these springs to provide water for drinking, irrigation, and livestock. Up until about a year ago, however, the landowner kept this spring locked up to outsiders because it did not have enough water to go around, and girls like the ones at the tap had to find water elsewhere.

The need to conserve water is an ever-more common aspect of daily life in this part of Kavre District. While some areas such as Tinpiple's adjacent pine forests have always been dry, other parts of Tinpiple have become drier in recent years. At the bottom of the area's rolling hills lie streams and rivers; not only it is difficult and expensive to pump the water uphill, but the water can only be pumped when the village is not experiencing its daily scheduled power cuts.

When pumped water is unavailable, residents usually rely on groundwater from springs to fulfil their daily water needs. Yet these springs can also be unreliable because they have the



The need to conserve water is an ever-more common aspect of daily life in this part of Kavre District.

tendency to dry up if the source is overused – the reason why springs in Tinpile were locked up.

In 2013, ICIMOD began working with the Nepal Water Conservation Foundation (NWCF) in partnership with residents from Tinpile and Dapcha, both villages in Kavre District, with the intention of tracking local water processes and finding ways to best use water in order to replenish the drying springs. The

team started to map the springs around each of the villages and collect information on how much water is released from each spring and which springs dry up in the dry season. As the project demonstrated, in order to flourish, the springs need high levels of groundwater, which gets replenished by the monsoon. However, in earlier times, groundwater was also replenished by large ponds that residents kept to wallow their buffaloes. These ponds are particularly vital for collecting rainwater during the dry season, when groundwater levels become low. In recent years, as livelihoods have shifted away from keeping buffaloes, many of these ponds have dried up or have been abandoned. The government, worried about the spread of malaria, also discouraged use of these ponds. Today, though, malaria has been mostly eradicated in Nepal. The team decided that one way to replicate this positive effect on groundwater levels would be to dig ponds at multiple points on the hillsides around each of the two villages. These ponds would collect monsoon runoff that would otherwise be lost downhill, and allow it to seep back into the ground.

With the help of the locals, NWCF built a total of six ponds in Tinpile and Dapcha. This included a pond above the spring that had been locked up. In the months that followed the building of the pond, the groundwater level became higher, and the spring began



to release more water. Eventually the owner unlocked it. It is now used by at least 50 families each day. Other locals also noticed the difference the ponds made on the springs, and started to dig ponds on their own land.

The 7.8 magnitude earthquake that shook Nepal on 25 April 2015 did not break any of these newly-built ponds, but it did shift the ground enough to affect the springs: some dried up, while others became more plentiful. “We will have to start mapping the springs all over again”, said NWCF’s Binod Sharma. “Our understanding of the area’s water dynamics will now be divided into two periods – pre-earthquake and post-earthquake.”

In December 2015, local government councils in Dapcha met to decide on yearly water management projects. The councils wanted to make spring rehabilitation a central part of their plans, and decided to construct and rehabilitate a number of ponds in the area. In one area alone, the councils identified eight potential sites

for future work. The projects will be implemented in the coming fiscal year.

The tap at which the girls from Tinpile gathered was one of the springs where water has increased. “I used to go to a spring closer to my home, but the earthquake dried it up”, said one girl as she lathered her hair. “I come three times a day, and have a longer walk now. But I don’t really mind – it gives me more time to talk with my friends.” The other girls started laughing, and splashed her with water.

It will be important in the future to integrate scientific knowledge with community knowledge and local governance in order to best manage local water resources. ICIMOD hopes that aiding communities in Kavre to gain a deeper understanding of local springs is a valuable place to start.

Partner: Nepal Water Conservation Foundation (NWCF)

Project title: Springs, Storage Towers, and Water Conservation: Exploring Decentralized Management Science for the Middle Hills of Nepal

Years active: Phase I: July 2013 – December 2014;
Phase II: January 2015 – June 2016



Making Water Use Decisions Locally

ICIMOD's work in three districts in Nepal
attempts to transform water management
through water use master plans



Villages in the Koshi River basin have to contend with myriad issues around water management: how much is available, how it is distributed, how it is used. The decisions on these issues are often made on the district and national level, and frequently lack the necessary nuance for local contexts. As a result, local-level management is usually informal and ad-hoc, and marginalized individuals are prone to be left out of the decision-making process. This sometimes gives rise to conflicts within communities and between villages. These conflicts are aggravated by the fact that the demand for water in both domestic and agricultural settings is increasing,

while in many places, water availability is decreasing.

Beginning in 2014, ICIMOD's Koshi Basin Programme, in partnership with HELVETAS Swiss Intercooperation Nepal, started an initiative in three different ecological zones in the Koshi basin to help promote effective, efficient, and equitable water management at the local level. The initiative's goal is to encourage the use of water use master plans, which are locally prepared plans that lay out a five-year usage strategy for all water-related issues, including irrigation, drinking water, sanitation, and disaster reduction. The aim is to improve access to water and ensure



The aim is to improve access to water and ensure equal water distribution among all individuals – especially those who are routinely marginalized, such as women and the poor.

equal water distribution among all individuals – especially those who are routinely marginalized, such as women and the poor.

These plans are unique in that they are developed in collaboration with local communities themselves, and

thus they are able to address the specific needs of each community while also working towards the goal of basin-wide resource management. ICIMOD and HELVETAS work actively with communities in the initial stages in order to ensure a long-lasting impact. While HELVETAS has experience in local-level planning, ICIMOD gives communities up-to-date, scientific knowledge on trends such as monsoon weather and water availability throughout the year, as well as creative solutions for sustainable water use. This information, which communities may not have access to otherwise, is worked into the plans. Once these plans are prepared, they are approved by the village development committee (VDC), which gives support in cash and kind, and ultimately takes it over. In the longer term, the goal is that the plans will be taken up and endorsed by the district development committee, and that they will facilitate talks between communities that live along the same tributary in order to create a larger, integrated master plan at the catchment level. By working to integrate upstream and downstream issues, these plans differ from previous water use planning at the VDC level. If successful, the project will be replicated in other districts in the Koshi basin.

At the start of the project, the team spent time visiting villages in Sindhupalchowk, Sindhuli, and Saptari, three districts that are linked through upstream-downstream



dynamics of the Sunkoshi River. There are unique concerns in each place. In the hills of Sindhupalchowk, the northernmost of the three districts, problems of mountain water runoff and water scarcity make it difficult to grow more profitable crops and vegetables. Further down in Sindhuli, significant portions of the communities are marginalized populations of Dalits and indigenous tribes; poverty rates are more than 50 percent. The district frequently suffers from floods, droughts, and food insecurity. In the plains of Saptari, pumping groundwater is a challenge, and frequent flooding causes soil and riverbank erosion, which leads to difficulties in field irrigation. In each

of these different places, the team met with different members of the community who have a stake in water issues. The team spoke with them about the idea of water use master plans, and asked them to provide feedback on the planning. HELVETAS also contracted local NGOs to conduct technical and socioeconomic surveys on water needs in an effort to bolster plans. Local residents and local authorities welcomed the idea as a way to more effectively manage one of the community's most vital resources.

In March 2015, 30 selected participants from Sindhupalchowk, Sindhuli, and Saptari travelled to Kathmandu for a four-day training



on how to create and execute a water use master plan that is gender-sensitive and socially inclusive. The training consisted of presentations, group discussions, and fieldwork, and encouraged interaction among the participants with the hopes that they could build off of one another's ideas. By the end of the workshop, the participants drew up plans for how they could start the water use master plan process in their area. The plans, if effectively executed, should reach around 12,000 households in 12 VDCs of the three selected districts.

The 2015 Nepal earthquake was a set-back but also an opportunity for local level water management:

Effective management has become even more vital as new challenges arise around sanitation and access to water. Sindhupalchowk was one of the hardest hit districts, and nearly all houses have been damaged or collapsed. Families here and elsewhere have moved into temporary shelters that do not always have reliable water sources, making them more susceptible to water-based inequalities. In the weeks that followed the earthquake, HELVETAS and ICIMOD distributed rice, lentils, tents, and solar lamps to some of the neediest families in Sindhupalchowk. One of the largest lessons learned from the earthquake is that disaster mitigation plans need to be strongly integrated into water use master plans. As the districts move forward with recovery, it is the hope that participatory local water management will help communities re-emerge stronger. In the long-term, this project aims to spur basin-wide conversations centred on water management and based on issues that originate at the local level.

Partner: HELVETAS Swiss Intercooperation Nepal

Project title: Support to Local Level Water Use Master Plan in Selected Districts of the Koshi Basin (Nepal Part): A Collaborative Action Research of ICIMOD and HELVETAS Swiss Cooperation

Years active: May 2014 – December 2015

Further reading:

Nepal, S; Flügel, WA; and Shrestha, AB (2014) 'Upstream-downstream linkages of hydrological processes in the Himalayan region'. *Ecological Processes*, 3(1), 1-16.





Planning for the Future

Hydrological modelling determines future water availability and has the potential to help planners and decision makers



Basin-level water availability in the context of climate change is a major concern for many regional planners and decision makers. While the extent of these changes is still not completely clear, scientists at ICIMOD predict that precipitation will increase during the monsoon but decrease during the winter, and that flooding will become more extreme, which will lead to problems with food production. In a region that is already facing increasing water scarcity and a growing population, the question of how much water will be available in the future and how this will interact with changing social and economic conditions is an important one.

In early 2013, the Koshi Basin Programme, in partnership with the International Water Management

Institute (IWMI), completed a first of its kind study on future climate change scenarios, water availability, and possibilities for agricultural adaptation in the Koshi basin. As more data becomes available and the study is refined, it will be a valuable tool for future water resource planning.

To understand the water dynamics at play, the research team applied the Soil and Water Assessment Tool (SWAT), a basin-level hydrological model that helps to determine future water availability scenarios through assessing data on precipitation, surface runoff, and groundwater and river flow. The model also helps to determine the sources of a river's flow – whether from precipitation, underground, or melting snow and glaciers – which is useful information

for water resource planners and decision makers.

Using SWAT output data, the research team developed an innovative approach that integrated this data with the Water Evaluation and Planning (WEAP) model to assess future water availability until the middle of the century. Using input from the SWAT model, the WEAP model is able to estimate current and future water demands for different sectors,

As more data becomes available and the study is refined, this will be valuable tool for future water resource planning in the basin.

including domestic, agricultural, industrial, and hydropower sectors. Most importantly, WEAP can calculate unmet water demand and help decision makers understand the impacts of upstream developments in downstream communities.

The results of these two models showed that the available water in the Koshi basin is largely untapped: only 7% is currently utilized. These results suggest that there is great potential to use water from the Koshi basin for economic and industrial activities in the future, and that current issues around water scarcity largely stem from a lack of investment. Additionally, data also suggested that the Koshi

River can generate 37 times more energy than the amount of energy that Nepal annually imports from India. This information can help planners make decisions about the construction of hydropower infrastructure.

The output produced by these two models will aid individuals who work in the Koshi basin in making plans for the future. Later in 2015, the Koshi Basin Programme will hold a workshop for government officials on how to use this data in their work. While this initial study has produced information primarily about water availability on the basin-level, the team is working to refine the models so that there is data available for the local-level as well. Local-level data on water availability is valuable for communities working to better manage their resources. ICIMOD's hope is that a better understanding of water resources will make future planning in the Koshi basin a little bit easier.

Partner: International Water Management Institute

Project title: Water Availability and Agricultural Adaptation Options of the Koshi Basin under Global Environmental Change

Years active: February 2013 – March 2015

Further reading:

Chinnasamy, P; Bharati, L; Bhattarai, U; Kadhka, A; Dahal V; and Wahid, S (upcoming) 'Impact of Planned Water Resource Development on Current and Future Water Demand of the Koshi River Basin, Nepal'. Accepted for publication in *Water International*.

Bharati, L; Gurung, P; Smakhtin, V; and Jayakody, P (2014) 'The Impact of Climate Change on Water Resources Development in the Koshi Basin, Nepal'. *Mountain Research and Development* 34 (2), 118-130



A photograph of a person in a small wooden boat on a body of water. The person is shirtless and is using a long wooden pole to navigate the boat. In the background, there is a small, grassy island with a small, conical structure and a cow standing on it. The water is calm, and the sky is clear.

Rethinking the Relationship Between Resources

ICIMOD research argues that a 'nexus approach' should be incorporated into future climate change adaptation strategies



As the effects of a changing climate start to become apparent in the Koshi basin and elsewhere in the Hindu Kush Himalayas, workable adaptation strategies are increasingly important for maintaining a healthy environment and sustaining rural livelihoods. However, not only is the Koshi basin a complex environment that covers a diverse range of landscapes across China, India, and Nepal, the population is also growing, putting stress on resources and land. Smart, innovative policies will be necessary as the region moves forward into the future.

In the spring of 2015, two ICIMOD researchers, who were supported in

part by the Koshi Basin Programme, published a paper entitled “The nexus approach to water-energy-food security: an option for adaptation to climate change” emphasizing a new way to manage these future challenges. Published in *Climate Policy* journal, this paper advocated a “nexus approach” that linked together discussions about climate change and the interdependence of energy, food, and water. While in many cases in the Hindu Kush Himalayan region the need to adapt to future climatic scenarios is widely acknowledged, actual adaptation strategies remain much more blurry. The paper not only brought in a fresh perspective, but also suggested some feasible strategies for moving forward.



The paper not only brought in a fresh perspective for managing natural resources, but also suggested some feasible strategies for moving forward.

Future predictions for the Hindu Kush Himalayan region suggest that growing population pressure will also make it more difficult to grow food and access water. Crop yields in South Asia are expected to decrease up to 30% by 2050 if practices continue at the

normal rate. Even today in the Koshi basin, water, a resource that was once abundant, is becoming increasingly scarce. This makes it challenging to grow rice and wheat, two crops that require large amounts of water. To add to this, in many contexts, these resources – food, energy, and water – directly affect each other. Producing more food strains water and energy, which will also be in higher demand as the population grows. While scientific research recognizes the relationship between these resources, this understanding is too rarely applied to future climatic scenarios, the paper argued.

Another problem is that current regional adaptation strategies for



climate change usually give preference to one resource over another. For example, micro-irrigation technologies such as drip and sprinkler irrigation reduce water demand by increasing efficiency, but also increase energy demand. With this in mind, the paper proposed that future adaptation

strategies focus on “win-win” solutions that work across all three resource sectors in ways that are compatible with each other and that minimize trade-offs. The paper laid out specific examples on ways to do this: among other things, farmers should switch to drought-tolerant crops, which increases food yield and decreases water demand, and communities should improve water management so that there is more water to meet water and energy demands.

Article: Rasul, G and Sharma, B (2015) The nexus approach to water–energy–food security: an option for adaptation to climate change. *Climate Policy*, (ahead-of-print), 1-21.

This study was part of ICIMOD’s Himalayan Adaptation, Water and Resilience (HI-AWARE) Programme, funded by the UK’s Department for International Development (DFID) and Canada’s International Development Research Centre (IDRC); the Himalayan Climate Change Adaptation Programme (HICAP), implemented jointly by ICIMOD, CICERO, and Grid-Arendal and funded by the Ministry of Foreign Affairs, Norway and the Government of Sweden; and the Koshi Basin Programme of ICIMOD funded by the Department of Foreign Affairs and Trade (DFAT) of Australia.

This paper suggests new ways of approaching resource management and development plans in the coming years in national- and local-level planning. If successful in the Hindu Kush Himalayan region, ICIMOD also hopes that the ideas presented in the paper can be applicable in other parts of the developing world that may face similar challenges in the years to come.



In Search of More Time

Community-based flood early warning
systems will help communities in the
Koshi basin better prepare for a flood



During much of the year, the rivers that cut through Mahottari District in southern Nepal are small trickles on dry, stony beds. Children play amongst the rocks, and nearby residents easily ford the water on bicycles. However, during the rainy monsoon months, the rivers swell into torrents, coursing swiftly downstream, often breaching the banks. On this part of the Gangetic Plains, where the land is flat for hundreds of miles around, rising water during this part of the year has the potential to mean dangerous flooding. Many of the villages nearby these rivers have constructed embankments to keep out the water, but this is not always enough. It is often the poorest individuals who live closest to the river, in weak houses

made of bamboo and mud. For them, floods can mean disaster.

The residents of Suryahi, a village near the Indian border, expect a flood every year. "Last year, the floodwaters came up to our chest", said Sunita, a woman in a magenta cotton sari with a ready smile. For days, this flood also blocked the highway that connected this part of the country with the rest of Nepal, bringing people, food and other goods to a standstill. When a flood happens, neighbours gather on one another's roofs, which are usually safe from the water. If they have enough time, they also collect valuables like seeds and bedding from their homes and move their livestock, which otherwise drown, to higher ground.

The problem, however, is that no one is certain when a flood will happen. “We usually hear about a coming flood from the milkman”, said Sunita. Each morning, a milkman from a neighbouring town crosses the river on his way to Suryahi. If the river seems unusually high, he calls people in the surrounding villages and tells them to prepare for the coming water. While men often worry about losing official documents like land deeds, Sunita

“We usually hear about a coming flood from the milkman”, said Sunita

and other women in the village are especially concerned about floods because they do not know how to swim, although they have to assure their children’s safety. Growing up, boys swim and bathe in the river or nearby ponds, girls usually stay inside. Because of this, for the women and other residents of Suryahi, knowing that a flood is coming two or three hours in advance can make all the difference. If a flood comes during the night, residents of Suryahi do not know a flood is coming until it is already too late.

In response to these yearly floods, ICIMOD’s Koshi Basin Programme, together with the Department of Hydrology and Meteorology’s Community Based Flood and Glacial Lake Outburst Risk Reduction Project, is currently piloting United Nations

Development Programme-supported community-based flood early warning systems along the nearby Ratu Khola river in an effort to give flood-prone communities like Suryahi the extra time that they need prior to a flood. The systems, which were improved based on community feedback and successfully implemented at a few selected sites in the Indian state of Assam in 2012 under ICIMOD’s HICAP initiative, work on the notion that upstream and downstream communities along rivers are inexorably linked, and can work together to provide each other with vital, life-saving, and nearly real-time information. The systems are simply and domestically built so that locals can take charge of operation and upkeep, and find maintenance tools and equipment in their own villages. From the start, the project works closely with local governments and communities so that the early warning systems can continue even after the Koshi Basin Programme ends.

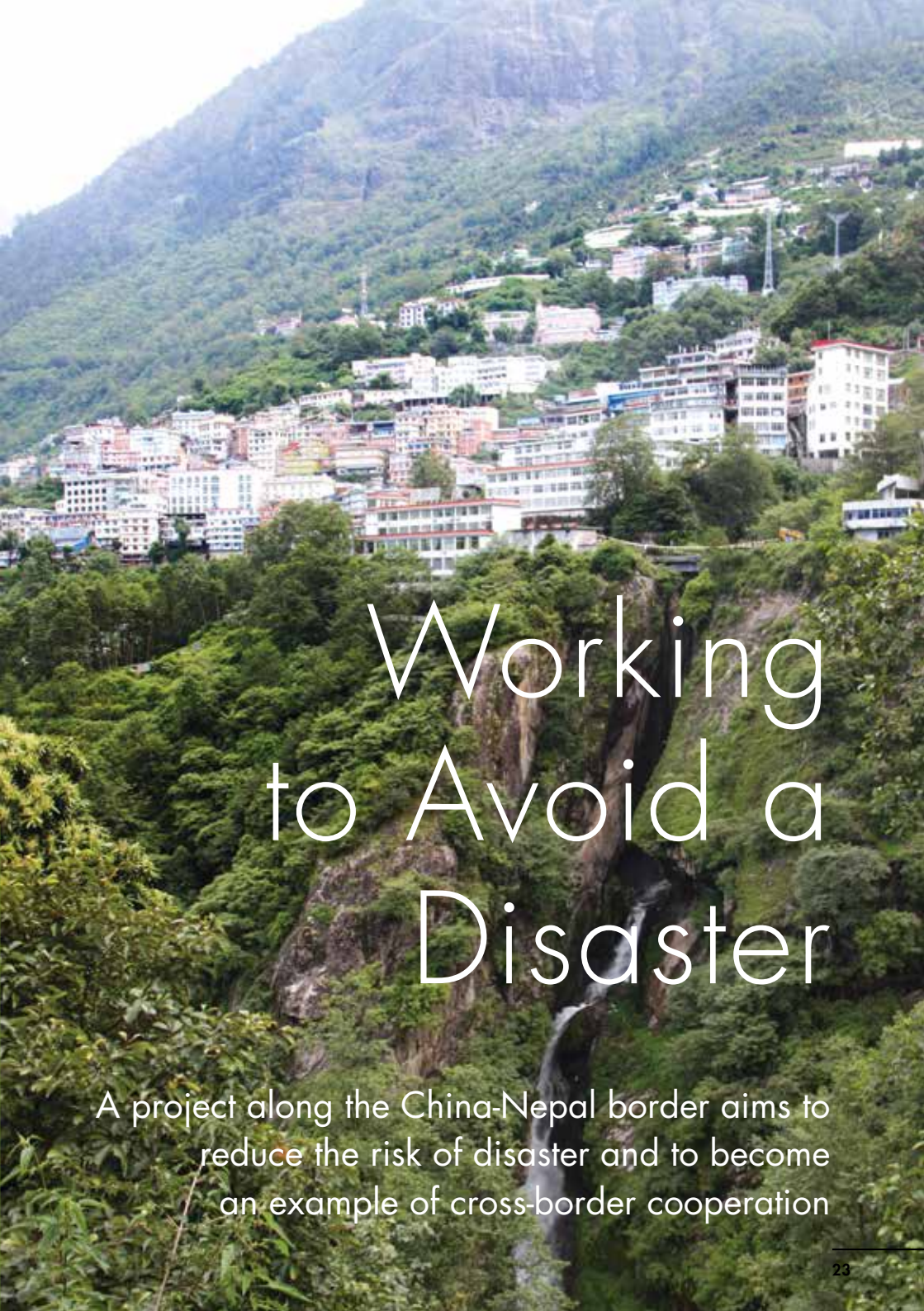
The mechanics of the system begin with a sensor rod that is calibrated in consultation with the local communities to the specific conditions of the landscape and river, and installed in an upstream section of a flood-prone river. When water levels begin to rise during the monsoon season, the sensor sends a message in the form of a light and a loud buzzing noise to a receiver located at a nearby house of someone who has volunteered to be the system’s local

caretaker. When the water is rising to dangerous levels, the caretaker calls or sends a text message to the numbers on a contact list of individuals downstream as well as the adjacent community and government institutions to inform them of the potential for floods. These programmes aim to install at least three of these systems on the Ratu Khola in locations that give vulnerable downstream communities enough time to evacuate if necessary.

The establishment of community-based flood early warning systems in the Koshi basin is still in the initial stages, but it is moving forward. In early June 2015, ICIMOD held a five-day training session in Kathmandu with 16 participations from Afghanistan, India, and Nepal to show how to use the warning systems. Four of these participants were the selected caretakers of planned installation sites in Mahottari District. Over the course of the session, the participants learned how to monitor the sensors while also building a closeness and trust with one another that will be indispensable in the event of a flood. When the time came to put together the sensor for the first time, participants were eager. “This system is easy to understand and use”, said Rajkumar, one of the participants from Mahottari District. “Before, we never used to know for sure how high the water was, but now there hopefully won’t be problems. This will be good for our villages.”

Back in Mahottari District, residents are enthusiastic about the project’s potential to help them improve their response during a flood. “Even an hour advanced warning gives us enough time to save most of our animals,” said Prem Chandra, a resident from Suryahi. Often, floods in this region last seven to 15 days, and are only the start of problems. Sanitation frequently becomes an issue in the days following a flood, particularly for women: “It’s hard to find a proper place to go to the bathroom after a flood”, said Sunita. “Women have to be much more discrete than men.” One man who lived by the river has lost his house five times over the course of his life. Others lose their crops and other forms of livelihood. Mitigating these challenges requires long-term effort and planning. In the short-term, however, the installation of community-based early flood warning systems are a small but fundamental step in helping communities cope with the floods.

This pilot project is a part of the Himalayan Climate Change Adaptation Programme (HICAP) in collaboration with local partners AARANYAK and Sustainable Eco Engineering. HICAP is implemented jointly by ICIMOD, CICERO, and Grid-Arendal and is funded by the Ministry of Foreign Affairs, Norway and Swedish International Development Agency (Sida). ICIMOD has piloted CB-FEWS in the catchments of two rivers – the Jiadhal River in Dharmaji District and the Singora River in Lakhimpur District – in the Eastern Brahmaputra River Basin. Building on past experiences, a CB-FEWS is being implemented in Ratu River in Mahottari District in the Koshi River basin under the Koshi Basin Programme and another system is being considered in Baghlan province in Afghanistan.

A scenic view of a densely populated hillside town, likely in Nepal, with a waterfall cascading down a rocky cliff in the foreground. The town is built on a steep slope, with numerous multi-story buildings in various colors (white, red, blue, yellow) clustered together. The background shows a steep, forested mountain slope under a clear sky. The overall scene is lush and green, with the waterfall adding a dynamic element to the landscape.

Working to Avoid a Disaster

A project along the China-Nepal border aims to reduce the risk of disaster and to become an example of cross-border cooperation



In the early hours of 2 August 2014, nearly two kilometres of soil, mud and rock, which had become loosened by the yearly monsoon rains, detached from a hillside in the district of Sindhupalchowk north of Kathmandu and slid downwards towards the village of Jure. The debris wiped out large sections of the village, and then continued until it reached the Sunkoshi River below, where it blocked the water and created a dam. In the hours that followed, the dammed water formed into a lake that, should it burst, would unleash torrents of water on hundreds of villages, reaching as far south as India. Besides creating the dam, the landslide killed 156 people, and displaced more than 430. It submerged a hydropower plant that supplied electricity to Kathmandu and other places, and it destroyed sections of the highway linking Nepal and China, which cost the country nearly

USD 400,000 in trade revenue each day it remained closed. After 45 days, the Nepal Army helped the country avert even more disaster by digging a canal and releasing some of the dam's water.

Disasters along this section of the Koshi River basin are not new. On 11 July 1981, an ice avalanche hit Cirenma Tso, a glacial lake in the mountains of the Tibet Autonomous Region of China, just north of the Nepal border. The avalanche caused the lake's water to surge and breach the glacier's lip. The water travelled down the mountains and across the border into Nepal, sweeping up houses, people, and bridges as it moved. Ultimately, more than 200 people died, and economic losses climbed as high as USD 300 million. The bridge connecting China and Nepal was gone, and as much as

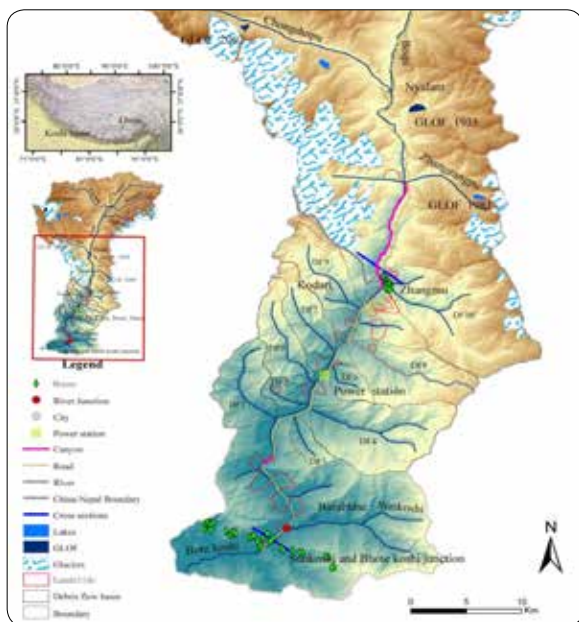
27 kilometres of highway were destroyed. For months, any overland travel or trade between the two countries was effectively impossible. In the past 50 years, at least five other similar disasters have affected the Koshi River basin region.

These disasters highlight the urgent need for regional cooperation around the management of the sub-continent's water resources and hazardous risks.

These disasters highlight the urgent need for regional cooperation around the management of the sub-continent's water resources and hazardous risks. They demonstrated not only the dangerous fragility of the physical link between China and Nepal, but also the transboundary nature of the basin's water systems and natural disasters. Cooperation and proper supervision of water systems in China could mean improved lives and livelihoods downstream in Nepal and India. Research findings have shown that the glaciers in the region are retreating and glacial lakes are increasing. As a

result, the risk of hazardous landslides and glacial lake flood outbursts has also increased. Local and national governments of both Nepal and China looked for ways to improve water and risk management in recent years.

In response to these developments, ICIMOD's Koshi Basin Programme, in partnership with the Institute of Mountain Hazards and Environment under the Chinese Academy of Sciences, started the Water Management and Hazard Risk Reduction Project in 2013. The project, which will continue through 2016, has the goal of reducing the risk of more disasters along the vital Nepal-China trade corridor, among other places. The team set out to map the landscape, precipitation, geology,





initiating community-based flood warning systems in the area.

The resulting action plan fed into larger ongoing efforts of the Chinese government to reduce the risk of landslides in the area. In May 2014, China decided to invest USD 483 million

and economy around Zhangmu, the Chinese border town that sits nestled in a lush green hill above the river gorge that divides the two countries, in the hopes of creating a disaster mitigation plan.

After a year of research and mapping, the team identified 18 potentially-dangerous glacial lakes in the mountains of the Tibet Autonomous Region, including Cirenma Tso, which had reformed. The hills around Zhangmu, too, had sections that were at risk of landslides. The team presented their findings at Nepal's Tribhuvan University, and drew up a proposal with specific action points for cross-border cooperation, some of which included creating an interactive water resources and hazards information platform for government ministries, establishing a landslide catchment demonstration site along the area's trans-border highway, and

into the implementation of risk reduction initiatives around Zhangmu. Encouraged by the response, the team has now shifted its effort downstream to the Nepal side of the border, where it is hoping to initiate an early flood warning system that can work across countries. The project stands as an example of constructive regional collaboration that can not only help lessen the area's potential for future disasters, but also serve as a model for other similar projects across the Hindu Kush Himalayas.

Partner: Institute of Mountain Hazards and Environment (IMHE), Chinese Academy of Sciences (CAS)

Project title: Water Management and Hazard Risk Reduction Related Policy and Institutional Analysis in China for Koshi Basin Management

Years active: March 2013 – December 2016



Before the Water Comes

Koshi basin communities can now access
up-to-date information on floods



In the plains of Bihar in northern India, flooding has a long history. Most recently, in 2008, poor maintenance caused a breach in the Koshi embankment, the structure that protects villages adjacent to the river. Water poured out of the embankment and washed over the plains of northern India, ultimately affecting around 3 million people and culminating into one of Bihar's worst ever floods. That's why there was concern six years later on 14 August 2014, when consistent heavy rainfall in Nepal caused major rivers, including the Koshi River, to rise to dangerous levels. ICIMOD's flood management team was monitoring the rainfall and river flows, and sent a

flood outlook to Nepal's Department of Hydrology and Meteorology (DHM). The outlook was forwarded by DHM to radio and news stations, and helped downstream populations prepare for the worst.

ICIMOD was able to receive this up-to-date, accurate information on rainfall and potential floods that August because of a project that began in 2010 that aimed to improve flood forecasting and to minimize the loss of human life and property across the region's major river basins, including the Indus, the Ganges, and the Brahmaputra. The Hindu Kush Himalayan-Hydrological Cycle Observing System (HKH-HYCOS),



The project includes different components meant to build the technical capacity of stakeholders, and to make flood information available to the wider public.

a regional component of the World Hydrological Cycle Observing System (WHYCOS) supported by the Ministry of Foreign Affairs, Government of Finland, includes different components meant to build the technical capacity of stakeholders and make flood information available to the wider public. Because of the transboundary nature of many of the region's flood

disasters, the project also made efforts to strengthen cross-border cooperation in disaster management.

Since 2014, ICIMOD has made improvements to the Koshi basin flood outlook system with support from the Australian Department of Foreign Affairs and Trade (DFAT), including activities to build the technical capacity of stakeholders and make the flood outlook operational. Now, an up to 72 hour advanced flood outlook can be provided to Nepali and Indian stakeholders in the Koshi basin. Working closely with national agencies in Nepal and Bihar, India, the system employs radar technologies to operate 12 automated web-based

sensors and transmit data to national hydrometeorological services, as well as an ICIMOD-run regional flood information system server. These provide real-time data and information on river water levels and rainfall in different vital locations of the basin that are combined with GFS (Global Forecast System) modelled rainfall predictions and analysed to produce the flood outlook. The public and other interested institutions can access the latest updates on floods from websites maintained by ICIMOD and DHM.

To ensure operational aspects of the flood information system, the project is working to build the technical capacity of national agencies and knowledge around its use. For example, in March 2014, ICIMOD ran a two-day training in the town of Dhankuta in the eastern part of the Koshi basin for 20 station gauge readers and observers from 11 station locations. The training included theory, group work, and a visit to one of the stations in order to promote a deeper understanding of real-time data collection, how to operate and maintain the station equipment, and how to rectify technical problems when they arise. Most importantly, the training emphasized how to assure the collection and transmissions of good quality data, which can make the difference between death and life for many in the towns and villages of the Koshi basin.

The flooding that occurred in parts of Nepal and Bihar in August 2014 did not unfold into a major disaster; however, the issued flood outlook gave some communities the time they needed to evacuate. The flood outlook's success has been noticed by Bihar's State Disaster Management Authority, which has shown interest in integrating the system into its own disaster management activities. In this sense, the project not only has improved the quality of flood data available in the region, but also has set an example of progressive cross-border cooperation that is essential in the event of a disaster.

HKH-HYCOS is a regional component of the World Hydrological Cycle Observing System (WHYCOS), a global programme of the World Meteorological Organization (WMO) and supported by ICIMOD core and programme donors, including Australia's Department of Foreign Affairs and Trade since 2014. The project seeks to enhance regional cooperation and strengthen the capacity of national hydrometeorological agencies in flood forecasting by establishing a regional flood information system. Based on real-time hydrometeorological observations from 38 stations installed by the project and operated by the national agencies, and satellite observation based precipitation forecasts, the project is able to provide regional and basin-wise flood outlook information to stakeholders in the countries of the Hindu Kush Himalayas through web and mobile-based applications and help minimize the potentially disastrous impacts of floods.

Find the Koshi Flood Outlook at:
www.icimod.org/koshifloodoutlook



The Mountains' Shifting Soils

A new project brings together researchers from
China, India, and Nepal to study sediment
dynamics in the Koshi basin



Despite their height, the Himalayas are some of the youngest mountains in the world. This brings with it an element of fragility because many of the mountains' formations have yet to permanently settle. Because of this, the Himalayas are highly vulnerable to erosion, and each year in the Koshi basin monsoon rains wash as much as 135 million tonnes of sediment into the rivers. These rivers, bulging with seasonal glacier and snow melt and rain, rush down to the Gangetic Plains, carrying loads of sediment along with them. The sediment is deposited on the plains' flat riverbeds, and, over time, these riverbeds begin

to rise. This prompts rivers to divert and meander to find new, easier paths, which can be dangerous for nearby communities. Over the past 220 years, the Koshi River has moved approximately 115 kilometres westward. In its wake, it has eroded farmlands, washed away crops, and displaced many people who live on the densely-populated plains surrounding it.

In order to better understand the Himalayas' transboundary geomorphological processes, the Koshi Basin Programme has started an integrated, basin-wide study looking at the causes of land degradation



The aim is that the project will not only break new ground of our understanding of erosion and sedimentation processes in the Koshi basin, but also set an example of regional science collaboration on environmental challenges.

and the impacts of erosion and sediment in relation to water-related hazards. The study, which began in 2014 and will continue until 2017, brings together cross-border

expertise from the three Koshi basin countries. Using GIS technology, land modelling, and statistics, the Institute of Geographic Sciences and Natural Resource Research, which is part of the Chinese Academy of Sciences, is conducting research on land use and land cover change to understand the relationship between environmental factors and erosion. Researchers from the Indian Institute of Technology-Kanpur are using a landscape evolution model to understand the movement of sediment and its overall relationship with the basin's rivers, and Nepal's Department of Hydrology and Meteorology is collecting data from five sediment stations in the upper section of the Koshi basin to analyse erosion processes. The aim is that the project will not only expand the understanding of erosion and sedimentation processes in the Koshi basin, but also set an example of regional science collaboration on environmental challenges.

While the research is still in the early stages, some advancements have already been made. Researchers working on land use have produced a series of maps and an accompanying paper that details soil loss over 20 years, and have marked out conservation priority areas on which to focus future management. These areas are mostly in the hilly and mountainous regions of Nepal and the Tibet Autonomous Region of China.



Taken together, the project's goal is to create transboundary knowledge around erosion and sediment dynamics in the Koshi basin that will help in designing sustainable management and hazard mitigation plans in the future. Proper management requires an understanding of where sediment comes from and how it is distributed on a basin-wide level. With this knowledge, planners can design stable water channels and dams, promote smart soil conservation practices, and encourage irrigation schemes that lessen erosion and help the region to avoid future disasters.

Partners: Indian Institute of Technology, (IIT-Kanpur, India); Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences (IGSNRR, CAS); Department of Hydrology and Meteorology (DHM), Nepal

Project title: A study on sediment dynamics and sediment connectivity in the Koshi Basin: Implications for river hazards (IIT-Kanpur, India); A study on land use change and land cover change, erosion and land degradation in the Koshi River Basin (IGSNRR, CAS); Improvement of discharge and sediment data in the Koshi River Basin (DHM)

Years active: IIT-Kanpur, India: June 2014 – June 2016; IGSNRR, CAS: July 2014 – June 2016; DHM: April 2015 – June 2017

A photograph of a man in a light grey shirt and red shorts plowing a field with two oxen. The oxen are harnessed together, pulling a wooden plow. The field is filled with dry, golden-brown grass. In the background, there is a line of trees under a clear sky.

Monitoring Nepal's Bread Basket

New technologies have helped to create a
comprehensive crop monitoring system



In the southern part of the Koshi basin, the mountains and hills of the Himalayas flatten out to wide, stretching plains. These plains run along the Nepal-India border, and comprise some of the country's most fertile land. More than half of Nepal's agriculture is based in this region, and the crops grown here are shipped to other regions throughout Nepal. Because of this, reliable and timely weather forecasts and information around seasonal cropping patterns are critical in assuring the region's food security. Until now, however, Nepal has lacked a comprehensive system that brings this information together in a meaningful way.

Responding to this need, ICIMOD in 2014 partnered with Nepal's Ministry of Agricultural Development (MOAD) and the World Food Programme (WFP) to integrate new technologies in crop monitoring to create a technologically advanced, real-time system that contributes to understanding and analysis of agriculture in Nepal. The system brings together data collected from open source remote sensing technology, satellites, ground-based hydrometeorological stations, public and private domains, and volunteers. It provides information on local and regional cropping systems, weather forecasts, the area of crops sown, crop health, and drought probabilities.

The products of this crop monitoring system are fed into a twice-yearly Crop Situation Update produced by MOAD, WFP, and the United Nations Food and Agriculture Organization (FAO). The Crop Situation Update provides a comprehensive overview of the domestic food supply situation by focusing on the production and trade of major summer and winter crops in Nepal. It also helps to identify anomalies in the country's food production, which reveals areas that need special attention.

The system provides information on local and regional cropping systems, weather forecasts, the area of crops sown, crop health, and drought probabilities.

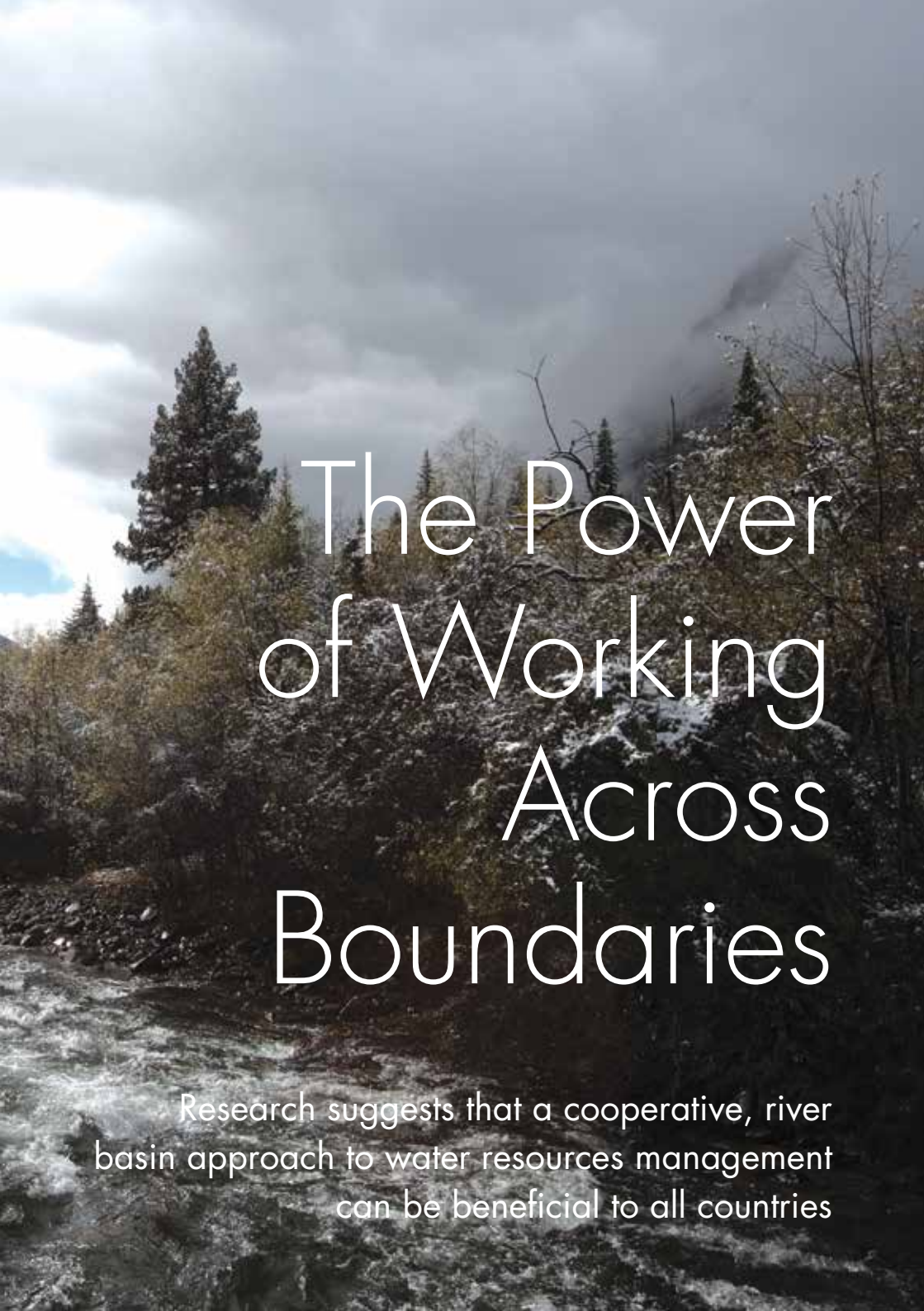
In addition, ICIMOD is striving to make vital information from the crop monitoring system accessible to farmers. A team is making use of the growing ubiquity of mobile phones in Nepal and creating an app that gives information on crops and drought. While mobile technologies have been aiding farmers in India and elsewhere in recent years, no comparable resources yet exist in Nepal. The app developers plan to include information on weather, crop season, best farming practices, local crops, agricultural market prices and arrivals, availability of fertilizers,

electricity timings, disaster warnings, training opportunities, government schemes, plant and veterinary disease prevention, and financing and insurance services. Moreover, a drought monitoring system, which is in the process of being developed, will provide short- and long-term information on predicted droughts. The team also plans to translate the information on the app into Nepali script so that more farmers will be able to use it. The app is expected to be launched by the end of 2015.

With both the online monitoring system and the app, the programme hopes to deliver accurate agricultural information to the people who depend on it most. This information has the potential to not only bolster the livelihoods of farmers, but also improve environmental management and resilience to climate change in Nepal.

The crop monitoring system is a collaborative initiative between the Sustainable Development Investment Portfolio-supported Koshi Basin Programme and the USAID- and NASA-supported SERVIR-Himalaya initiative at ICIMOD.



A dramatic landscape photograph featuring a river in the foreground, surrounded by dense, snow-dusted evergreen and deciduous trees. The sky is filled with heavy, grey clouds, with a patch of blue visible on the left. The overall mood is somber and majestic.

The Power of Working Across Boundaries

Research suggests that a cooperative, river
basin approach to water resources management
can be beneficial to all countries



In the Koshi basin, China, Nepal, and India are all interconnected by a common river and water system. As the population in the region grows, reliable access to this water becomes increasingly important. However, water supplies are erratic and are not equally distributed throughout the year: water is abundant in the monsoon season, creating hazards, but scarce in the dry season. These circumstances demand well-planned water resources management, which is also fundamental to the socioeconomic and environmental health of the basin. However, while water does not follow international boundaries, approaches to water management often do. This has created a fragmented and uncoordinated approach, which leads to the inefficient management of transboundary water resources.

While certain researchers have argued that transboundary cooperation should be a central aspect of water management in the Hindu Kush Himalayas, putting this into practice has been difficult. One of the biggest challenges in bringing countries together for transboundary management has been in demonstrating that everyone can benefit in real ways. However, a recently-published paper with ICIMOD's Koshi Basin Programme might help to change this. The paper, published in *Water Policy* and entitled "Why Eastern Himalayan countries should cooperate in transboundary water resource management", found that regional cooperation using a river basin approach is essential to maximize the benefits from the basin's water resources. Importantly, it also found that there are potential benefits for countries using a river basin approach to water resources management.

These potential benefits are varied and great: cooperation can help bolster everything from flood mitigation, hydropower energy and energy security, water transport, and political relations. Regional cooperation can play an instrumental role in harnessing monsoon water for more productive use in the dry season; however, this requires large investments and sound technologies, and can only be realized through a larger river basin approach. Similarly, cooperation can also facilitate a basin-level water transport network, which would promote the integration of local economies, better use of resources, and economic and industrial growth. On a larger scale, countries also have something to gain: Nepal can produce more hydropower, which means less time that communities spend gathering other fuel sources, such as wood, and improved forest and individual health; India can reduce its risk of flood damage and have fewer scheduled power cuts; and China can improve its relationship with its neighbours, which opens up profitable trade opportunities.

Cooperation, the paper also argued, can take different forms ranging from active communication to joint projects, research, and investment. Joint research can produce information that all parties find credible, which is often a challenge when working on transboundary issues. Cooperation can likewise take the form of a basin-wide data system, which shares timely

information on meteorological and hydrological developments.

In February 2016, more than 250 representatives from China, Nepal, and India came together for the first time to put regional cooperation around the Koshi basin into practice. A two-day forum in Bihar, India, hosted leading experts and government officials who discussed water security and livelihoods in the basin. Panel discussions and technical sessions looked at specific challenges around disaster management in the different parts of the basin, and how to bolster the collection of evidence-based data so that information can be more easily translated into policy. The forum was a tangible step towards further transboundary collaboration on issues of water management, and demonstrated a path for a more sustainable future for water and communities in the Koshi basin.

Article: Rasul, G (2014) 'Why Eastern Himalayan countries should cooperate in transboundary water resource management'. *Water Policy* 16, 19-38.

This study was part of ICIMOD's Himalayan Adaptation, Water and Resilience (HI-AWARE) Programme, funded by the UK's Department for International Development (DFID) and Canada's International Development Research Centre (IDRC); the Himalayan Climate Change Adaptation Programme (HICAP), implemented jointly by ICIMOD, CICERO, and Grid-Arednal and funded by the Ministry of Foreign Affairs, Norway and the Government of Sweden; and the Koshi Basin Programme of ICIMOD funded by the Department of Foreign Affairs and Trade (DFAT) of Australia.





When the World Shakes

After a massive earthquake, ICIMOD responded
with data, analysis, relief, and government
support in the Koshi basin



On 25 April 2015 at three minutes to noon in Nepal, the ground began to shake. Throughout the hills and valleys of the Koshi basin, the sides of cement, stone, mud, and brick buildings started to quiver and crack. People ran out of their homes and waited, hoping for the best.

The 7.8 magnitude earthquake and the 7.3 magnitude earthquake that followed approximately two weeks later on 12 May devastated a large part of Nepal, including the Koshi basin, killing more than 8,000 people and resulting in ten billion dollars in economic losses.

In many hilly and mountainous areas, individuals had to worry not only about shelter, food, and water during the earthquake's aftermath, but also about landslides. With each aftershock, the earth and rocks that clung to the side of mountains became loosened and had the potential to slide down over settlements, roads, and infrastructure. Monsoon rains, which usually start in June and also loosen the soil, exacerbated the already threatening conditions.

The Koshi Basin Programme's response to the disaster was immediate and multi-fold throughout

the basin. In the days following 25 April, the programme shared its inventory of existing and potential landslides in the Koshi basin with an international team of volunteers from ICIMOD, the National Aerospace and Space Administration (NASA), the University of Arizona, and the US Geological Survey. The team worked off the existing inventory and incorporated incoming data from satellite imagery to assess landslide-affected villages and rivers,

The Koshi Basin Programme's response to the disaster was immediate and multi-fold throughout the basin.

and identify landslide-prone areas. The efforts identified over 3,000 landslides in Nepal, including in the Koshi basin, and assembled a database of 250 landslides that had happened after the earthquake. The information was shared with the Government of Nepal, which helped the government and international agencies respond to the disaster.

Additionally, throughout the month of May, the Koshi Basin Programme distributed rice, lentils, oil, tarps, face masks, soap, medicine, oral rehydration packets, and sanitary items to households in Sindhupalchowk

and Sindhuli, two districts in which the programme works.

Ratatar, a village in Sindhuli that received relief, is perched on a green ridge. It is home to a small community known as the Hyau, some of the most marginalized people in the entire district. The earthquake completely destroyed all of the community's mud-built houses. In May when relief supplies came, residents of the village were living in small huts they had made out of materials found nearby. The huts, however, did not protect well from the rains, and people spoke of damp floors and mosquito bites. Food and water were also scarce: the earthquake had punctured Ratatar's water tank and grain storages were now buried under building wreckage. Villagers worried about work and getting enough money to rebuild their houses; most villagers are daily wage labourers, and little work was available after the earthquake. Ratatar received no outside help before the Koshi Basin Programme arrived, and, although the overall relief effort was small, the community deeply appreciated it.

Farther north in the basin, researchers working with the Koshi Basin Programme at the Institute of Mountain Hazards and Environment, Chinese Academy of Sciences (IMHE-CAS) quickly moved to evaluate the post-earthquake conditions in the upper reaches of the Koshi basin in the Tibet Autonomous Region (TAR), where



it was reported that at least 26 people had died, and nearly 8,400 people were at risk.

After submitting a post-earthquake response policy recommendation based on previous fieldwork in the region, IMHE researchers partnered with China's Ministry of Land and Resources, and completed a seven-day, on-the-ground geological hazard investigation of earthquake-affected areas of the upper Koshi basin. The investigation found that the region would benefit from a hazard management plan and the installation of flood early warning systems, should aftershocks trigger the eruption

of a glacial lake. The Chinese government moved to take the team's suggestions forward.

A four-day disaster loss assessment in earthquake-affected areas of TAR with China's National Disaster Reduction Commission (NDRC) complemented this geological hazard investigation. The team assessed casualties, property losses, and infrastructure damage and provided guidelines for post-earthquake reconstruction at an NDRC meeting in Beijing in May 2015.

Also in May, nine researchers from IMHE, along with the TAR's Department of Land and Resources,



completed an intensive, month-long investigation of geological hazards specifically in Nyalam County, where the Koshi Basin Programme bases some of its work. The researchers surveyed 45 villages and 328 geological hazard sites, and found more than 200 earthquake-induced hazards, including landslides, collapsed slopes, debris flows, and unstable slopes. The investigation culminated in a series post-disaster recommendations for the upper Koshi basin.

Yet, despite the initial rapid response, longer-term recovery throughout Nepal remained difficult. Efforts were

often slow and piecemeal, and six months after the first earthquake, many earthquake-affected communities in the Koshi basin were still waiting for basic relief supplies. From September 2015 to January 2016, relief efforts were further complicated when Nepal's southern border with India was largely closed due to political tensions, which all but stopped the flow of supplies throughout the country. During this time, the Koshi Basin Programme, along with The Energy and Resources Institute, distributed 450 solar lamps to earthquake-affected and unelectrified households in Ratanchura, Jalkanya, and Baseshwor village development committees of Sindhuli District. The lamps were in addition to 200 solar lamps that the programme distributed in July in Sindhuli. For many individuals, the lanterns were a small step towards the resumption of normal life.

While trauma from the earthquake still lurks in many places throughout the Koshi basin, communities want to move beyond the disaster and resume normal life. ICIMOD's goal was that it could play a small part in encouraging brighter days ahead.





A New Perspective

Efforts to understand the Koshi basin's upstream-downstream linkages have the potential to change river basin management



In the northernmost part of the Koshi basin in China's Tibet Autonomous Region, the snowy mountain landscape of the Himalayas turn into vast stretches of barren hills, marshlands, and big sky. The upstream section of the Koshi River cuts through this high-altitude landscape, and helps to feed a variety of freshwater ecosystems. Here, communities are primarily made of up Tibetan farmers and grazers, who live in small villages spaced out along the dusty roads and rugged mountain valleys.

Approximately 300 kilometres southwest as the crow flies is the Nepali town of Dhankuta, a cluster of buildings perched on a ridge

in the rolling forested foothills of the Himalayas. The town is the headquarters of Dhankuta District, a bustling commercial centre of the region.

Although on the surface these two areas do not seem to have much in common, they are intimately linked by the Koshi River. When ICIMOD's Koshi Basin Programme began in 2013, the programme made it a priority to better understand the basin's upstream-downstream linkages and the relevance of these linkages for water management at the basin and local level. Research found that a well-managed ecological environment upstream will directly benefit the

ecological environment downstream – for instance, by allowing for clean and sustainable water for irrigation. More importantly, by sustaining soil conservation and vegetation cover in the upstream, risks of flash floods – which may trigger larger water-induced hazards in the downstream – will be

Integration of this upstream-downstream perspective represented a new approach to water management in the region, and something that could fundamentally improve resources in the basin in the years to come.

reduced. Integration of this upstream-downstream perspective represented a new approach to water management in the region, and something that could fundamentally improve resources in the basin in the years to come.

The Koshi Basin Programme began by thinking about upstream-downstream linkages on a local level. These days, Dhankuta faces challenges of both water quantity and quality. Forested areas upstream are turning into agricultural land, where farmers frequently use pesticides. These pesticides seep into the soil and water, and are carried downstream, contaminating Dhankuta's drinking water. Additionally, in the past 15

years, water levels in the nearby rivers have decreased by nearly half due to an increase in agricultural activities. During the dry season, water for drinking and washing becomes difficult to access for members of the community who are located far away from reliable sources.

In response to this, the Koshi Basin Programme started working with Green Governance Nepal and the Dhankuta municipality to foster linkages between the communities close to the area's drinking water sources and the residents of Dhankuta. The goal is to help meet the current demands for drinking water by promoting a system of benefit sharing. Under the benefit sharing system, Dhankuta residents pay a nominal monthly fee to the municipality, which is then transferred to upstream communities as compensation for helping to preserve the quality and quantity of the water supply. Instead of receiving cash, upstream communities asked that the compensation be invested in agricultural trainings, road construction, and school development. Current market alternatives for drinking water cost approximately 30 times more than that of the benefit sharing system, which means that these alternatives are unaffordable for many Dhankuta residents. The project is in its initial stages, but has the potential to make water more affordable for local residents as well



as lay the foundation for sustainable water resource management in the area.

As local initiatives began to get underway, the Koshi Basin Programme also moved to implement the upstream-downstream approach on a basin-level scale. The programme focused on building partnerships with institutions that would encourage a healthy ecological environment in the northernmost part of the basin with the understanding that, in future years, this work would advance innovative and evidence-based research and benefit the downstream environment as well.

In August 2015, a team consisting of experts from China's Yunnan Institute of Environmental Sciences and the Koshi Basin Programme carried out a

two-week long field survey in Nyalam, Tingri, and Tingkey counties of the Tibet Autonomous Region. The goal of the survey was to establish a baseline of the current status of the area's freshwater ecosystems, in particular wetlands, and how local communities have been interacting with these ecosystems on both economic and social levels. Except for the second National Survey of Wetland Resources conducted by the Government of China in 2010, which the public has limited access to, little information has been readily available on this evolving ecosystem.

The goal of the research was to examine the effectiveness of environmentally conscious government policies and incentive schemes, which were started in 2010. These schemes included the implementation

of the 'Incentive Mechanism for Grassland Ecological Protection', the establishment of a network of grassland and wildlife monitors from nearby villages, and the erection of billboards in counties that promote wetland protection and conservation in village rules and regulation.

The initial results of the survey suggest that these policies have positively benefited the wetlands ecosystem: the researchers found that overgrazing and environmental destruction, which were once predominant in the region, are increasingly under control. According to local statistics, the number of livestock in and near the wetlands has reduced by 30%, and will be further reduced to sustain the carrying capacity of monitored grasslands. In addition, in the wetlands near the town of Gangga and Dengmotso Lake in Tingri county, and the town of Jiangga in Tingkey county, a large number of fish and bird species have been identified, including *Triplophysa*, black-necked crane, bar-headed goose, and the ruddy shelduck (*Tadorna ferruginea*). The researchers found that the wetlands have served as a key biodiversity habitat for migrant birds during their breeding period.

The team plans to use the results of the survey in a larger analysis on freshwater ecosystem services and the associated policy impacts. More broadly, the idea is that this pioneering study will contribute to wider discussions on the relationships between humans and their

environment, as well as upstream and downstream linkages in the Koshi basin in the future.

Beyond the ecosystem survey, the Koshi Basin Programme is also in the process of initiating a variety of other projects in the Tibet Autonomous Region in order to foster a healthy upstream environment in the basin. This includes research in partnership with Tingri County's Agriculture and Animal Husbandry Bureau on the impact of grazing on the area's marshlands and floodplains, which are particularly valuable and vulnerable components of the region's wetlands. The programme is also soliciting collaboration with Tingri County's Water Supply Bureau to start a project that will protect and manage drinking water sources in the northern Koshi basin.

These projects, while small, have the potential in time to come together into something big. Mainstreaming the upstream-downstream perspective into the region's river basin management strategies once seemed like a distant reality, but now, this reality is not so far out of reach.

Partners:	Green Governance Nepal
Project title:	Assessment of Freshwater Ecosystems in Koshi River Basin, Nepal
Years active:	February 2015 – January 2016
Partners:	Yunnan Institute of Environment Science (YIES)
Project title:	Ecosystem Services Studies in the Chinese part of the Koshi River Basin
Years active:	February 2015 – December 2015





The Changing Times

A study finds that while environmental conditions in the Koshi basin are changing, constraints are keeping communities from fully adopting adaptation strategies



As knowledge of climate change filters through to communities in the Hindu Kush Himalayas, individuals are trying to understand how these environmental changes will affect their daily lives and how they will have to adapt in response. Many of these communities have begun to implement various climate-smart adaptation strategies; however, for scientists and decision makers it is not always clear which communities are using which strategies, or how effective these strategies are to the specific needs of the community. Yet without this foundational knowledge, it is difficult for decision makers to know how to move forward.

In 2015, researchers supported by ICIMOD's Koshi Basin Programme tried to answer some of these questions for the Koshi basin. They wanted to understand how climate change has been affecting the basin, how agriculture and other livelihood practices have been shifting as a result of these changes, and options for how these communities can best adapt. Because the environments in the Koshi basin are extremely varied, the researchers made an effort to include the basin's different agro-ecological zones. The study included sites from the hills and plains of Nepal and flood-affected parts of the Indian state of Bihar. The team conducted



Researchers wanted to understand how climate change has been affecting the basin, how agriculture and other livelihood practices have been shifting as a result of these changes, and options for how these communities can best adapt.

a trend analysis of available climate data and field interviews in each of the selected sites.

The team found that while the impacts of climate change varied in different parts of the basin, on a basin level, there is less water available for agricultural purposes, and, at the same time, incidents of floods and droughts are increasing. Together, these conditions have reduced crop yields, increased fallow lands, damaged properties, and displaced communities. The study also found that over the past three decades, the amount of cultivated land has decreased on a basin level, likely due in some part to these adverse conditions. However, despite these developments, many Koshi basin communities have not widely adopted appropriate adaptation strategies, which usually include a combination of measures like building embankments, shifting the location of houses, switching to drought-resistant crops, and floodplain zoning. The study suggested that communities in the Koshi basin face several constraints that limit their adoption of adaptation strategies, including limited financial resources, lack of technical knowledge, lack of awareness about adaptation options, lack of collective action, unclear property rights, and the ineffective role of state agencies.

The findings from this research have helped synthesize current



understanding of agricultural and environmental trends in the Koshi basin. The team has drafted a paper with their results and are in the process of getting it published. The aim is that this research will aid decision makers in identifying the current gaps in planning, and encourage them to press for better strategies that help lessen some of the constraints that communities face. With this help, individuals will be able to make decisions that will help their communities remain strong in the years to come.

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Agricultural adaptation options to deal with changing water availability in the Koshi River Basin.

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Bringing It All Together

An integrated information platform gives users
valuable information on the Koshi basin



For scientists and researchers working on transboundary issues across the Hindu Kush Himalayan region, finding data that does not stop at borders can be a challenge. This is also true for those working on water and livelihood-related projects in the Koshi River basin, a region that covers parts of China, India, and Nepal. From the beginning of ICIMOD's Koshi Basin Programme, a goal was to create a knowledge base that incorporates data generated by the programme and its partners, one that promotes information sharing and takes into account the perspective of the entire basin, beyond the confines of borders.

The result of this effort is the Koshi Basin Information System (KBIS), a web-based platform that launched in June 2014 and currently sees more than 200 unique visits per month. The system brings together a wide range of up-to-date information on climate change and variability, water and agriculture, socioeconomic dynamics, and disaster through satellite maps and vector imaging, tables, and graphs. The compiled information includes data from ICIMOD publications, partner-provided field and monitoring data, and data from open sources such as the US Geological Survey, the National Oceanic and Atmospheric Administration, Nepal's Department of Hydrology and Meteorology, and more.



The aim of this platform is to make Koshi-related information available not just to the programme's partners, but to the wider public as well.

Unlike many other resources available, KBIS allows researchers to choose a combination of different parameters – for instance, the percentage of irrigated land with the amount of annual soil loss. These parameters are then mapped over each other, a feature meant to aid in innovative analysis and new ways of seeing.

“The KBIS is a wonderful set up”, said Rajiv Sinha, head of the Department of Earth Sciences at the Indian Institute of Technology in the Indian state of Uttar Pradesh. “We have used it to look at data related to our project such as rainfall, land use and land cover, and drainage maps.” He is currently partnering with the Koshi

Basin Programme for a transboundary research project on sediment in the Koshi basin and its relationship with rivers and floods, and has made active use of the information provided by KBIS.

Other partners, too, have found that the system aids them in their Koshi-related work. Hu Guisheng and Jiang Liguang, both researchers at the Chinese Academy of Sciences, noted that KBIS has helped them to get basic data about the Koshi basin and to compare data with other available sources.

The aim of this platform is to make Koshi-related information available not just to the programme’s partners, but to the wider public as well. With this in mind, the platform developers created a mobile app that allows users to access KBIS from anywhere, including the field. The app was launched in the summer of 2015, and brings the best features of KBIS and its related components to mobile phones, including a daily-updated regional flood outlook that gives vital information on the condition of the region’s rivers. The hope is that the platform will continue to improve based on user feedback, and become an important resource for anyone who is looking for, up-to-date, reliable, scientific information on the Koshi basin.

The development of this system has been made possible through ICIMOD’s Koshi Basin Programme (KBP), which is supported by the Australian Government through the Sustainable Development Investment Portfolio for South Asia and Hindu Kush Himalaya Hydrological Cycle Observation System (HKH-HYCOS) supported by Ministry of Foreign Affairs, Government of Finland.

Explore the system at www.icimod.org/kbp/kbis



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