

Building Mountain Resilience: Solutions from the Hindu Kush Himalaya

FOR MOUNTAINS AND PEOPLE



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 Himalaya (HKH) – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan – 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 and downstream issues. ICIMOD supports regional transboundary programmes through partnerships with regional partner institutions, facilitates the exchange of experiences, and serves as a regional knowledge hub. We strengthen networking among regional and global centres of excellence. Overall, we are working to develop economically and environmentally sound mountain ecosystems to improve the living standards of mountain populations and to sustain vital ecosystem services for the billions of people living downstream – now and in the future.



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Building Mountain Resilience: Solutions from the Hindu Kush Himalaya

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Contents

List of Contributors	vi
Acronyms and Abbreviations	vii
Foreword	ix
Building mountain resilience: Solution from the Hindu Kush Himalaya	x
Distribution of resilience building solutions in the HKH (map)	xi
Sustaining Natural Resources	1
1. Improved rainwater harvesting	3
2. Improved terracing for enhancing soil fertility on sloping land	7
3. Incentive for ecosystem services	11
4. Innovations in value chain	15
5. <i>Jholmal</i> for small-scale farmlands	19
6. Low-cost water storage ponds for smallholders	21
7. Managed pollination services	23
8. Promoting mountain niche crops: large cardamom	27
9. Women-centric resilient agriculture development	31
Changing Behaviours and Practice	35
1. Building women’s capacities to leverage remittances	37
2. Climate and flood-resilient housing	41
3. Cool roofs: a low-income solution in a warmer climate	45
4. Customizing traditional skills	47
5. Flood-resilient sanitation	51
6. Mobile messaging: Extension services in remote areas	55
7. Mobilizing women as leaders	59
8. Sanitation and waste management for responsible heritage tourism	63
9. Solar pumping irrigation system	67
Improving Governance and Services	
1. Agriculture drought monitoring system	73
2. Climate-resilient forest management system	77
3. Community-based flood early warning system	79
4. Inclusive planning for local scale water management	83
5. Information alerts for forest fire management	87
6. Leveraging the water-energy-food nexus at local levels	89
7. Promoting mountain perspectives in higher education	93
8. Regional flood outlooks	97
9. Sustainable livelihoods for the marginalized	101

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Acronyms and Abbreviations

AdaptHimal	Improving Livelihoods and Enhancing Resilience of the Rural Poor in the Hindu Kush Himalayas to Environmental and Socio-economic Changes
AEC	Agro Enterprise Centre
AKRSP	Aga Khan Rural Support Programme
AMIS	Agriculture Management and Information System
ANCA	Api-Nampa Conservation Area
BCAS	Bangladesh Centre for Advanced Studies
CB-FEWS	Community-Based Flood Early Warning System
CBD	Convention on Biological Diversity
CEAPRED	Center for Environment and Agricultural Policy Research, Extension, and Development
CFRH	Climate and Flood-Resilient Housing
CHEA	Central Himalayan Environment Association
CICERO	Centre for International Climate Research
CLTS	Community-led Total Sanitation
DADO	District Agriculture Development Office
DAO	District Agriculture Office
DDMA	District Disaster Management Authority
DFO	District Forest Office
DISCO	Soil Conservation Office
DoF	Department of Forest
DoFPs	Department of Forest and Park Services
DOFRP	Developmental On-Farm Research Pilot
DRD	Department of Rural Development
DRR	Disaster Risk Reduction
DSCWM	Department of Soil Conservation and Watershed Management
ECDF	Environment Conservation and Development Forum
Eco-San	Ecological Sanitation
EU	European Union
FECOFUN	Federation of Community Forestry Users
FNCCI	Federation of Nepalese Chambers of Commerce and Industry
GB	Gilgit-Baltistan
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GLOFs	Glacial Lake Outburst Floods
HI-AWARE	Himalayan Adaptation, Water, and Resilience Research
HICAP	Himalayan Climate Change Adaptation Programme
Himalica	Support to Rural Livelihoods and Climate Change Adaptation in the Himalaya
HKH-HYCOS	Hindu Kush Himalayan Hydrological Cycle Observing System
HRD	Human Resource Development
HUC	Himalayan University Consortium
IBA	Important Bird Area
IBI	Indus Basin Initiative

ICIMOD	International Centre for Integrated Mountain Development
IFAD	International Fund for Agricultural Development
IIRM	Institute of Integrated Resource Management
IPCC	Intergovernmental Panel on Climate Change
KBI	Koshi Basin Initiative
KRB	Koshi River Basin
KSLCDI	Kailash Sacred Landscape Conservation and Development Initiative
MAWG	Mountain Agriculture Work Group
MDC	Municipality Development Committee
MHT	Mahila Housing Sewa Trust
MIID	Myanmar Institute of Integrated Development
MoAD	Ministry of Agricultural Development
MODIS	Moderate Resolution Imaging Spectroradiometer
ModRoof	Modular Roofing System
MoFSC	Ministry of Forest and Soil Conservation
MoPE	Ministry of Population and Environment
MPA	Megh Pyne Abhiyan
MSI	Management Systems International
NABARD	National Bank for Agriculture and Rural Development
NARC	Nepal Agriculture Research Council
NIDS	Nepal Institute of Development Studies
NPC	National Planning Commission
NTB	Naya Tola Bishambharpur
NTC	Nepal Telecom
NTFPs	Non-Timber Forest Products
ODF	Open Defecation Free
PARC	Pakistan Agricultural Research Council
PCRWR	Pakistan Council of Research in Water Resources
PES	Payment for Ecosystem Services
PoP	Package of Practices
RMCs	Regional Member Countries
RMV	Resilient Mountain Village
SAARC	South Asian Association for Regional Cooperation
SABAH	SAARC Business Association of Home-Based Workers
SANDEE	South Asian Network for Development and Environmental Economics
SDGs	Sustainable Development Goals
SHAN	Sanitation, Health and Nutrition
SSP	Swayam Sikshan Prayog
TAR	Tibet Autonomous Region
TERI	The Energy and Resources Institute
UIB	Upper Indus Basin
UNFCCC	United Nations Forum Convention on Climate Change
VDC	Village Development Committee
WASH	Water, Sanitation, and Hygiene
WUMP	Water Use Master Plan
WWF	World Wide Fund for Nature

Foreword

With its partners, ICIMOD is fully committed to doing its part to support the major global agreements reached in 2015 – the Sustainable Development Goals, Paris Agreement and the Sendai Framework. All these agreements highlight the importance of identifying solutions that combine sustainable development pathways with climate resilience and disaster risk reduction. The global consensus on these issues is inspiring and encouraging for ICIMOD, which has been working for the last 34 years to provide innovation for and knowledge about mountain communities. While generating and sharing new knowledge forms the core of ICIMOD’s mission, identifying and promoting solutions to the multiple challenges faced by mountains and mountain people drives all our work.

During the Medium Term Action Plan III (2013-2017), ICIMOD and its partners in eight regional member countries piloted several resilience building solutions on the ground as a step to promoting these ideas on a wider scale. The response was overwhelming. These solutions not only served as a reality check on our own approaches but also offered valuable lessons to a wide range of stakeholders. We used these lessons to develop an overarching framework on Resilient Mountain Solutions for our Medium-Term Action Plan IV (2018-2022).

Faced with a complex and uncertain future, the coming years are even more so for mountains that contend with rising temperatures, dwindling natural resources, and rapidly increasing outmigration. Therefore, the need to focus on affordable and replicable solutions that can affect significant change is more important than ever.

The solutions in this book are based on years of hard work and collaboration between ICIMOD and its partners. These solutions provide valuable information about approaches and technologies that can inform communities, practitioners, decision makers and governments alike. In this way, we believe the “small” solutions presented can make a great contribution to global development agenda.



David Molden, PhD.
Director General
ICIMOD

Building mountain resilience: Solution from the Hindu Kush Himalaya

Sustainable and resilient mountain development is very much a part of ICIMOD's mission statement. Through its programmes and initiatives, ICIMOD works to build the resilience of people and natural resource systems in the mountains, hills and plains of HKH. Building sustainable value chains, preparing natural resource management plans, installing flood early warning systems, and piloting Resilient Mountain Village programmes are a few examples of how ICIMOD is contributing to resilience building.

The resilience lens for mountain context

Resilience building in the mountains would need to be both anticipatory and transformative, bringing together the notions of 'bouncing back' and 'bouncing forward'. This understanding is in line with the definition of resilience provided by the Inter-governmental Panel on Climate Change (IPCC 2014) that refers to 'The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation'¹. For the HKH, given its mountain specificities, unique upstream-downstream linkages, and immediate development needs, there are additional challenges to building resilience arising out of non-climatic phenomena such as large-scale male outmigration, growing urbanization, and mounting pressure on natural resources. Solutions for building socio-ecological resilience can therefore be understood as those mountain-specific interventions contributing to a system's recovery from shocks and stressors (climatic and non-climatic), its improved adaptive capacity, and transformative change.

Methodology

The solutions presented in this volume are transdisciplinary in approach. All the solutions are derived from knowledge co-created with stakeholders who will benefit from and sustain a particular intervention. Most of the solutions are piloted and tested, providing feedback from society to science and back to society, ensuring a health mutuality between experts and beneficiaries. As the HKH contains a plurality of people and interest groups, contributing to the complexity of issues, we realize that solutions must be customized and tailored to specific areas based on collective wisdom and indigenous knowledge provided by stakeholders.

Location, scale and scope of the solutions

Given our experience working in the HKH for more than three decades, we present a selection of 27 resilience-building solutions from the various initiatives and programmes at ICIMOD and its partner organizations. A majority of these solutions were piloted in Nepal but in their uptake spread to other countries in the HKH. There are parts of the region, especially in the north-western part, in which there is a dearth of interventions. Also, there is a need to look at high altitude areas where natural conditions are more fragile and the lives of local people more tenuous and challenging.

The solutions are grouped into three categories: 1) Sustaining natural resources, 2) Changing behaviours and practice, and 3) Improved governance and services. This is not a perfect categorization, nor do all the

¹ IPCC, 2014: Annex II: Glossary [Mach, K.J., S. Planton and C. von Stechow (eds.)]. In: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, pp. 117-130. Retrieved from https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_Glossary.pdf

solutions fit neatly into one category or another. But we think this organization highlights key aspects for creating transformative change in the HKH.

Key factors and conditions

ICIMOD's resilience building framework suggests that interventions at the community level would need to act on multiple combinations of factors (e.g., no single silver bullet) depending on the local conditions. This tailored approach can be seen in several of the solutions presented in this volume.

From our work, we have come to understand that solutions work better in combination. Even in a techno-centric intervention, people's behavior and related institutions play a central role in the ultimate success of the solution. And, conversely, solutions aimed at creating behavioural change or bringing about improved governance can often benefit through the implementation of a technological element.

Gender

Women in the HKH are much more vulnerable and at risk from disasters, natural resource degradation, and gaps in governance. Rising outmigration of male household members (means women must assume more responsibility for the household, natural resources, and the community, but often without a commensurate change in their roles in decision making or local governance).

Therefore, it is key that all the solutions here are designed and implemented with adequate consideration of how gender dynamics may affect or be affected by the solution. Solutions that are explicitly women-focused clearly establish that it is possible to enhance women's capacities so that they emerge as community leaders and decision-makers when it comes to risk and resource management.

Importance of partnerships

Partnerships have been crucial to the success of each of the solutions presented in this compendium. Besides promoting the credibility of the intervention at local level and playing a vital role in stakeholders' engagement, ICIMOD's implementing partners contribute to post-project sustainability. Partnerships have helped in expanding the portfolio of tailor-made solutions to fit the wide diversity of contexts in the HKH.

Our partnerships have taken two forms. In the first, we partner with the community so they may take ownership of the solutions without dependence on external support. The second form of partnership reaches out to the private sector to develop economic opportunity for resilience building in the HKH.

The scaling 'up' and scaling 'out' challenge

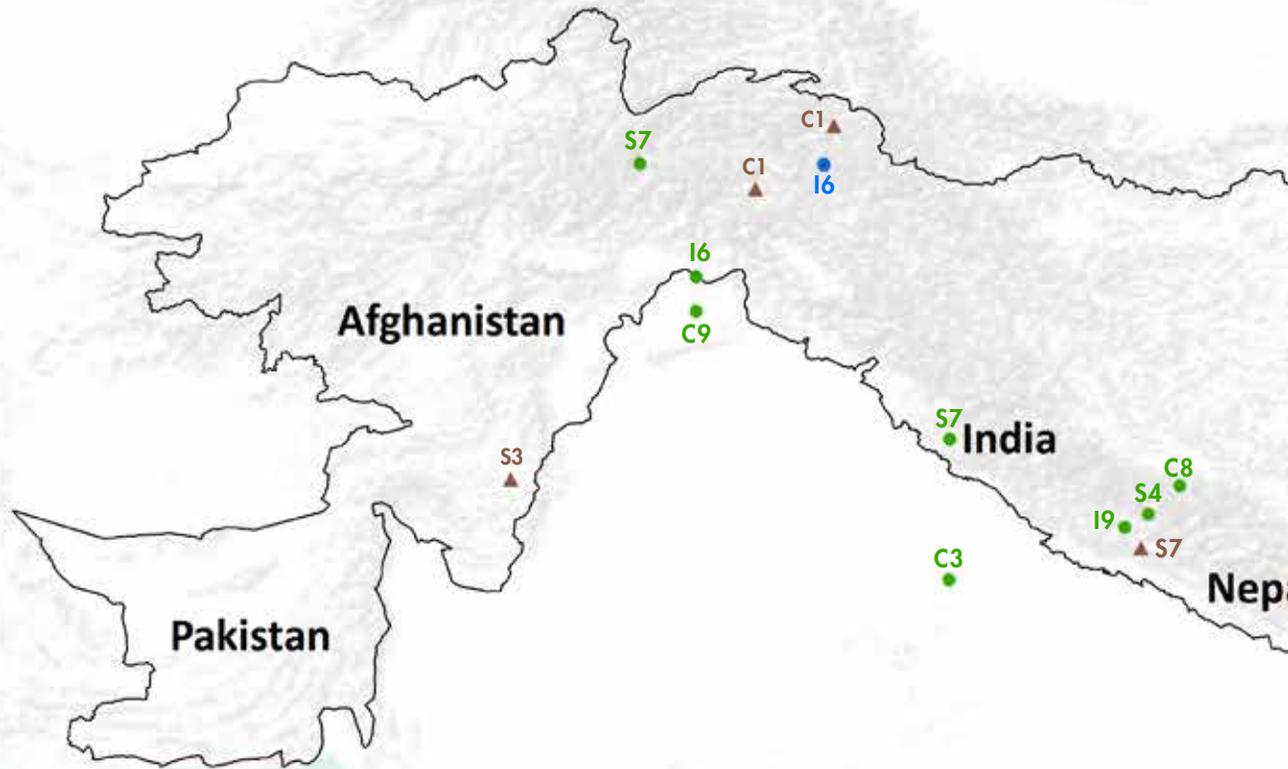
A solution's ultimate success is the degree to which it is 'scaled up' (taken from local levels to national and international levels, either through practice, policy, or procedure) or 'scaled out' (taken to a wider area or other sectors). Solution pilots have played an important role in ICIMOD's experience because key policy and practice actors are often motivated by demonstrable evidence.

Robust monitoring and evaluation contributes to solution validation and plays a key role the scaling up or scaling out a solution. For some of the solutions presented here the validation applies to a country-specific context. With further impact assessments and comparable cost-benefit analysis, these solutions can be taken to other regional member countries of ICIMOD.

Summing up

Resilience building is pre-requisite to achieving the sustainable development goals (SDGs) in the HKH. The development of simple, affordable, and local solutions can go a long way to address challenges arising from the complexity and dynamism of the mountain context. Replication and scaling up these solutions requires a deepening as well as broadening of partnerships, institutional capabilities, and policy engagement at multiple scales.

Distribution of resilience building solutions in the HKH



● Primary location

▲ Uptake location

● Primary + uptake

□ HKH region

S: Sustaining natural resources;

C: Changing behaviours and practice;

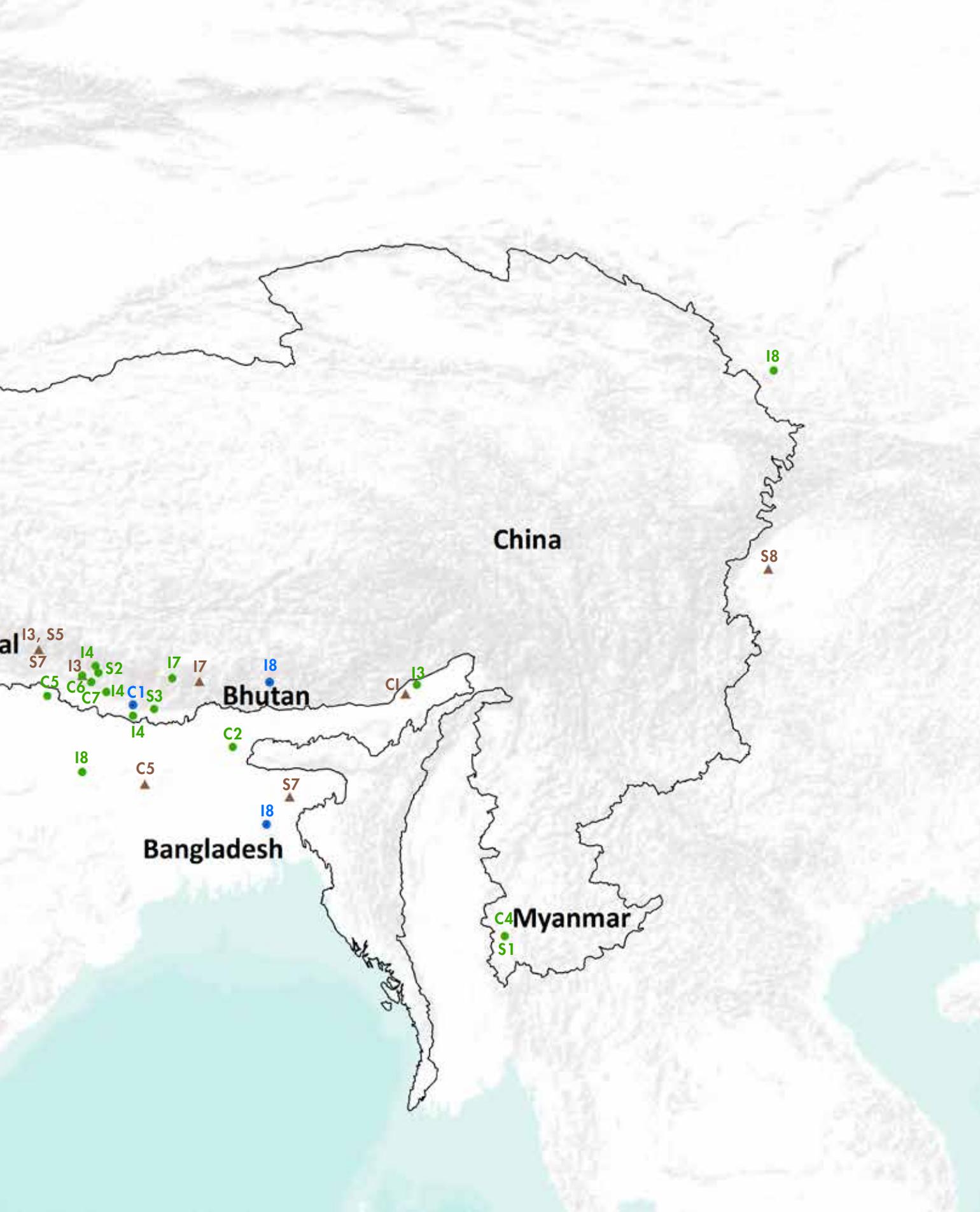
I: Improving governance and services;

How to read the map

Number indicates chapter number from the corresponding section

e.g. **S1:** Improved rainwater harvesting

(Please refer to Contents)







**Sustaining
Natural Resources**



Improved rainwater harvesting

Improved rainwater harvesting systems at household and community levels with larger storage capacity were demonstrated under ICIMOD's Himalica initiative in villages in Myanmar that were facing an acute water shortage. The traditional roof RWH systems at household level were improved, new ponds constructed, and a few existing community ponds repaired (sediment excavated). Local communities now have much more water for drinking and sanitation purposes during the dry season. The measures have reduced the drudgery of women, as they spend less time and energy bringing water during the dry season. Communities are consuming more water by an average of 11 lpcd in wet season and 18 lpcd in dry season, saving 1.5-2.0 hours per day in fetching and travelling a shorter distance by about 2 km during the dry season.

Roof water harvesting helps communities cope with droughts and dry seasons

The issue

In the Letmaungwe hills of Southern Shan State in Myanmar, many villages located on the tops and slopes of the hills are fully dependent on rainwater. There are no ground water sources such as springs, tube wells, and bore wells in many villages. Therefore, the communities face acute water shortages for drinking and irrigation during the dry months. Most of the houses have private roof rainwater harvesting systems of about 100-200 litre capacity for storing drinking water during the rainy season (June-September). The rest of the time, people collect water from open community ponds.

During the seven months of the year when water is in short supply (November–May), water collection requires a significant amount of time that could otherwise be spent on several productive activities. Households are forced to drink turbid water from open and contaminated community ponds. Waterborne diseases like stomach ache and diarrhea are common in the villages. Livestock are taken to the community ponds, and in some villages the same pond is used for drinking water.



This plastic water harvesting pond in Myanmar provides a water source in the dry months

The solution

Sustainable changes or improvements to existing water sources in these five villages required strong ownership by the local community. Therefore, to mobilize the community in regard to water management, Water Management Committees (WMCs) were formed in six pilot villages. To build capacity of project professionals and the Water Management Committee, hands-on practical trainings on improved water management, WASH, and water quality management were organized. Himalica also supported the WMCs to create rules and regulations for managing their available water resources. All new water harvesting systems were constructed with partial contributions from the participating families.

In addition to capacity-building and community mobilization, Himalica's RWH project in six pilot

villages – namely Pan Tin, Tha Yat Pin, Kyaung Nar, Kyaung Taung, Zee Yar, and Antpet in Shan State, Myanmar have achieved the following:

- Constructed 78 RWH systems at household level, each with a storage capacity of 450 litres
- Constructed 20 community RWH systems, with storage capacities ranging from 13,500 to 90,000 litres
- Improved more than 100 RWH systems at household level through providing a mould for tank construction and replacing worn-out or lost parts or patching roofs, replacing bamboo/zinc gutters with polyvinyl chloride (PVC) pipes, and the covering of exposed storage tanks with zinc and bamboo sheets.
- Constructed a new community pond with a storage capacity of 5,000,000 litres near Kyaung Taung village.

- Dug out sediment from and improved three existing community ponds, and increased their collective storage capacity by about 2,400,000 litres.

Impact and uptake

Water consumption increased by an average of 18 lpcd and 11 lpcd during the wet and dry seasons, respectively, due to additional water harvesting structures. The RWH structures near the homesteads have not only increased water availability, but have also improved livelihoods by alleviating the labour burden. In all villages during the dry season, 1.5–2.0 hours were saved by the water being available closer to home. The distance travelled to fetch water during the dry season was also reduced from an average of 2.7 km to 0.6 km. For women and children, this is

“We are happy to have community rainwater harvesting tanks with project (Himalica) support. Fetching water was such a tiring job. It took us 1.5 hours to get water each day during hot dry months. Now, we spend just 15-30 minutes to fetch water. Moreover, we have more time for farm activities, household work and children’s education. Our health is also improving because the water from the tanks is clean, compared to open ponds.”

Women of Kaung Nar Village, Shan, Myanmar

Stored water reduces time and distance needed for water collection





These rainwater tanks in Myanmar mean women spend half an hour per day collecting water compared to several hours before the tanks were installed

a welcome change, as they now have more time for recreational activities, reading, and writing.

The project's efforts in water management have been encouraged by the parallel efforts of private and government groups. The Department of Rural Development (DRD) supported a pumping water system to lift water from the Yan Chat Myaing spring to the villages. The department installed a diesel pump, constructed a collection tank of 20,000 litre capacity at Yan Chan Myaing spring, and established pipelines to distribute water to Pantin, Tayetpin, Kyaungnar and Kyaung Taung villages. The water is collected in community tanks. Furthermore, a private donor worked with a local monk to bring water from Inmee stream near Heho, through a pipeline that has served all project villages; community tanks that were created with Himalica support, has been used for storing this water supply.

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Further reading

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Improved terracing for enhancing soil fertility on sloping land

The terracing technology is a combination of vegetative and structural measures that address the soil, nutrient, and moisture loss problems associated with traditional outward-sloping land, which is reshaped into a series of level or gently sloping platforms across the slope to form terraces. Nitrogen-fixing hedgerow species and quality fodder grass species, which bind the soil, are grown along the newly established terrace riser margins that are constructed using soil-filled bags and other locally available materials. This low-cost technology is culturally acceptable due to which farmers have been motivated to replace maize crops with cash crops and fodder after improving terraces.

Improved terracing can improve agricultural production while also preventing erosion and enhancing the nutrient content of the soil

The issue

Mountain agriculture has its specific characteristics and challenges as compared to agriculture in plain areas. In mountains, crops are grown on sloping land that is mostly rain-fed. Rainfall of pre-monsoon and monsoon seasons erodes the fertile topsoil and applied nutrients. Soil moisture in the sloping land doesn't last long, as runoff is higher than infiltration. This is a major cause of the lower soil fertility and lower production of mountain agriculture compared to the plains. The high intensity of rainfall leads to rill, sheet, and gully erosion, and landslides, which cause damage to cultivated land and crops.

The solution

Terracing was demonstrated on six farmers' land in Kubinde village of the Kavrepalanchok district of Nepal in 2002, and by 2014 the technology was adopted by more than 90% of the total households of Kubinde village and surrounding villages. The local line agency office of the Department of Soil Conservation and Watershed Management was involved in developing the technology to make use of their experiences and to come up with a validated technology that the department could use in its own programmes. Before implementing the terrace improvement work in Kubinde village, a Terrace Improvement



Traditional cultivation, like that shown in this photo, erodes the soil and depletes the nutrients in the ground

Committee was formed with local farmers, and committee members were then trained on sub-watershed management and soil and water conservation measures.

Major activities of terrace establishment include construction of riser walls using empty cement bags filled with soil and stone. In few cases, dried bamboo clumps were used. The terracing activity starts with excavation of soil from the upper part of the field and placing it to build up the lower part behind the terrace riser wall to create a level platform/bed. Grasses and hedgerow species are then planted on the outward margins of the terrace risers.

Maintenance activities of established terraces include smoothing the surface of land, rill, and sheet erosion each year caused by monsoon and pre-monsoon rainfall; slicing terrace risers once

or twice a year; and maintenance of hedgerow/ grass planted along the terrace margins by cutting them regularly to maintain a height of 50 cm.

The technology reduces the slope length and angle, so that soil erosion and soil fertility losses are minimal compared to the sloping land. The flat area of terraces reduces runoff and enhances infiltration, which makes more moisture available to crops. Fodder grown along the terrace margins reduces drudgery, particularly for women and children, as grasses for cattle are available near the households.

In 2003, ICIMOD estimated the establishment and maintenance cost of terracing based on 1 ropani (508.5 m²) land, and it was extrapolated to a hectare of land. The total establishment cost was USD 1,287 and the annual maintenance cost was USD 342.



Traditional outward facing terraces where soil and nutrient losses are high



Paddy cultivation on improved terraces in Nepal are increasing the quality and quantity of production

Impact and uptake

In the demonstration site, terracing led to increased production of maize, potato, and beans. Some farmers have started growing vegetables and rice after two to three years of terracing, which has resulted in household income increasing by 100%. In addition to crop production, the production and quality of fodder has also increased. The price of land increased considerably after terracing from USD\$410 in 2001 (for 1 ropani = 508.5 m²) to between USD 370 and USD 2,055 per ropani in 2006.

Initially, two adopters (out of six) of this technology shared the benefits with new farmers within their villages and the surrounding villages. ICIMOD revisited the village to observe the status of technology 12 years after the initial demonstration and found that over the years, most of the farmers of Kubunde village and surrounding villages had improved their sloping land. For a household, it took more than five years to convert entire sloping land into level terraces. Each household converted their land

gradually, rather than at once, because of financial and labor constraints. Out of 350 households in Kubinde village and surrounding villages as of 2014, 329 households had adopted this technology.

Contributor

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Incentive for ecosystem services

Payment for ecosystem service (PES) is recognized as a tool to sustaining ecosystem services flows while also contributing to livelihoods of resource dependent communities. PES is mostly described as a free market based approach to conservation where consumers of ecosystem service pay to the producers/managers. However, a "true" PES that is based on free market is difficult to establish. Further, there are arguments against purely market based PES schemes in terms of commoditization of nature that does not necessarily benefit the poor segments of the population. Instead, an incentive based mechanism is advocated to ensure benefits to mountain communities for their efforts in conservation and ecosystem management.

Fishermen from Tinsukia, Assam, India. Wetlands support the livelihoods of many rural households in the Hindu Kush Himalaya

The issue

The Hindu Kush Himalaya (HKH) is unique in terms of its biological and cultural diversity. The HKH harbors diverse ecosystems which provide numerous goods and services to about 210 million mountain inhabitants and 1.5 billion living in the surroundings and downstream. However, with global environmental changes, including climate and other forms of changes, the ecosystem's ability to supply goods and services is directly impacted, ultimately having negative livelihood and socioeconomic consequences to the local communities. Additionally, the growing population and economies in the HKH further

accelerate the human pressure, thus adversely influencing ecosystem health and its ability to supply the services.

Payment for ecosystem service (PES) is recognized as a tool for sustaining ecosystem services flow while also contributing to the local livelihoods of resource-dependent communities. PES is mostly described as a free market-based approach to conservation in which ecosystem service consumers pay the producers/managers. However, a "true" PES that is based on a free market is either difficult to establish or hardly exists in practice. There are further arguments against purely market-based PES schemes,



Payment for ecosystem services can be structured to provide equitable access and benefits to all members of a community

describing commoditization of nature that does not necessarily benefit the poor segments of the population.

ICIMOD's research suggests moving from a purely market-based mechanism to an incentive-based mechanism to ensure benefits to mountain communities for their efforts in conservation and ecosystem management. It is argued that incentive mechanisms, if well embedded in a policy instrument, can be effective in ensuring a long-term supply of ecosystem services in the Himalaya.

The solution

The incentive mechanism needs a proper institutional arrangement among stakeholders, including buyers, sellers, and the local government. A tripartite institutional arrangement

(Figure 1) has been tested and found effective in implementing the incentive mechanism. Mediation and facilitation from the local government is crucial for effective implementation of this mechanism. While consumers of any particular ecosystem service, such as water, agreed to provide incentives to upstream communities (or producers), which not only encourages upstream communities to conserve the upstream ecosystem but also provides support for alternative livelihood options.

While developing the incentive mechanism for ecosystem services, it is worth understanding the economic value of particular ecosystem services (Figure 2). The value of any particular service in terms of consumers' willingness to pay (WtP) helps in negotiation and agreement. However, the collective willingness to pay may not be same as the individual WtP, which mostly determines

Figure 1. Suggested institutional arrangement for an incentive mechanism, including possible roles

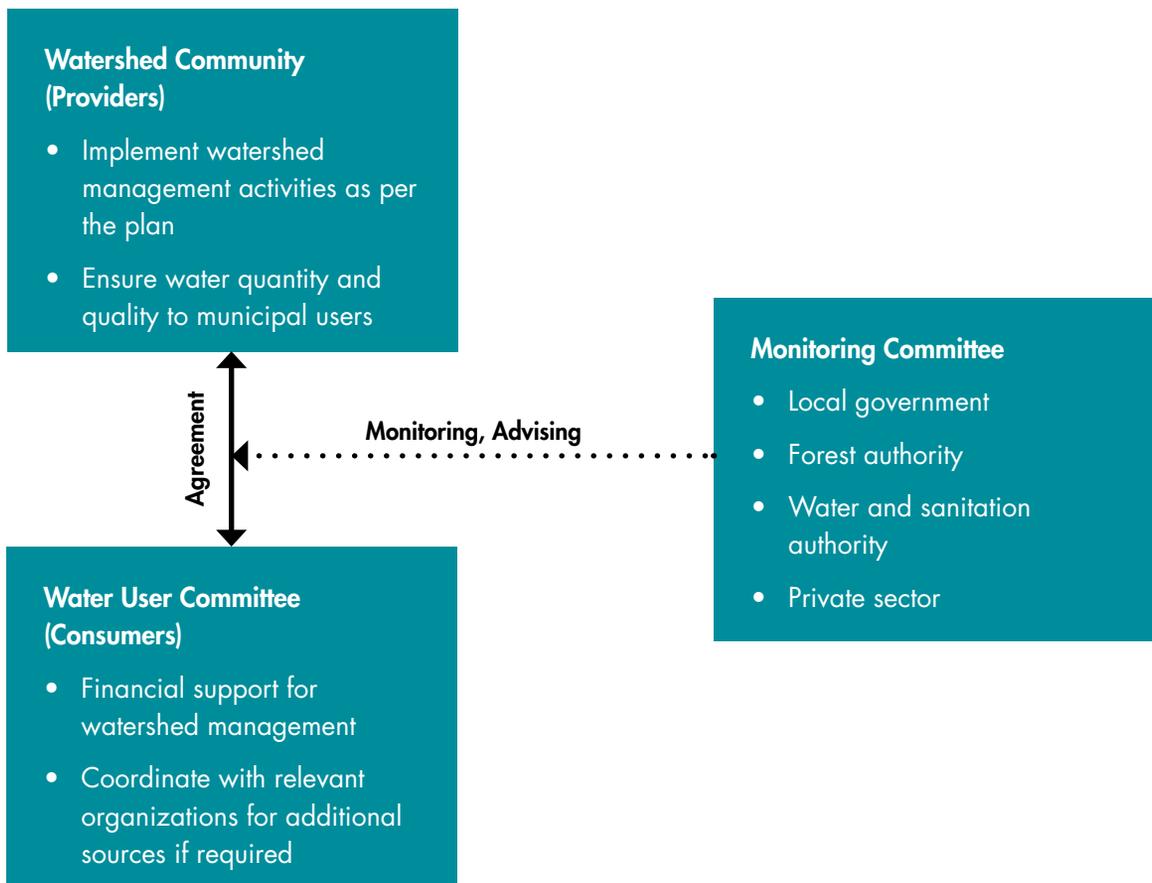
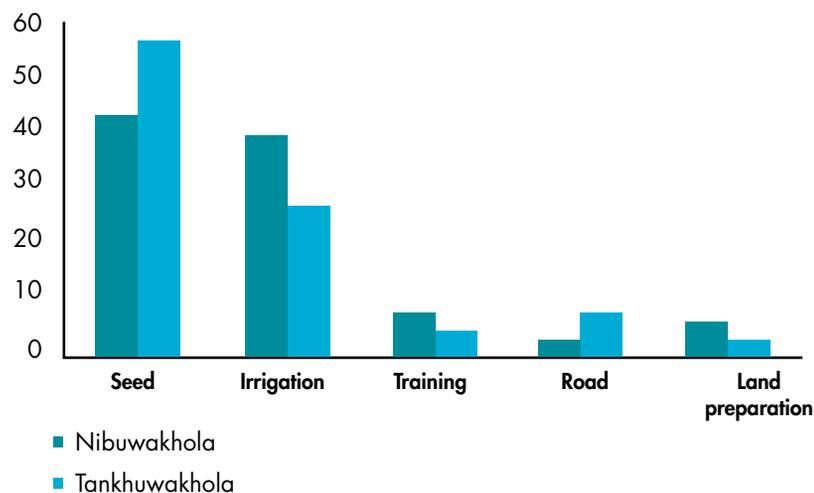


Figure 2. Preferences for different incentive forms (Dhankuta, Nepal)





Payment for ecosystem services are devised by community members to create context-appropriate schemes

the incentive to upstream communities. In Shardukhola watershed in Nepal, the total willingness to pay for water services is USD 118,000 per annum to support watershed management activities, where individual household willingness to pay per month is USD 3.48, which is 18% more than the present water tariff. Similarly, in Baitadi, Nepal, total WtP for doubling the water availability is about USD 4,500 per year. In both cases in Nepal, water consumers agreed to provide incentives to upstream communities under an institutional framework and agreement.

Impact and uptake

Incentives for ecosystem services is one of the solutions that can effectively engage communities in managing their resources, while ensuring the long-term supply of ecosystem services. In collaboration with various partners in the member countries, ICIMOD has been effectively working on exploring ways to establish incentive mechanisms for ecosystem services, which include understanding the economic value of ecosystem services, bringing stakeholders together for an effective agreement and institutional arrangement, and evidence-based

policy support at the central and provincial governments. In Nepal, a PES policy was drafted, whereas the provincial government of GB in Pakistan endorses PES in their development program.

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Innovations in value chain

Poverty and male outmigration are affecting lives in far western Nepal, especially that of women (around 50%). Inaccessibility of location, lack of access to resources and services, and limited skills and capacities have traditionally constrained women's participation as market actors. Under these circumstances, *allo* (Himalayan Nettle in English) has become a high-value niche product around which women form groups and start small enterprises as home-based workers. Raw *allo* transforms into a viable value chain with innovation in product design and after addressing quality expectations and needs. Increased efficiency and innovation at the local level (from mere barks to high-quality, branded, finished products) has not only enhanced the livelihood of rural women, but also increased their influence in the community.

Women demonstrating their weaving skills at an international trade fair

The issue

Naugad rural municipality, located in the remotest far western part of Nepal, is a pilot site of the Kailash Sacred Landscape Conservation and Development Initiative (KSLCDI) by ICIMOD. Placed in the Api-Nampa Conservation Area (ANCA), it is characterized by poor accessibility, limited economic opportunities, and high outmigration, leaving women and marginalized communities behind. An estimated 20 tons of raw Allo bark is produced annually in Darchula, with eight to nine tonnes of this from Naugad (ICIMOD 2015). However, despite the substantial availability, local people had limited knowledge and awareness until recently about the possibility of developing sustainable Allo-based enterprises.

The solution

The Kailash Sacred Landscape Conservation and Development Initiative (KSLCDI) initiated its work in Allo to mainstream it into a commercial value chain with a focus on conservation and sustainable development. A value chain intervention was designed to bring possible innovation/value additions to this nature-based fiber in Naugad, with the aim of providing a sustainable income, thereby building the resilience of the target community.

A community-owned common facility center (CFC) was established with private sector support from the SAARC Business Association of Home-Based Workers (SABAH) in Nepal, a

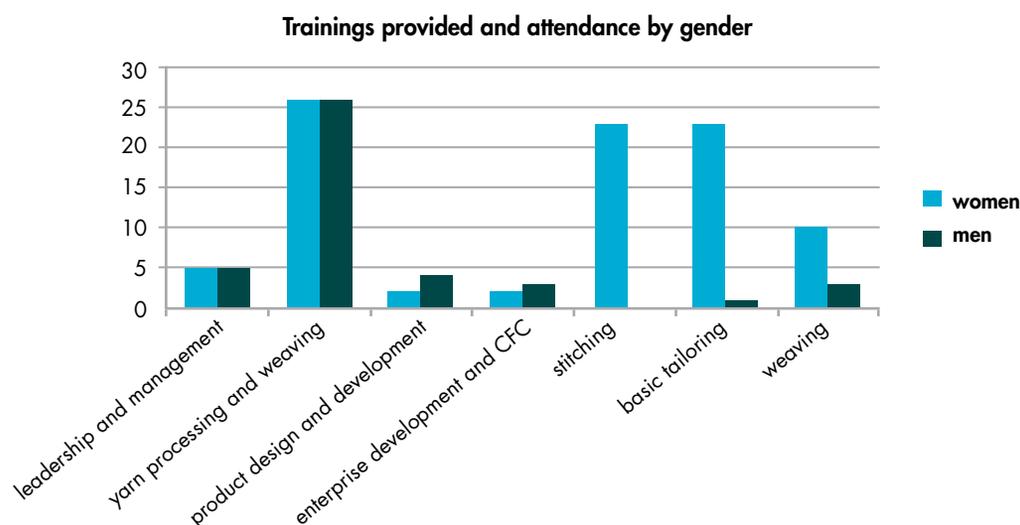


SABAH-Nepal and REVA Organics promoting the Kailash-Truly Sacred Brand at the NHTF, Kathmandu

social business organization which now has 82 members (69 women), with 150 households benefiting directly and indirectly. The center played a key role in demonstrating the various stages of product designs and quality, and learning about market needs and expectations, as well as entrepreneurship. With its initial success, the scope of the center is increasing day by day. At present, 76 people work as active members of the CFC, of which more than 75% are women. A majority of the women members participated in stitching, tailoring, and weaving. The center nurtured a number of women-owned enterprises at different nodes of the chain, as well as provided various exposure opportunities in the cities of India and Nepal. A buy-back guarantee provides security to members of CFC. The quality and range of Allo products has increased markedly, opening a greater possibility

of value addition, as well as additional income to the community. Today, CFC is trading various other products, such as beans, ghee, rice, and medicinal herbs to SABAH, as well as other local and regional traders.

The involvement of marginalized groups despite the restricted socially-constructed rules of participation, especially for women, has changed, as these marginalized groups are now viewed as important actors in the chain. Traditionally, the Allo fiber has been processed, spun, and woven as a coarse product for household use; today, women have considerably increased their skills in thread-making, stitching, and weaving following the training. They are now able to produce diversified products such as bags, purses, suits, cushion covers, scarves, shawls, pot holders, and runners to meet the market demand in both local and international markets. Through



	Impacts of pre- and post-intervention in 2016	Present status
Group members (women)	23 (19)	76 (67)
Price per kg of <i>allo</i> thread	800 NPR	1,100 NPR
Fuelwood used to boil 6 kg of <i>allo</i>	240 kg	Around 80 kg
Time needed to boil 6 kg of <i>allo</i>	6 hours	Around 3 hours
Market outreach	Local market	Clothing industry, Kathmandu market

Source: ICIMOD 2016

enterprise development and leadership training, the community enterprise today is run by these women leaders. Trainings have been given using picture series manuals so that women who are mostly uneducated can understand the market chain in a holistic and participatory way.

KLSDCI focused on strengthening the backward-forward linkage between SABAH and the community in order to build the resilience of the community. The initiative developed a mechanism with SABAH-Nepal to build capacity at the local level, which strengthens their supply chain, reduces logistics costs, and increases the share of benefits to the community. A Kailash transboundary brand, “Kailash – Truly Sacred”, has been created to bring recognition to the local products in high-end international niche markets.



With investments toward enhanced production of *allo*, linkage with other line agencies, networking between individual groups/clusters, transboundary market interface between SABAH-Nepal and Riva Organics, India, and water and energy conservation actions, the foundation is laid for sustainability of the interventions. Some of the strategies for minimizing the effects of climate change and maintaining

“We are using private sector for allo value chain promotion in KSLCDI as we believe they are the experts of business. The Nepal government has ensured the sustainable resource use while promoting business in Naugad.”

Resham Bahadur Dangi, Foreign Aid Coordination Division (FACD), Ministry of Forests and Soil Conservation (MoFSC), Nepal

a sustainable Allo business in the area were nursery establishment for resource sustainability; rain water harvesting and afforestation programs for water conservation; use of improved cooking stoves for efficient energy supply; and introducing drought-resistant species.

Impact and uptake

The visible change indicators as well as characteristics of these interventions are increased individual and institutional capacities, higher income, innovative products, inclusiveness, better access to markets, and wellbeing in the lives of the community. The impact study of ICIMOD indicates that the mean income of the target communities increased by nearly 30% between 2013 to 2015. Apart from a significant increase in income just from the sales of thread, these marginalized groups are earning additional income from bags, cushion covers, hats, stalls, mufflers, and coats which they sell to SABAH at a premium price, as these products are sold in Kathmandu as well as on the international market. Members working in CFC earn more than NPR 3000/month from stitching, which is more than the local daily wage. More than 25 Allo-based entrepreneurs are now in business, showing the outscaling impact of a small intervention that KSLCDI started in 2014.

The interventions also had significant social and environmental benefits through the introduction

of new technology and process innovations. Modern equipment was provided to CFC, as well as its members, to improve efficiency. The replacement of the traditional katuwa (hand spindle) with modern equivalents improved thread quality and increased income from Allo by 27%. The introduction of energy-efficient “rocket” stoves reduced by two-thirds the amount of firewood needed to boil 30 kg of nettle bark. This improvement decreased tree felling and reduced smoke emissions and indoor air pollution. Cooking time per batch was reduced by 45 minutes, providing women with more time to work in Allo processing. Sustainable harvesting training and processing techniques have improved yarn quality considerably, as well as ensured regeneration of the plant. The use of ash instead of caustic soda reduced negative health impacts and is more environmentally friendly, as the chemical was washed into nearby rivers, polluting the water. The ash method enables production of chemical-free fiber, an organic product with a niche value in the international market.

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Three variants of jholmal

Jholmal for small-scale farmlands

Jholmal is a homemade bio-fertilizer and bio-pesticide which is prepared by mixing and fermenting locally available material in a defined ratio that includes animal urine, water, beneficial microbes, farmyard manure, and leaves with a pungent odour and taste. It is helpful in controlling insect pests that attack and damage crops, protects crops against fungal and vector-borne diseases, and improves plant health.

The issue

The smallholder mountain farmers living in the hilly terrain usually have less cultivable lands and thus require wise utilization of the lands for maintaining soil nutrient and land health. However, intensive use of chemical fertilizers and pesticide by the farmers results in soil fertility depletion and simultaneously affects human health due to the consumption of heavy chemical residue-loaded vegetables, staple crops, and fruits. Chemical fertilizers and pesticides are therefore not a long-term solution for agricultural sustainability, as the productivity decreases over time and they further accelerate harmful environmental and health impacts.

Kavre district, situated in the mid-hills of Nepal, has long been a place of significant agricultural production with a large market for fresh vegetables in the capital city of Kathmandu. However, changing climatic conditions, coupled with excessive usage of chemicals and hazardous pesticides, not only resulted in soil degradation but had led to a situation in which agricultural products were totally banned in the vegetable market of Kathmandu.

The solution

Jholmal is based on a local traditional practice, and its use in the agricultural farmlands safeguards both the environment and human



Local communities preparing *Jholmal*

health. The preparation of *Jholmal* requires locally available plant materials mixed with animal manure and urine, and most of the mountain farmers raise livestock for milk, meat, and manure; thus, the use of *Jholmal* is a cost-effective solution to the smallholder mountain farmers. Instead of purchasing expensive chemical fertilizers and pesticides that are harmful to environmental, land, and human health, the homemade *Jholmal* could assure economic benefits to the smallholder farmers and is ecologically beneficial in many ways.

An experimental study conducted on two varieties of rice in 2015 and 2016 using i) traditional farming practices with *Jholmal* and ii) chemical fertilizers/pesticides showed that use of *Jholmal* increased the productivity compared to using chemical fertilizers. Nevertheless, the farmers used to spend more money to purchase

chemical inputs to increase the agricultural productivity. For example, a baseline survey conducted by CEAPRED and ICIMOD in 2014 covering five villages of Kavre showed that each household spent on average about NPR 23,000 (~USD 230) annually to purchase chemical inputs for their farmlands. This cost to the farmers in Kavre is much higher compared to the expenses incurred for *jholmal* production annually.

Impact and uptake

With successful piloting at several villages from three Village Development Committees at Kavre district, the use of *jholmal* has been upscaled to Udaypur district in eastern Nepal. The Government of Nepal has further announced the upscaling of resilient mountain solutions; one of its packages involves distributing *jholmal* to 14 other districts of Nepal. CEAPRED has received additional independent funding to take up similar practices in other sites. The concept of Resilient Mountain Village, of which *jholmal* is part of, is being promoted by ICIMOD in its next 5-year Medium Term Action Plan in the regional member countries across the HKH.

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Low cost water storage ponds for smallholders

Seasonal water shortages in the Hindu Kush Himalaya, coupled with excess water in the monsoon, is a critical issue in the agriculture sector. Thus, harvesting rainwater during the monsoon season through water channelizing into the plastic storage ponds is highly recommended so that rainwater collected during monsoon can be used during dry periods or droughts.

This pilot water harvesting pond demonstrates efficient water management and technology suitable for small holder farmers

The issue

A vulnerability assessment study carried out in three Village Development Committees (VDCs) at Kavre district in Nepal revealed that drought and water scarcity are severe problems faced by farmers. To address this issue, efficient water management practices were required to be implemented which are simple and affordable to the mountain farmers.

The solution

ICIMOD and the Center for Environment and Agricultural Policy Research, Extension, and Development (CEAPRED) have piloted simple and affordable solutions suitable for smallholder farmers to adapt to the ongoing environmental

and socioeconomic changes in the mountains. Using a concept of “zero waste water”, the farmers in Kavre district were encouraged to dig small plastic ponds near their homestead for collecting waste water from their household chores, which could be used for irrigating a home garden or kitchen garden during the dry season or drought. The plastic is used to reduce water seepage underground. Most of the farmers constructed a plastic pond of 7 ft. x 4 ft. x 75 cm depth with a capacity of storing 2,000 litres of water. Likewise, larger community-managed plastic ponds were also constructed, having dimensions of 18 ft. x 24 ft. x 1 m depth with a capacity of 16,000 litres to collect waste water from the drinking water tap, small stream, or any other water source. In areas with clayey soil,



Water storage ponds are easy and inexpensive to install

earthen ponds made by simply digging a hole of considerable size in the ground could also retain waste water without using plastic.

These different kinds of water storage ponds support smallholder farmers in growing crops throughout the year by increasing the reliability of irrigation, particularly in dry periods. However, to avoid high water loss from evaporation, these ponds should be constructed with shade trees. Apart from this, drip irrigation and other traditional practices like mulching could also be combined for integrated water management in small-scale mountain farmlands where there is water scarcity.

The water storage plastic ponds are low-cost and are an effective way to capture and store household waste water and overflow water. They are built using simple technologies and even the smallholder mountain farmers can afford them due to the low investment required. This ensures easy uptake of the technology by the practitioners, as well as the farmers, through learning and sharing by themselves.

Impact and uptake

The low-cost water storage pond and community ponds first piloted in three VDCs of Kavre were further upscaled to four additional sites

in Panchkhal municipality of Kavre, Nepal. Likewise, several water-smart technologies that use a combination of science and local knowledge with low investment and minimal external technical support were promoted in eastern Nepal. The Government of Nepal has further ensured the upscaling of low-cost water-smart technologies as resilient mountain solutions across 14 other districts in Nepal. Additionally, ICIMOD, with its partner organizations, is also planning to outscale the initiative to other regional member countries of the Hindu Kush Himalaya in the near future.

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Households can rent bee colonies in Himachal Pradesh

Managed pollination services

Pollination services provided by honeybees and beekeeping help in improving the livelihoods and food security of mountain people by enhancing the yield and quality of crop production, biodiversity conservation and better ecosystem health, and income generation from the sale of bee products, most prominently honey. This solution presents the contribution and role of managed pollination services through beekeeping in improving resilient agriculture and livelihoods in mountain areas.

The issue

Over 80% of plants and three-quarters of world food crops rely on animal pollinators. Insects, particularly bees, are the most effective pollinators of agriculture and horticulture crops. However, there is growing evidence indicating an alarming decline in pollinator abundance and diversity globally and in the HKH due to factors such as habitat loss, spread of pathogens, excessive chemical pesticide application, competition from alien species, and climate change.

The decline in natural pollinators has a negative impact on crop production, examples of which have been reported from the cash crops farming areas of the Himalaya. An extensive ICIMOD study carried out in 2002 in the apple farming areas of China, India, Pakistan, Bhutan, and

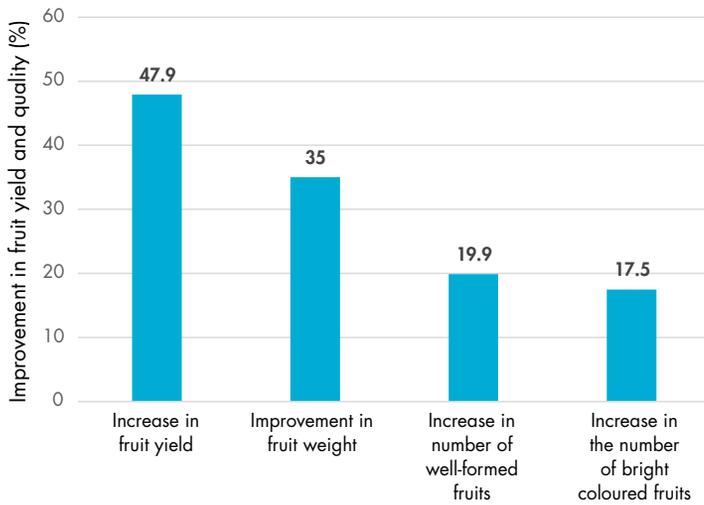
Nepal showed a severe decline in apple yield and quality as a result of inadequate pollination.

With a decline in the naturally occurring pollinators, honeybees assume an increasingly important role as pollination service providers. Honeybees are reported to be one of the most efficient providers of crucial and high-value pollination service and play an indispensable role in enhancing the production of many economic crops such as fruit and nuts, vegetables, pulses, oilseeds, spices, and fibre and forage crops.

The solution

Pollination service provided by honeybees and beekeeping has been identified as a simple, low cost, environment- and women-friendly

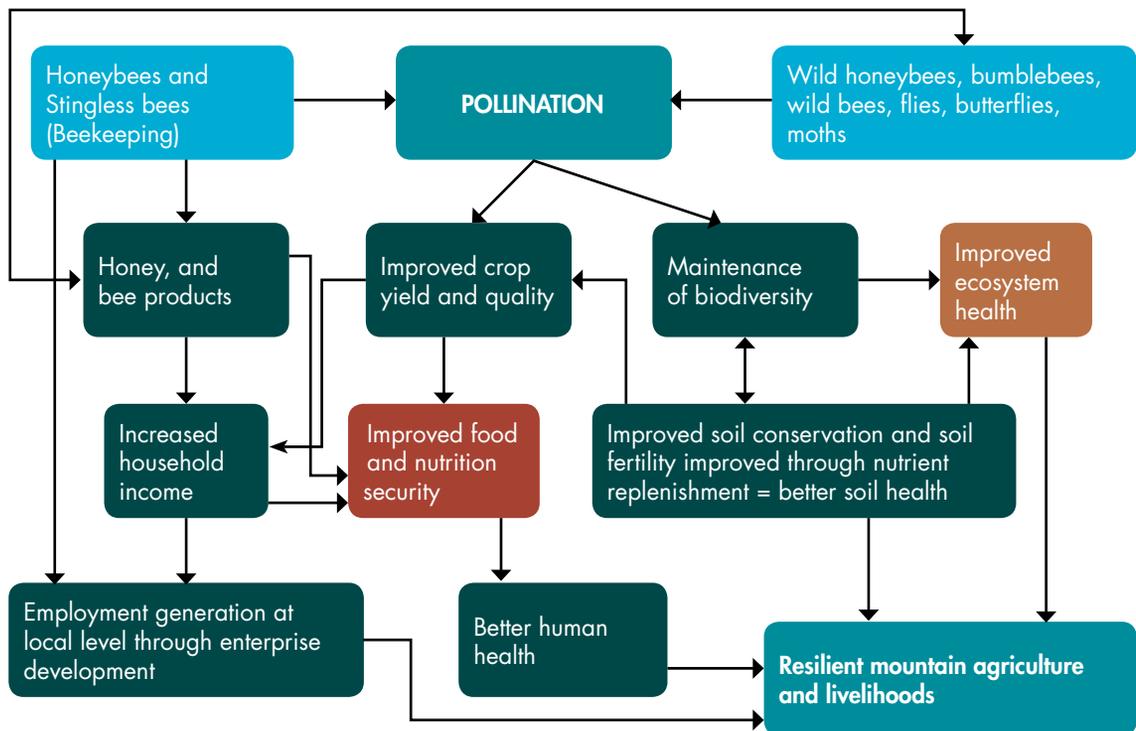
Figure 1: Improvement in apple yields and fruit quality due to honeybee pollination in Chitral, Pakistan



option that helps improve mountain agricultural productivity, ecosystem health, and livelihoods of the mountain people in the HKH.

A recent collaborative action research study conducted by ICIMOD (as part of the Himalica Initiative) and the Aga Khan Rural Support Programme (AKRSP) in Chitral, Pakistan concluded that introducing honeybees for pollination – and not just for honey production – and training farmers to properly manage bee colonies enhanced the setting of fruits by up to 14%, reduced premature fruit drop to 6%, and enhanced the overall fruit yield by 48%. It also enhanced the quality (i.e., weight, shape, and colour) of the apples (Figure 1).

The role of pollination in resilient mountain livelihoods and ecosystems



Realizing the importance of honeybees as pollination service providers, apple farmers in Himachal Pradesh in northwestern Indian Himalaya are using honeybees/beekeeping for managing apple pollination. Supported by the Government of Himachal Pradesh, there exists an organised system for hiring and renting bee colonies for apple pollination in Himachal. Orchard owners rent bee colonies for pollination of apples and pay the beekeepers for this service. The current rate for hiring a bee colony for apple pollination is USD 12-15 per colony for the two-week-long apple flowering period. This large-scale use of managed pollination has led to the establishment of several pollination entrepreneurs not only in Himachal and but also in its neighbouring states. This has provided employment and income generation opportunities for the local youth. However, only 23,000 colonies are currently used for pollination in

Himachal, which is just one-tenth of the huge requirement of 250,000 colonies to pollinate over 90,000 hectares of apple orchards in the state, indicating the huge scope for creation of more pollination based enterprises.

Pollination service helps in creating a mutually beneficial relationship between the poor beekeepers, who are paid for providing bees for pollination, and the orchard owners, who use the pollination service and receive a higher yield and quality of produce. Furthermore, the byproducts of the pollination service of honeybees, such as honey, beeswax, and pollen, are rich in nutrition and health benefits and further increase household income, if marketed. In fact, beekeeping is a part of the culture of mountain communities across the HKH and has sociocultural, economic, religious, and spiritual significance to mountain communities.

A beekeeper and his family in Nepal





An action research farmer with his bee colony in an apple orchard (Chitral, Pakistan)

Impact and uptake

Studies by ICIMOD reveal that beekeeping makes close to 50% contribution to household cash income in Chitral, Pakistan, in Alital in Dadeldhura district in Nepal, in the Kishoreganj area of Bangladesh, and in the Kullu valley of Himachal Pradesh in India.

Supported by various government and non-government development organizations and favourable agroclimatic conditions, mountain agriculture is transforming from traditional cereal crops-based farming to cash crops farming. Currently, around 25% (i.e., 6.63 million ha) of the cultivated area in the HKH is under cash crops farming, with total annual production of around 46 million tonnes. Many of these crops require cross pollination by insects such as bees for optimum crop production. Pollinating such

a huge area of crops would require 20-24 million colonies of honeybees. This reveals a tremendous scope for establishing pollination enterprises that would provide self-employment opportunities to millions of youth and women.

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Promoting mountain niche crops: large cardamom

Mountains offer economic opportunities in the form of niche products, which are low-volume, high-value, and non-perishable. Large cardamom is one such mountain niche crop that offers a comparative advantage to farmers of the eastern Himalaya (i.e., Sikkim and the Darjeeling hills in India, the eastern part of Nepal, and southern Bhutan), particularly in areas where agroclimatic conditions are conducive. However, in recent years, the production and productivity of large cardamom has declined due to environmental, biological, and socioeconomic factors. Since 2015, a pilot project under the Himalica initiative at ICIMOD has been implemented in Taplejung district, Nepal with the aim of building the resilience of the cardamom production system through simple and affordable practices to reduce the effects of climate change, and to achieve income diversification. The early results in terms of increase in crop yield and uptake of demonstrated technologies by the communities are very encouraging.

Large cardamom pods

The issue

The large cardamom, with its attributes of being low-volume, high-value, and non-perishable, is a boon for farmers of the eastern Himalaya. However, extreme climate events such as drought, increasing pest or disease infestations, erratic rainfall patterns, unpredictable hailstorms, or snowfall have begun impacting traditional management practices and the crop cycle. For example, the flowering and harvesting seasons of cardamom have altered due to rising

temperatures. At the same time, the increased dependency of farmers on cardamom poses higher risks because of production fluctuation and price variability. For example, in 2014 the price of cardamom capsules reached USD 28 per kg and dropped to USD 10 per kg in 2017.

The other issue is that of lack of knowledge among large cardamom farmers about the economic gains possible through value-added products like cardamom tea or curry powder. Farmers are used to selling cardamom pods (in



Making use of cardamom fibre for value added products

40 kg sacks) without proper processing, grading, and packaging to traders who do the primary processing and then export the cardamom to other countries.

The solution

The alder-based cardamom farming system requires more labour, improved water management, quality planting materials, timely soil nutrient management, appropriate shade management, and integrated pest and disease management practices across the eastern region. By building on lessons learnt from Sikkim, India and considering local knowledge, Himalica developed a Package of Practices (PoP) to reduce the risks of cardamom crop failure. The PoP is complemented with capacity-building strategies for the sustainability of the alder-based cardamom production system.

The package includes simple and affordable climate-resilient technologies and practices, as well as viable options for reducing risks and diversifying income, e.g., integrating honeybees, horticultural crops (kiwi, shitake mushroom), and livestock in the cardamom farming system. For climate resilience, the package includes weather-smart, soil/nutrient-smart, water-smart, energy-smart, and knowledge-smart practices (as described in Box 1), along with an emphasis on the enhanced conservation of effective pollinator species.

Himalica has showcased climate-resilient practices in 12 demonstration sites managed by farmers groups and facilitated by the partner organization, Environment Conservation and Development Forum (ECDF). In addition, the project has supported bringing market actors closer to the producers and adding value

through branding and product diversification. Social enterprises like SABAH (SAARC Business Association of Home Based Workers) have been on board for product development. Communities are sensitized and trained to make diverse products using cardamom powder as the main ingredient, along with selling cardamom pods. The brand “HIMALICA products from mountain people” has been also created and promoted. In a similar effort, knowledge and skills of selected community members to produce cardamom fiber-based products for sale as souvenir items have been enhanced. The project is also partnering with “ICT for Agriculture Pvt. Ltd” to provide Short Message Service (SMS) on crop advisory, weather forecasts, and market price information to cardamom farmers.

Impact and uptake

More than 400 households are now actively engaged in adopting the package of practices on their own initiative in the Himalica pilot and other villages. Early results indicate that the good practices have improved soil structure, soil water-retention capacity, and air circulation inside the cardamom stands, leading to a better microclimate. Cardamom clumps with manure can withstand heavy hailstones and drought for longer periods compared with non-manure clumps. Farmers are using less fuelwood for drying cardamom capsules because they have improved dryers, thus contributing to lower carbon dioxide emissions. The plots with manure/mulching and other practices have yielded 750 gm dried cardamom capsule per plot, compared to only 350 gm dried capsule from the other plots.

Convinced by the pilot, the National Spice Crop Development Programme of the Department of Agriculture, Nepal joined hands with ICIMOD to co-publish a manual in Nepali,

Box 1: Package of practices

Weather-smart practices

- Varieties planted based on altitude.
- Keep the weeds intact in the field until the winter is over to prevent frostbite.
- Delay harvesting by a few days if rainfall is predicted.
- Practice using dried weed and crop traces to protect the tender leaves on top of the bushes from frostbite or snow.

Soil/nutrient-smart practices

- Use of well-decomposed dung.
- Plant leguminous trees or shrubs.
- Apply cow urine + plant extract based “*jholmal*” as bio-nutrient fertilizer, as well as bio-pesticide.
- Intercrop nitrogen-fixing pulses or beans to enrich the soil nutrient base.
- Thin old and dense alder trees (>15 years old).
- Prepare bio-compost and vermi-compost.
- Use slashed pseudo-stem, weeds, or leftover fodder residue with dung for mulching to provide additional nutrients and conserve soil moisture.
- Plant Titepeti in the large cardamom farms to control harmful insects.

Water-smart practices

- Dig out several pits throughout the plantation stands to store water during the rainy season and increase soil moisture.
- Make water ponds above the plantation, which helps to improve the soil moisture status.
- Establish water harvesting plastic ponds at suitable locations within the plantations to arrest rainwater during monsoon, which can be used during the dry season.
- Use sprinkler irrigation during dry periods at least twice a week.
- Use weeds to mulch around the bushes for soil moisture retention.

Energy-smart practices

- Promote an improved dryer that consumes less fuelwood and emits less carbon while saving labour.
- Use of dry fuelwood of hardwood species such as chilaune, katus that provide enough heat.
- Monitor fire flames constantly and reshuffle the capsules while drying to maintain consistency.

Knowledge-smart practices

- Promote ICT-based information on market price, weather, and crop advisory services to help producers to minimize risks and increase bargaining power.
- Create social capital working in groups and cooperatives.
- Facilitate buyer-seller meets and buy-back arrangements.
- Engage producers’ groups in collective business enterprises.



Product diversification for expanding domestic markets

titled “Resource Book for Farmers”. The same has been published in English in partnership with The Mountain Institute, Sikkim and Sikkim Agriculture Development Bank. Recently, the newly-elected representatives of the Funling Municipality in Nepal invited ICIMOD to support them in developing their plans for sustainable development of agriculture, with particular focus on cardamom.

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Women cultivating potatoes in Kavre, Nepal

Women-centric resilient agriculture development

The Resilient Mountain Village (RMV) approach offers simple and affordable solutions for mountain farmers to adapt to ongoing environmental and socio-economic changes and prepares them better for future challenges. The approach combines local knowledge with scientific risk and vulnerability assessments, to contribute to resilience building through enhanced productivity and disaster risk reduction (DRR) with simple, affordable, and people-driven solutions. The project focuses on three overarching goals: climate resilience, socio-economic resilience, and future resilience. Together these goals form a basis for an integrated approach to sustainable development and resilience building in mountain communities.

The issue

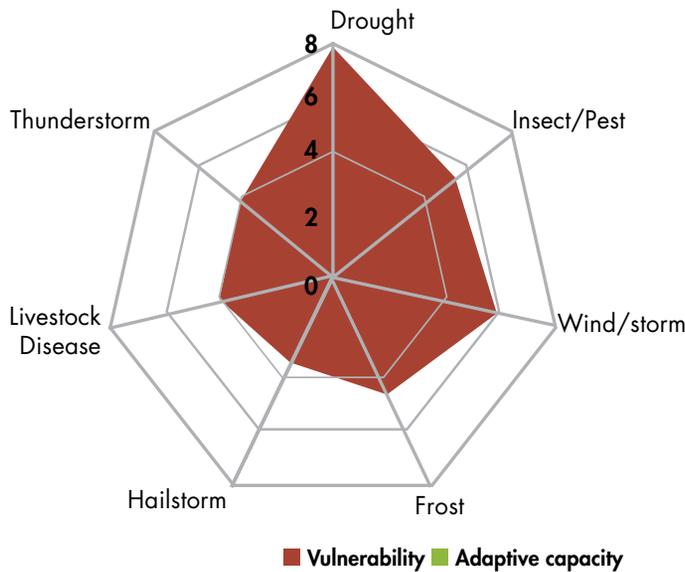
Kavre district, situated in the mid-hills of Nepal, has long been a place of significant agricultural production with a large market for fresh vegetables in the capital city of Kathmandu. However, in the past 20–30 years, an increase in hazard risk due to changes in rainfall patterns has been observed in Kavre. Changes in the rainfall pattern and in seasonality are the most severe challenges impacting agricultural production, the livelihood mainstay for over two-thirds of the population here. In addition, crops are being affected by higher incidences of insect pest attacks, forcing farmers to apply higher

doses of “red-labelled” chemical pesticides, leading to severe health hazards to people and the environment. Simultaneously, increasing outmigration, predominantly by young men, has substantially shifted the responsibilities of agriculture to women.

The solution

The Resilient Mountain Villages (RMV) approach was developed by ICIMOD, and the pilot project has been implemented in eight villages by the Center for Environment and Agricultural Policy Research, Extension, and Development (CEAPRED) since 2014. Based on a risk

Figure 1: **Vulnerability Assessment**



assessment and participatory planning (see Figure 1), the project addresses water scarcity, soil nutrition, crop productivity, information gaps, risk reduction, and institutional linkages.

The project takes a holistic approach to simultaneously address aspects of resilience enhancement. A number of technologies and practices based on farmers’ traditional knowledge, as well as scientific knowledge, are tested, demonstrated, and disseminated (see Table 1). Average investment per household was less than USD 100 in first two years of interventions. The actions are kept site specific, simple and affordable to ensure easy uptake for

“This year I made NPR 66,400 (~USD650) selling my cucumbers grown on a patch of 375 m². And I did it all without using chemicals just by producing and applying jholmal” **Sita Neupane, Kavre**



Women farmer using leaf color chart to determine nitrogen requirement for the plants

farmers and to enable practices to be shared by word of mouth among the communities not directly participating. The local level government departments are involved from the beginning to ensure the ownership and support from them. A project management committee has been formed representing all stakeholders, ensuring approval, monitoring, and networking with other organizations.

Impact and uptake

The project has directly benefitted 1,089 households, out of which 1,212 (83%) are women farmers. Female participation is high, partly because the project encourages women to join, but also because of the high level of male outmigration – in almost 40% of the households in the mid-hills, at least one man had migrated.

The project is supported by district line agencies and agro-veterinary centres in Nepal. Regular monitoring from high-level authorities, including Nepal’s National Planning Commission (NPC), has also aided upscaling efforts. The Government of Nepal has already adopted and

Table 1: Interventions and outcomes related to water management and soil nutrition

Key area of vulnerability	Key interventions	Results
Water Availability	<ul style="list-style-type: none"> Water source protection Household-level conservation ponds Community water storage Waste water management 410 plastic ponds at the household level 128 ponds (plastic and soil-cement) at the community level 52 installations of drip irrigation Conservation of 16 existing water sources 	<ul style="list-style-type: none"> Data shows 67.4% increase in cucumber/ bitter gourd output Twenty-five hectares upland gained Increased access to water for irrigation All participating households manage their own kitchen garden with collection of waste water at the household level
Crop and Cropping Patterns	<ul style="list-style-type: none"> Intercropping Mix cropping Crop rotation Promoting mulching practices Varietal selection 	<ul style="list-style-type: none"> Introduction of direct-seeded rice and SRI, which required less irrigation Three hectares of land applied mulching during (dry) summer season
Soil Nutrients	<ul style="list-style-type: none"> Promoting <i>jholmal</i> Improved compost management Intercropping with leguminous crops Green manure for rice planting 	<ul style="list-style-type: none"> Increased production output for rice (17.3%), wheat (25.5%), Tori (34.3%), and cauliflower (25%) with the use of <i>jholmal</i> compared to farmers' previous practices
Pests and Pathogens	<ul style="list-style-type: none"> Irrigation management <i>Jholmal</i> practices 	<ul style="list-style-type: none"> Production of pesticide-free food crops (safe food production) Reduction in health hazards Reduced sale of chemical pesticides from the local shop Increased sale of "jeevatu", a microbe needed for <i>jholmal</i> preparation
Information Gaps	<ul style="list-style-type: none"> Mobile-based crop, weather and market advisories Engagement with local schools to collect weather data through simple meteorological equipment as information and learning opportunity for students 	<ul style="list-style-type: none"> Three-fourth of the users of mobile-based advisories are women farmers Increased awareness helping them prepare better for climate and market related challenges

included the RMV in its development plan and currently plans to pilot this approach in 14 districts.

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Changing Behaviours and Practice



Building women's capacities to leverage remittances

Outmigration of men requires women to acquire new skills, capacities, and knowledge to deal with new challenges, including the impacts of extreme weather events. Through action research it is established that women-focused interventions aimed at raising awareness and the ability to process information, improving the ability to plan and budget, and supporting women to adopt low-cost and no-regret flood preparedness measures have the potential to enhance the adaptive capacity of their households.



As men migrate for work, women assume greater responsibility for managing disaster risks for the household

The issue

Udayapur district is located in the Koshi River sub-basin of Nepal. The district experiences annual floods that destroy crops, kill livestock, displace people, damage infrastructure, and disrupt communication. The migrant workers from the Udayapur district of Nepal are generally male and employed in the urban centres within the country, as well as abroad. This outmigration of men exposes women to new tasks related to disaster preparedness, food security, and farm management, for which they are often unprepared. Women would not have had the same opportunities to access information,

participate in markets, access extension services, and partake in government programmes as men do. Outmigration of men therefore requires women to acquire new skills, capacities, and knowledge to deal with new challenges.

The solution

An action research by the International Centre for Integrated Mountain Development (ICIMOD) and the Nepal Institute of Development Studies (NIDS) aimed at increasing women's awareness and ability to process information about financial services, flood preparedness,



Growing seasonal vegetables in the kitchen garden can diversify a household's livelihoods portfolio

and livelihood diversification, and, accordingly, plan the utilization of the household resources. A women's group was formed in each treatment village. Within the group, each individual household has the flexibility to set its own priorities and goals. The training events had been organized in a sequence: (1) financial literacy; (2) flood preparedness; and (3) livelihoods diversification and business planning. Over 200 women from migrant-sending households participated in training and village-level extension services.

Better management of household income is essential for target-based savings, a part of which could then be utilized to manage risks, including extreme weather events. A three-day financial literacy training was organized in each treatment village. This training included a discussion on

terminology, risk management, the importance of budgeting, financial goal-setting with targeted savings, and mapping of financial institutions and household financial resources. On completion of this training, each participant received a household budget book and coin box.

During the period between the financial literacy and flood preparedness training, group meetings were held regularly in each treatment village. These meetings provided an opportunity for the participants to share their experiences and revise different modules from the aforementioned training manual. During this period, the village coordinators also ensured that female participants – who did not have a savings account – opened one in the nearest government-registered cooperative. The monthly household visits by village coordinators provided

another opportunity for the participants (and sometimes their family members) to communicate their feedback to the research team.

Since the participants were busy with planting of the paddy, the flood preparedness training was imparted through a series of eight group meetings in each treatment village. Each meeting was around two hours long. Priority areas for the household-level flood preparedness (e.g., drinking water, food, emergency go-bag, and snake bite) had been identified in consultation with the participants. As part of the training, various solutions in the context of priority areas were explored. The participants were encouraged to include female hygiene products, special food items for pregnant women and babies, and to identify documents in the go-bag. The participants were also encouraged to identify

short-, medium-, and long-term goals associated with the aforementioned priority areas. This training aimed to enhance a participant's ability to process relevant information and plan accordingly. During the period between the flood preparedness and livelihood diversification training, group meetings were organized in each village once every three weeks. The household visits by village coordinators continued as before.

Through the training on climate-smart livelihood diversification, female participants were encouraged to grow short-duration crops that can be harvested in the pre-monsoon or post-monsoon season, which would help them to manage flood risks. This training focused on the growing of short-duration vegetables (i.e., production practices, sorting, grading, and market linkages) and the preparation of bio-

Improving female financial literacy leads to better management of household income, which is a critical aspect of disaster risk reduction





In the aftermath of a disaster, establishing ones identity is essential in accessing relief and assistance for recovery

char (a fertilizer prepared using organic nutrients and biomass). Some households had also received training to develop a business plan (i.e., mapping of investment and expenditure; income mapping; discussion of risks and uncertainties; and understanding market demand). After the livelihood diversification training, group meetings and household visits by village coordinators continued as before. A Junior Technical Assistant provided support to the participants to grow vegetables on a commercial scale using bio-char.

Impact and uptake

The evaluation of this action research was done using an experimental study design (i.e., case-control and before-after). This was supplemented by household-level monthly monitoring data, which were used to track the progress of the interventions. Among the treatment households, an increase in the number of savings accounts, adoption of target-based savings as a means to address flood risks, and investment in safe drinking water and food storage had been observed.

This action research has been replicated in the Lakhimpur district, Assam, India (in collaboration with Institute of Integrated Resource Management (IIRM) and Swayam Sikshan Prayog (SSP)), and the Hunza and Nagar districts of Gilgit-Baltistan (in collaboration with World Wildlife Fund-Pakistan). Evidence from action research in Gilgit-Baltistan helped to mainstream “migration as an adaptation” in Gilgit-Baltistan’s Climate Change Action Plan. All three action research studies taken together cover 700 women from migrant-sending households.

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Climate and flood-resilient housing

ICIMOD's partner, Bangladesh Centre for Advanced Studies (BCAS), has been conducting research in the Teesta floodplains under HI-AWARE, to understand the specific requirements of those affected by floods every year, especially relating to housing. They are piloting Climate- and Flood-Resilient Housing (CFRH) that entails the raising of earthen foundations, the use of flood-resilient building material for housing, and the provision of homestead gardening, among other options, to test whether it sustains itself as a safe haven for occupants during floods.

This flood-resilient house sits on a raised earthen foundation protected by grass on all sides

The issue

In Bangladesh, which is downstream of three major rivers in the South Asia region, the Ganges, the Brahmaputra and the Meghna, floods hit every year as both flash floods and seasonal long-stay floods which inundate an average of 26,000 km² or 18% of the total area of Bangladesh annually. In the Teesta floodplains, although protected from floods by existing embankments on its right bank, some areas remain waterlogged, and the breaching of embankments during each monsoon has become a regular phenomenon.

The formerly cyclical pattern of floods seems to have been disrupted by the changing climate and anthropogenic activities. This has made communities, especially those living on Char lands (small river islands or sand bars in the middle of rivers and their banks), extremely vulnerable to floods. Communities suffer loss of livelihoods, agricultural produce, and habitation caused by flowing flood waters or inundation.

Kaunia Upazila, located in the northwest district of Rangpur, is a floodplain in the downstream of the Teesta River where Char lands are regularly affected by seasonal floods, riverbank erosion, thunderstorms, drought, heat, and cold waves.



The front face of a flood-resilient house in Bangladesh. One of several ICIMOD pilot houses

It is here that BCAS, along with its partner, C4RE Services Ltd., is conducting action research on Climate- and Flood-Resilient Housing (CFRH) in one cluster each in two villages, namely Char Dhushmara and Char Haibat Kha, which are victims of seasonal floods each year. Accordingly, there is a need to introduce a solution that addresses the loss of habitation and livelihoods that essentially renders people stranded, pushing them back into the depths of poverty.

The selection of the two villages is such that Char Dhushmara is situated on the left bank of the Teesta, while Char Haibat Kha is on the right bank of the river. Both villages are situated a few kilometers apart in the downstream of the Teesta Bridge at Kaunia.

The solution

The CFRHs have the following characteristics.

- Houses have been elevated on raised plinths with facilities for sanitation, safe drinking water, and small household livelihoods of poultry, livestock, and homestead garden.
- The raised earthen foundation has been planted with various grass species and fruit trees to act as natural barrier against soil erosion.
- Improved cooking stove (ICS) and solar panels are additional features to cater to energy needs.
- Skill-development training on homestead gardening, poultry rearing, and handicrafts has been provided as part of implementation.

In a bid to build local capacity, the intervention includes the following.

- Local masons have been given training on building CFRH structures and slope protection.
- Local carpenters have been trained in wood and bamboo preservation to make these building materials of CFRH as well.
- A manual on developing climate- and flood-resilient construction materials and technologies has been developed.

Another remarkable feature and type of the CFRH for this area is the portable wooden house. These houses have been widely used in flood-prone areas of the Ganges floodplains, especially in Shariatpur, Munshiganj, and Faridpur in Bangladesh, for a long time. They normally use *lohakath* (iron wood) (*Xylocarpus*

dolabriformis) as pillar, plain iron sheet painted white as the walls, and corrugated iron sheet for the roof. However, *lohakath* is quite expensive. Therefore, an effort in the HI-AWARE pilot is to try to reduce this cost by using locally-available eucalyptus (*Eucalyptus regnans*) or other low-cost wood seasoned to last long in humid weather. Two such houses are under construction now in Char Haibat Kha. The cost of a normal two-storey 3x6 m² house with locally-available woods may be as low as US\$ 3,000 if local low-cost wood is used.

Impact and uptake

Despite the damages to more than 530,000 low houses and other infrastructure through August 20, 2017, the CFRHs did not face inundation in the floods of July and August 2017. However, minor damage were caused

Dwellings in the region are routinely affected by floodwaters



to the pilot houses. For example, the hedge row plantation at Char Dhushmara cluster was partially damaged due to erosion by flood waters. The homestead garden was also partially damaged at Char Dhushmara cluster due to people from neighboring submerged houses taking shelter there along with their domestic livestock-poultry. Conversely, this can be taken as an indicator of the effectiveness of the pilot, as it was able to support flood-affected people with its ability to shelter them in the event of an emergency. The families living in these CFRH houses have expressed the utmost satisfaction and have appreciated the comfort that these houses afford.

Important indicators also include the demand for the CFRH technology from within the community and outside, along with the development of a market for raw materials and trained labour in the near term. Eventually, upscaling this pilot could bring relief from inundation and livelihood insecurity to the flood-affected residents and provide habitat security, including access to basic amenities, water, and sanitation, even during floods and inundation.

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Cool roofs: a low-income solutions in a warmer climate

Climate change-related heat stress is believed to be one of the greatest threats to human health. Poor people in particular are at high risk of heat-related illness. Heat stress, already a problem in the warm, low-lying Indo-Gangetic plain, is likely to further intensify in the coming decades. Several innovative and traditional building measures have been tested to some extent, but mostly on an individual basis and with solutions targeting the upper and middle classes. What temperature levels people are actually exposed to, both inside and outside of their houses, and whether low-income housing can offer sufficient protection against heat are still open questions.

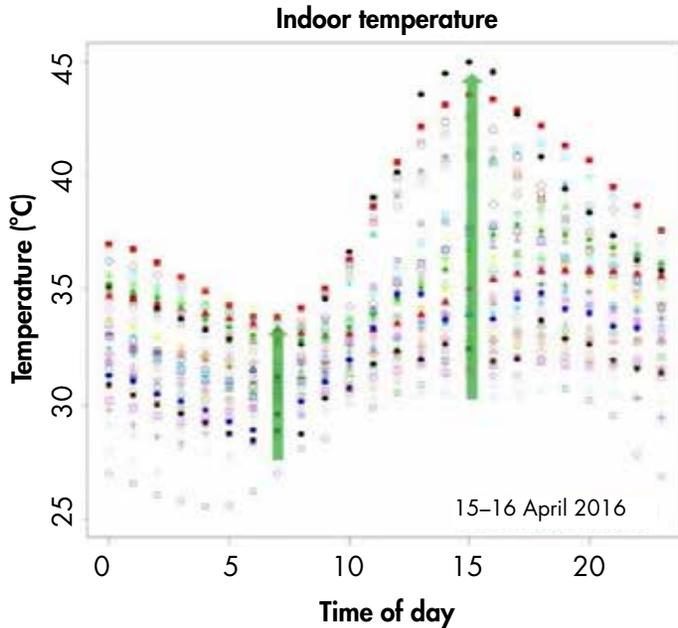
Testing modified roofs as an adaptation measure for indoor heat exposure in low-income neighborhoods

The issue

Temperatures are rising as a consequence of climate change. The heat wave events of 2015 in Pakistan and India showed the catastrophic consequences of extreme temperature on humans, even in regions where one would expect people to be accustomed to heat. The heat wave resulted in the loss of more than 4,000 lives. But the problem is not confined to areas historically considered hot. Extremely high temperatures have been observed in mountainous areas and the need for cooling and cooling devices during the summer season is increasing all over the HKH. In urban areas the heat is exacerbated by the urban fabric; concrete and built-up mass, limited ventilation or vegetation, and many anthropogenic sources of heat make

cities several degrees warmer than the countryside. Options to escape the heat are limited.

The implications of this microenvironment can be substantial. Active-cooling air conditioners can achieve necessary indoor temperature reductions, but they are less accessible to the poor, energy-intensive, and therefore counterproductive to global mitigation efforts – especially in the global south where primary energy demand is skewed toward cheaper non-renewable energy sources. However, certain strategies already exist that help reduce indoor temperatures, like improved building design, using appropriate insulation and both reflective and isolation materials. At a larger level, strategies are based on improving environmental



conditions: street corridors can be designed as ventilation paths; vegetation cools through shade and evapotranspiration; open water brings relief, if refreshed; and water bodies may be used as heat/cold storage facilities. These strategies help achieve temperature reductions or improve thermal comfort in their own way. However, the poor remain vulnerable, not being able to afford active cooling mechanisms and with limited opportunities to install passive cooling mechanisms to cope with the extreme heat.

Most measures that have been tested seem to take the temperature down by one to three degrees, so an integration of approaches is required, including not only combinations of technical solutions, but collaboration with city designers, architects, project developers and, most importantly, local stakeholders. A better understanding of varying heat exposure related to the environment will help design low-cost interventions in resource-poor countries.

The solution

ModRoofs, developed by ReMaterials (<http://re-materials.com>) and promoted by Mahila Housing Sewa Trust (MHT) in Delhi, are

especially designed to replace asbestos/corrugated tin roofs in a low-income setting and are a way of insulating the roof with co-benefits. ModRoof is a modular roofing system for slum and village homes in the developing world. The main component of the roofing system is blue panels that are custom manufactured from packaging and agriculture waste. To address the challenges of operating in the developing world, ReMaterials designed the roofing system to be modular, allowing easy shipment, installation, and replacement of individual panels.

The ModRoofs, which are made from recycled materials and are water-resistant, were especially developed for slum houses and the marginalized, which makes it an interesting and realistic measure to test. Together with MHT TERI, Wageningen Environmental Research and partners will do thorough continuous analysis of indoor temperature reduction to see whether during the day time a 5-6 °C air temperature reduction can be achieved. If so, this would provide further support for outscaling this innovative solution.

The graph shown above depicts the indoor diurnal temperature range across 45 low-income houses in Delhi on 15-16 April 2016. It shows a large variation in both night and daytime temperatures, indicating there is room for improvement using existing techniques.

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Customizing traditional skills

In the Letmaungkwe Hill Tracts of Southern Shan State, Myanmar, bamboo is an important non-timber forest product for local livelihoods and environment. Value chain analysis in Myanmar under ICIMOD's Himalica initiative found that local bamboo producers would get more cash income if they could process bamboo products themselves rather than just selling bamboo culms (stems) to traders. The communities have long had the traditional skills to weave bamboo and make a variety of products for household use (house walls, baskets for grain storage, etc.). Himalica organized practical training and mentoring on value-added bamboo products; the bamboo products are promoted through social media and trade fairs; and the bamboo processors supported to improve their value chain by establishing appropriate linkages with traders and consumers. For sustainability of bamboo stocks, the craft persons are planting bamboo seedlings and harvesting bamboo sustainably. Many community members, especially youth, from other villages have been inspired and now want to take up bamboo enterprise.

Bamboo is a valued local resource

The issue

Low and uncertain income is one of the main factors for low resilience of rural communities in the Hindu Kush Himalaya (HKH). Income diversification through allocation of household resources – natural, labour, capital for non-traditional production, processing, packaging, branding, and other forms of value-addition sustainability is one of the ways to increase income, thereby increasing the resilience of rural communities in the HKH as well.

There is a good market for value-added bamboo products in Myanmar, especially in the Inle Lake region, which is visited by thousands of domestic and foreign tourists each year. Local communities living in the Inle Lake catchment, including the Letmaungkwe Hill Tracts, have not harnessed this bamboo market potential for generating income and gainful employment. The communities make mats and baskets from bamboo for home consumption using traditional skills. Bamboo materials are also used for constructing houses and fences, and for



A man produces colorful bamboo weaves. Building value chains for local products keeps more income in the community

conveying roof rainwater into storage tanks. Raw culms (stems) are sometimes sold to merchants at a low price.

Pantin, Thayetpin, Kyaung Nar, Kyaung Taung, and Zee Yar are remote villages in the Letmaungkwe Hill Tracts of Southern Shan State. A baseline survey in 2014 found that the average annual income of households in these villages was USD 1,055. About 77% of the income was spent on household consumption. Nearly 50% of the households harvest non-timber forest products, including bamboo, for home consumption and minor income. Of the total households, only 0.5% of the households used to get income from handicraft. The bamboo value chain offers a good opportunity to increase the cash income of bamboo producers by operating in the emerging bamboo market.

The solution

Himalica attempted to customize the traditional weaving skills of communities for making products which are in demand. Practical training and mentoring on value-added bamboo products for 100 interested local artisans from the project sites were organised in 2016. By June 2017, 41 community members from Himalica pilot sites were producing various bamboo products like mugs, trays, and others for the market. These artisans were linked to potential buyers, and the products were promoted through Facebook, Trade Fairs, and World Bamboo Day celebrations. The entire process for the bamboo value chain is facilitated by the partner organization, the Myanmar Institute of Integrated Development (MIID).

The conservation and long-term utilization of bamboo resources can only be realized if they are harvested on an ecologically sustainable basis. Hence, the bamboo craft persons are trained on sustainable bamboo propagation and harvesting methods. Moreover, they have planted bamboo seedlings for increasing their bamboo stocks.

Impact and uptake

In September 2017, after one year of training, 41 bamboo product processors, including five women, from six villages have included the bamboo value chain as their new livelihood option. They produced a variety of bamboo items and earned, altogether, about USD 10,000. The number of households and their income from bamboo handicrafts is gradually increasing

(Table 1). While bamboo trays and mugs are very popular, the processors are also receiving orders for other items like beer mugs, clocks, tissue boxes, and stationery container boxes.

Due to the dissemination of the bamboo value chain success story through the media, including social media and trade fairs, many more communities are interested in the bamboo value chain. A demand-based training on bamboo craft was organized in August 2017 for 78 community members from different ethnic groups, mostly youth, from Taunggyi district in Shan. The existence of bamboo in large amounts, the increasing demand for bamboo products, as well as emphasis by the government for the sector in Myanmar, present major opportunities for local bamboo producers and other marketing actors in the Letmaungkwe Hill Tracts.

Increasing demand for bamboo products in Myanmar, like this sweeper, present an income opportunity for mountain communities





Demonstration of bamboo products

Table 1: **Bamboo value chain progress since September 2016 (Himalica project reports, MIID)**

Number of craft persons in March 2017	31	No women craft persons
Number of craft persons in September 2017	41	Five women craft persons
Villages involved in March 2017	5	Pantin, Thayetpin, Kyaung Nar, Kyaung Taung, and Zee Yar
Villages involved in September 2017	6	+ En Pak village
Total earnings in March 2017 (USD)	6,375	= 8,605,100 MMK
Total earnings in June 2017 (USD)	7,704	= 10,589,100 MMK
Total earnings in September 2017 (USD)	10,007	= 13,843,100 MMK
Highest income/person in March 2017 (USD)	887	By U Lin Youn from Kyaung Nar village
Highest income/person in September 2017 (USD)	960	
Minimum income/person in June 2017 (USD)	3.6	Started business in June 2017
Minimum income/person in September 2017 (USD)	11	Started business in June 2017

“ We now earn around 3 times more from value-added bamboo products. In the past, we received only about USD 2 (2500 MMK) per day from bamboo strings. So, we were struggling for our subsistence living requirements in the past. Now, our increased income is used for food, clothing, shelter, repairing motor-bike, fertilizers to use in the farms and giving labor wages etc. ”

Bamboo craftspersons, Himalica pilot, Myanmar

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Flood-resilient sanitation

Floods in north Bihar are a recurring disaster which, on an annual basis, destroy thousands of human lives, apart from livestock and assets worth millions. In addition, Bihar also happens to have a high incidence of open defecation in the country. The practice continues during floods as well despite problems such as lack of privacy, lack of spaces for defecation, erratic timings to be followed, and extreme self-restraint exercised by women on their bodies. Furthermore, in these areas with their high water tables, open defecation increases the risk of fecal contamination of the groundwater, thereby compromising drinking water quality. With flood patterns becoming more irregular due to climate change, the issue of safe sanitation is becoming more complex. ICIMOD and Megh Pyne Abhiyan (MPA) under HI-AWARE are piloting flood-resilient sanitation in Pashchim (West) Champaran district in North Bihar to alleviate the effects of poor sanitation in general, and especially during floods. In addition, the pilot is also creating a space for safe sanitation within the framework of flood-resilient habitat, which also includes safe drinking water, sustainable housing and local flood adaptation measures.

@ Megh Pyne

A facilitator from WaterAction (with hoe) helps to lay the foundation of an eco-san toilet

The issue

When conducting climate change research in mountain environments, it is important to take into account the different impacts and vulnerabilities that affect the upstream and the downstream communities. Water from the hills and mountains of the HKH flows down to the plains as rivers and streams that are important resources for life and livelihood of downstream communities.

The north Bihar region in India is a playfield of eight major rivers – Ghaghra, Gandak, Burhi

Gandak, Bagmati, Kamala, Bhutahi Balan, Kosi and Mahananda - that end up in Ganga making 77% of north Bihar vulnerable to floods. Flooding of these rivers once brought prosperity to the region; but with human interventions (such as construction of embankments) and erratic rainfall patterns, the character and relevance of floods have undergone a massive change.

The purpose of embanking the river is to prevent river water spilling into the countryside and thereby reduce the impact of flood on human, livestock and agriculture. Embanking



Humanure (shown here) is a toilet by-product that safely degrades inside the toilet and does not create groundwater contamination

the river meant dividing the landscape into two prominent sections – riverside and countryside. The former is located between the river and the embankments and the latter is the area “protected” by the embankment. The countryside, apart from being vulnerable to dangerous breaches of the embankment, is particularly affected by water-logging and becoming a source of numerous transmitted diseases. Villages on the riverside are totally ignored and exist as disregarded habitation and thus are extremely vulnerable. The impact of poor sanitation, is pervasive both in countryside and riverside and is not limited by embankments. Therefore, such a scenario requires a solution that takes care of both developmental (health) and adaptation needs.

The solution

By piloting the “Ecological Sanitation” (Eco-San) Toilet or the “Phaydemand Shauchalay” (meaning beneficial/productive toilet), as it is locally known, the attempt is to address the sanitation problem during floods in the area. The intervention is being piloted through MPA in Naya Tola Bhishambharpur (NTB), a village located in Bhagwanpur panchayat (village council) in Nautan Block of Pashchim Champaran district of Bihar.

The Eco-San toilet/Phaydemand Shauchalay is an innovative, self-sustaining sanitation unit that can work without plumbing and drainage facilities. Further, it:

- is flood-resilient and odorless,



A phyademand shauchalay (beneficial toilet) as seen at a home in Bihar, India

- is a double-chambered toilet that converts human waste to “humanure”, which is used as fertilizer in agricultural fields and kitchen gardens,
- collects urine separately, which can be used as a substitute for Urea in the crop fields or vegetable gardens after mixing with water in the ratio of 1:7 (litres),
- does not require flushing and hence saves water,
- collects waste above the ground and so prevents groundwater contamination, and
- provides the community, especially women, girls, and the elderly, a secure and clean enclosure for defecation even during floods.

Impact and uptake

The pilot has already received recognition from the state’s poverty alleviation and rural livelihoods program, JEEViKA, which has given financial support directly to women beneficiaries for constructing Phaydemand Shauchalay, in the form of SHAN (Sanitation, Health and Nutrition) fund. A 2016 study also indicates the cost effectiveness of the Eco-San toilet by providing benefits in the form of reduced health costs and avoiding expenditure on chemical fertilizers. It states that, for example, a six-member household would see an annual benefit of approximately INR 5,123 (around USD 80). Upscaling this pilot could vastly improve health and hygiene outcomes in the state and other flood-prone areas in the Hindu Kush Himalaya (HKH).

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Mobile messaging: extension service in remote areas

With an increasing number of mobile users among mountain communities, sending messages through mobiles has become one of the most efficient tools to provide information to people living in remote areas. The Resilient Mountain Village pilot adopted this approach to share information on weather (weather forecasting), market price, and agriculture advisories with the farmers in the pilot sites. RMV has been sending messages to lead farmers directly, and the messages are further shared by the recipients with other households in their neighborhoods.

ICTs like mobile phones hold immense potential to share real-time information about markets and agriculture, which can give farmers a competitive edge

The issue

The agricultural extension services in the mid-hills of Nepal are not only hindered by limited resources and scarcity of trained frontline staff at the district level but also by remoteness of the villages. Many villages in the mid-hills remain inaccessible, particularly in the monsoon season due to poor road network. In such villages farmers find it extremely difficult to access information about agricultural advisories as well as market prices and depend mainly on word of mouth. However, by the time information reaches them, it is generally too late.

The major technology dissemination approach adopted so far in Nepal has been the traditional direct interaction and field-level practical demonstration at the community level. Along with the traditional dissemination tools like national radio as well as local FM radios, televisions are also being used for extension services. Establishment of call centers, provision of toll free numbers at DADO's offices, SMS, and Apps are just being introduced and the modern smartphone-based Information and Communication Technology (ICT) is being started as a pilot intervention by various projects.



Mobile messaging helps women make more informed decisions about agriculture

The solution

The Center for Environmental and Agricultural Policy Research, Extension and Development (CEAPRED), in partnership with ICIMOD, has been piloting the mobile-based SMS initiative in Resilient Mountain Villages (RMV) pilot sites covering eight villages in four municipalities of Kavrepalanchowk district since 2014. The SMS provides weather information to over a thousand farmers so they can prepare to address adverse weather conditions, provides market price information to increase the bargaining power of farmers, and provides crop advisory services to help them adopt improved technologies to increase production.

A website is used for mass dissemination of the SMS through mobile. The mobile numbers of the lead farmers selected by the respective

communities are registered on the website and the required number of SMS is purchased from Nepal Telecom in advance. The messages are developed at the CEAPRED office by professional staff after collating the weather information from World Weather web, market information on vegetable crops collected from the local market and/or the AEC/FNCCI website, and technical messages on relevant topics for the particular crops and season developed by the concerned CEAPRED staff, and they are then sent to 200 farmers at eight sites. These messages are sent on Sunday, Wednesday, and Friday. Each farmer receiving the message shares it with four to seven of their immediate neighbors. The text messages are composed in the Nepali language so that even barely-literate farmers can read and understand the messages.

The mobile SMS is probably the most cost-effective tool of extension service to reach a large number of farmers at one time. In Nepal, a one-time SMS per person costs about NPR 1.8; at the same time, it has been established that a farmer increased income by NPR 20,000 compared to previous practice because of the advisory service through SMS.

Impact and uptake

The mobile-based SMS is one of the tested technologies in RMV pilots. The SMS has enhanced the decision-making capacity of farmers in the RMV pilot sites. Weather forecasting messages have enabled farmers to make the right decision in, say, crop harvesting; they would not harvest if the message is about the occurrence of rainfall in next day or so. Market price information has helped farmers

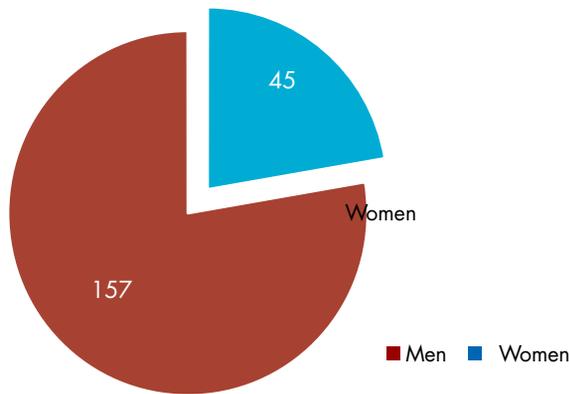
with price determination. In 2016, for example, the price trend in potatoes showed an abrupt increase from Rs. 20 to Rs. 25 within a period of one week at the wholesale market. This information on mobile SMS helped farmers to fetch a better price for their crop. Similarly, critical technical messages received through SMS motivated farmers to practice climate-adaptive safe food production technologies, and they are now able to increase the production with reduced costs.

CEAPRED and ICIMOD have been collaborating with the Government of Nepal, particularly with the MoAD (Ministry of Agricultural Development) since the beginning of the RMV project. The vice president and executive officers in the National Planning Commission have visited and appreciated the initiative. The Government of Nepal has initiated pilots on ICT through

A women's group in Kavre



Percentage of women farmers as lead farmer receiving SMS on mobile phones



On 22 April, SMS message on my mobile read like “there is a possibility of high wind and rain tomorrow in the area, so plan your agricultural activity accordingly”. Though, it was quite good sunshine on the message day and difficult to believe, yet the message spread within the community and people avoided harvesting activity on the predicted day. On the predicted day of forecast, there was a gush of wind and rain, and the SMS message saved us a lot.

– **Nirmala**, Mahadevsthan, Kavre

AMIS (Agriculture Management and Information system), for which the MoAD and NTC (Nepal Telecom) signed a MOU in 2015. Farmers are provided with technical messages and weather information.

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Mobilizing women as leaders

In 2014, under ICIMOD's HICAP initiative, an action research was implemented in Kavre and Sindhuli districts of the Koshi river basin in Nepal to test the hypothesis that a participatory approach to building adaptive capacity, specifically engaging women as leaders, is indeed effective in improving a community's ability to prepare for an uncertain climate future. The main output of the research was an action plan developed by the two communities with clear strategies to help improve their adaptive capacity. The earthquake in April 2015 put the research to test in different conditions than anticipated. While the participant communities faced severe losses, they were better prepared to respond to the earthquake. Being aware of which local institutions and officials to approach for support enabled them to effectively seek support for relief.

Having women participate in action research is an effective way to build leadership skills

The issue

Climate change has ushered in unprecedented fluctuations in temperature and precipitation, and nowhere is this more evident than in the Himalayan region. To decrease vulnerability to future climate hazards it is important to address social and political inequality as well as skills and knowledge deficits in the affected communities. Based on this understanding, an action research was initiated to identify the socio-cultural and institutional dynamics that shape gendered capacities to adapt to climate change within communities. The aim of the research was to equip communities, and particularly women,

with the skills to flexibly adapt to any changes they may face, and in this way enable them to respond to the multiple challenges posed by the rapidly changing socioeconomic and environmental situation in the region.

The key element of the action research is the process which involves the community to (a) identify the key elements of adaptive capacity as a community (important skills and the resources they need to adapt to change); (b) assess their own adaptive capacity (against the identified skills and resource needed for adaptive capacity in the community); (c) identify the reasons for good or bad performance against the skills



Women provide the force behind agriculture in the mid-hills of Nepal

and resources gaps; and (d) develop an action plan to improve capacities. The premise of the action research is that if a community follows this process, they will be better prepared to adapt to any change compared with interventions that focus on technical inputs on “what and how to do” things to adjust to the change.

The solution

The project trained women leaders from two communities on conducting needs assessments and identifying the skills needed for increasing adaptive capacity in their respective communities. The initial indicators of adaptive capacity were sourced from several studies investigating the determinants of vulnerability and resilience. These were narrowed down to include skills or traits that can be cultivated at the community level and further reaffirmed

through focused group discussions with the community. The nine indicators that were used in the study were: Leadership, Unity, Vision, Knowledge Sharing, Environmental Awareness, Agency, Learning from the Past, Agents of Change, and Monitoring Change.

For each indicator, participants were asked to decide on two important attributes that could serve as benchmarks for assessing the level of a community’s current capacity vis-à-vis each indicator. The performance of the community against each indicator was assessed in gender-segregated groups. Comparing each group’s assessments allowed the women and men to discuss the disparities between the two groups’ scoring. This led to the collective recognition of the impact of traditional gender roles, social norms, and power differentials in impacting the capacity of each group to adapt to changes.

The preliminary analysis from the focus group discussions and survey data was shared and discussed with the community, following which the women leaders worked with key community members, the village development committee (VDC) or municipality development committee (MDC) to develop a community-level action plan addressing the weaknesses noted through data collection.

The key outcome expected from the action research was the improved understanding of factors that enable or obstruct adaptive capacity in the community, especially among women. A key indicator of this outcome was the development and implementation of the action plan without any monitoring or direct support from ICIMOD or partner agency. The action plans reflected activities addressed to overcome the key gaps assessed by the communities during the preliminary research.

Impact and uptake

About 200 men and women (from 200 households) were reached directly through the activities of the research study in two villages in the Kavre and Sindhuli districts of Nepal, and about 800 women benefited indirectly through the capacity-building of the women's group and cooperatives in these villages.

Action plans created in the two districts recorded targets to be reached within three months and one year, respectively. The women leaders were to independently lead action on goals marked for three-month completion. Following the three-month evaluation, several things were noted as directly resulting from the action plans: (a) creation of an Environment Committee in both villages; (b) sharing of the action plans with local line agencies; and (c) mobilization of financial resources from local agencies for village development activities.

Women are trained as project leaders to conduct needs assessments and prepare action plans





As women take on more responsibility in local communities, leadership training and capacity building are essential

Relationship brokering with the various departments and municipal offices has created a better sense of connection between the local community and local bureaucracy. In interviews with the women leaders after the April 2015 earthquake, many agreed that these relationships helped to expedite government-controlled aid money for the relief effort. The women leaders also mentioned that having awareness of the services each office provides was crucial in the immediate aftermath of the disaster. Following the earthquake, the communities revised their micro-plans in view of the new situation, and used their skills to develop comprehensive plans for recovering from their earthquake losses, while still building their capacity to adapt to future changes and challenges.

The action research resulted in learning about the importance of leadership training, setting up formal associations to address environmental issues, and establishing communications with

local line agencies. Having these things in place, even after just three months, had a large impact on the ability of community members to have their voices heard in the chaos of the earthquake relief effort. According to participants, awareness around the importance of engaging both genders has increased and has impacted the traditional way that communities communicate with government and other outside groups.

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Sanitation and waste management for responsible heritage tourism

The Kailash Sacred Landscape attracts an increasing number of visitors, resulting in accelerated sanitation and waste pollution. Indiscriminate open defecation and increasing waste in the landscape pose serious environmental risks in sustaining ecosystems services apart from the direct impact on the health and wellbeing of local populations (man and animal). The Kailash Sacred Landscape Conservation and Development Initiative (KSLCDI) applied a community-led total sanitation (CLTS) and waste management approach to address sanitation and waste problems in Pulan County, TAR, PR China, the abode of Mt. Kailash and Lake Mansarovar. The approach focused on motivating behavioural change and promoted collective actions by county, township, and village representatives in managing this common problem. Sanitation and waste management have been integrated as an essential component of the Pulan local government's 13th Five-Year Plan, in the Pulan County Tourism Development masterplan, as well as in the village rules of Huor and Baga townships.

Sacred sites are growing in popularity as tourist destinations. Proper sanitation and appropriate infrastructure will be key to sustainable development of these areas

The issue

The Kailash Sacred Landscape represents an area approximately 31,175 km² across the southwestern portion of the Tibet Autonomous Region (TAR) in China, parts of northwestern Nepal, and northern India. Mount Kailash and Lake Manasarovar are highly revered as sacred places of worship by four major religions (Buddhism, Hinduism, Jainism, and pre-Buddhist animistic Bon), and thousands of people come

for pilgrimage every year. It is also a headwater source of four major rivers of Asia (Sutlej, Karnali, Brahmaputra, and Indus), providing direct lifelines and essential transboundary ecosystem goods and services locally, as well as further downstream to large parts of Asia and the Indian subcontinent.

Fresh water, biodiversity, food, forest, rangelands, wetlands, medicinal products, and energy are among the numerous goods



Sacred sites, like this one near Mt. Kailash, face increasing pressures to address the challenge of handling waste from tourism

and services provided by the Kailash Sacred Landscape ecosystems. Maintaining these services is crucial to contributing to the SDG targets that each country has set, apart from the fact that consistent mountain ecosystem services are key to building the resilience of communities in the Landscape. However, these services are under threat from improper waste management and open defecation from the increasing number of visitors to the Landscape. Hygiene, proper sanitation, and clean surroundings are essential for human and environmental health. They are also indispensable to attracting tourism for local livelihood co-benefits and to ensure food and nutrition security, a fundamental building block in developing resilience.

Unfortunately, lack of awareness on the part of government representatives, the local

population, tour operators, and visitors about the importance of cleanliness and maintenance of toilets had led to polluting of the Landscape. Open defecation goes on without restrictions. In addition, traditional and religious practices, lack of waste management infrastructure, and overlapping or missing responsibilities in the administration and among stakeholders contribute to inadequate toilet facilities, waste disposal, and recycling mechanisms. This not only threatens the highly sensitive environment but also undermines the very sacredness of Mount Kailash and Lake Manasarovar.

The solution

As a part of responsible heritage tourism, the Kailash Sacred Landscape Conservation and Development Initiative supported an

“open defecation-free and waste-free Kailash campaign” in Pulan county, TAR, PR China. The Pulan county is an area of 10,843 km² where Mt. Kailash and Lake Manasarover are located. It is inhabited by 10,000 people, with annual visitors ranging from 40,000 to 100,000. In a typical auspicious year, nearly a million people visit the Landscape.

The community-led total sanitation (CLTS) and waste management approach was applied. The CLTS approach focused on behavioral change by triggering the community’s desire for collective change to attain open defecation-free and waste-free villages. The approach propelled people into action and encouraged innovation, mutual support, and appropriate local solutions that led to greater ownership and sustainability.

A series of motivational and sensitization events included a training of trainers and mentorship trips of local leaders to Mainland China and the European Alps to experience directly best practices in sanitation and waste management. These efforts served as a catalyst for an increased understanding of the issues and provided motivation to the key decision makers on the need for focussed action on sanitation and waste. Rigorous training and mentorship programmes resulted in the building of increased capacity of local government officials and community members to better understand the connection between hygiene, sanitation, and health. It motivated the local leaders to frame rules and regulations regarding sanitation at the village, township, and community level. It promoted construction of low-cost sanitation facilities and at least one toilet per seven families was made the norm in every township. Strong ownership by the Pulan local government was manifested by integrating support for toilet and sanitation into their 13th Five-Year local development plan. The local government further

initiated leveraging funds for sanitation from the private sector, including the Tibet Tourism Co. Ltd. Ali Branch. Communities also initiated “toilet guards” to restrict open defecation and provide a strong in-house monitoring system.

The community-led approach to sanitation and waste management was crucial for the engagement of various stakeholders to achieve a collective effort in reducing environmental pollution. The inclusion of sanitation and waste management in the local development plan assured the sustainability of the initiative. Public-private partnership on waste management linked to employment and income of local people further contributes to sustainable waste management. The interventions addressed the dual objectives of better environmental management and poverty reduction that are key elements of resilience building for communities in the Landscape. However, this effort was preceded by sensitization training on responsible tourism (2013) for the key tour operators of China, India, and Nepal that emphasized the necessity of behaving responsibly in the core landscape. The use of responsible tourism guidelines is accordingly used by some key tour operators at Mt. Kailash.

Impact and uptake

The waste management initiative made significant progress, with a reduction in waste from 685 kg in 2013 to 58 kg in 2017 (Fig. 1). The initiative motivated local governments in setting up more than 22 garbage disposal sites and 120 waste bins in critical areas. Stringent rules were formulated for the disposal of waste at designated places by households, visitors, and businesses. Awareness and information signage on waste regulations were prepared in Tibetan, Chinese, and English in the Landscape. Provision of free garbage bags to tourists has motivated



Hundreds of thousands of people visit the Kailash Sacred Landscape each year to visit important religious sites

visitors to bring back their waste. Partnerships with the private sector, including Tibet Tourism Co. Ltd. Ali Branch, have led to the establishment of a small-scale waste-handling company at Gangsa, Baga Township, the main township at the base of Mt. Kailash. The company provided employment to socially disadvantaged members of the communities in the collection and segregation of waste. Some waste, especially metals and glass bottles, was segregated for further processing and recycling away from the Landscape.

The Pulan local government invests RMB 670,000 per year for waste treatment. In addition, private companies such as Tibet

Tourism Co. Ltd. Ali Branch and Beijing Apple Charity Foundation provide around RMB 200,000 for waste management purposes to the residents of Gangsa village. Mass cleaning campaigns around the major pilgrimage route and township involving students, doctors, nurses in the hospitals, party members, and soldiers resulted in improved awareness and response to waste management. Members of Gangsa village now undertake frequent waste management activities around the pilgrimage route, contributing to sound ecosystem and human health.

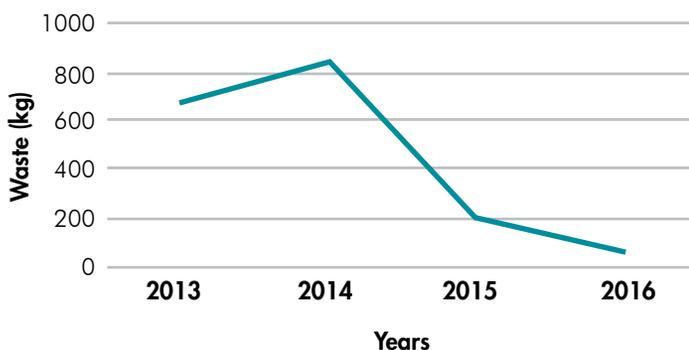
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Figure 1: **Quantity of waste at Mt. Kailash from 2013-2016**





Solar pumping irrigation system

Traditionally, in the absence or paucity of rain, farmers in some parts of the hills and mountain areas of the HKH have used dug wells for drawing water with the help of Persian wheels driven by animals. But these means are on the wane since they have become unpopular amongst the younger generation because of the hard labour and time required. Using conventional fuel/electricity-driven pumps to pump water for irrigation from rivers/streams can accrue high energy and monetary costs. Solar energy offers a more economically feasible and environmentally friendly alternative. HI-AWARE's pilot intervention primarily entails the use of Fixed and Portable Solar Pumps to enable on-farm use of drip irrigation, micro sprinklers, and dug wells.

A sprinkler gun is used to irrigate crops

The issue

Making agriculture flourish in the mountains and hilly tracts is replete with challenges. Common features that mark this geography are undulating terrain and small landholdings of farmers, among others. Rainfall can be erratic and has become more so with the changing climate. Extreme weather events can render on-farm water courses futile. The lack of irrigation planning, heavy dependence on rain, and the difficulty in accessing markets are major hurdles in the lives of farming communities in the hills. It is ironic that the mountain landscape that births many rivers and springs can present irrigation problems to its agrarian communities. This points to the problems stemming from lack of effective use of available water.

The rain-fed Soan River Basin in Punjab's Potohar region, which lies in the midstream of the Indus River Basin, is one such area where agriculture is heavily dependent on rainfall and ground water resources. The above-mentioned characteristics, combined with the mono-cropping form of agriculture, make this region extremely vulnerable to climate change impacts that can wipe out an entire season's produce.

The solution

To address water management and improve farm livelihoods' resilience against climate impacts, the Pakistan Agriculture Research Council (PARC), under the HI-AWARE initiative, is piloting Solar Pumping Irrigation Systems coupled with Climate-Smart Agriculture Packages in Chakri, Rawalpindi



Dug wells have a new lease of life thanks to solar-powered pumps that help draw water

in Punjab, Pakistan. This village falls in the Soan River Basin. The pilot is being implemented through the conversion of a single farm into a learning and training centre for other farmers and researchers, students, and professionals in the region. The pilot can thus be categorized as a “Developmental On-Farm Research Pilot” (DOFRP).

Typically, groundwater pumping relies on diesel driven pumps, which impose high costs on the farmers while negatively impacting the environment through emissions. On the other hand, solar energy offers a more economically feasible and environmentally friendly alternative. HI-AWARE’s pilot intervention primarily entails the use of Fixed and Portable Solar Pumps to enable on-farm use of drip irrigation, micro sprinklers, and dug wells.

An important and emergent feature of water availability for farming in the hills has been the effect on the recharge of dug wells that are

dependent on groundwater availability. The latter is in turn impacted by the erratic rainfall pattern and varying lengths of dry spells. This can mean low water availability when the crop requirement for it is high. These factors make the use of traditional irrigation methods such as flooding unviable. The solar pumps, therefore, have been designed with careful consideration of the rate of discharge, total available head, sunshine hours, and potential evapotranspiration, among other factors, so that farmers have access to water throughout the year.

The solar pumps also entail low operational costs once installed, as compared to the conventional fuel-driven pumps or animal-driven Persian wheels. Better water management has also allowed for agricultural diversification and production of off-season crops, which furthers the intent and aim of the pilot. Other components include a solar geyser for water heating, on-farm solar electrification, and an energy-efficient stove

for cooking purposes. Both fixed and portable solar pumps enable high-efficiency irrigation systems and are part of a package of practices that help farmers improve farm productivity.

Impact and uptake

The major indicator of impact is the adoption of these technologies and practices by other farmers, and consequently, the positive changes in baseline variables such as farm production, marketable surplus, on-farm water availability, soil nutrients, and crop diversity. It also envisages reduction in the use of chemical fertilizers and a reduction in post-harvest losses. Another indicator of success is the number of requests received for replication or technical assistance in activities concerning this Food–Energy–Water nexus.

The pilot has already received widespread attention and appreciation from government officials, researchers, and community members who are interested in adapting the pilot to suit their respective local settings. It will also help reduce the drudgery of women who can access water with much more ease thanks to the pilot intervention. Testimonials and evidence from different villages indicate exciting opportunities for out-scaling of this model to other areas.

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Drip irrigation is encouraged at a pilot site in Pakistan to utilise the limited amount of water available to farmers







Improving Governance and Services



Agriculture drought monitoring system

The key feature of the solution is to integrate satellite remote sensing into an operational agricultural monitoring system in Nepal that allows crop analysts to track the development of the growing season and provide actionable information to decision makers for developing effective agricultural policies and a timely response to food shortfalls.

Pippa Bradford of the World Food Programme, Nepal, explains the use of drought monitoring for food assistance planning

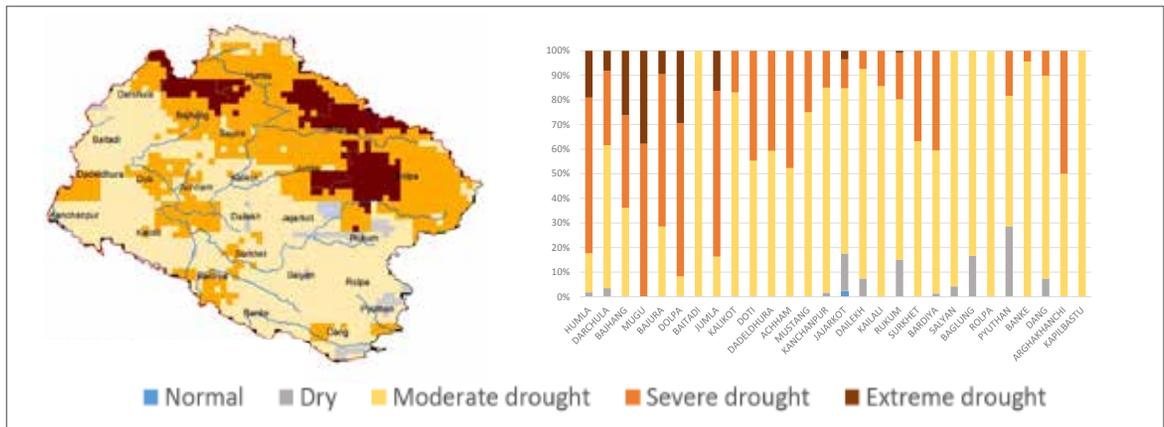
The issue

In Nepal, two-thirds of the total population depend on agriculture for their livelihoods, and more than one-third of Gross Domestic Product (GDP) comes from the agriculture sector. However, agriculture production across the country continues to be challenged by various factors, such as a high degree of spatial and temporal climate variability, dominance of rain-fed agriculture systems, farmers' fragile economic conditions, and traditional mountain practices. Under the influence of climate change, weather or climate conditions become uncertain (in both timing and intensity) and as a result farmers and institutions are unable to adapt, causing bottlenecks in crop productivity and resulting in livelihood vulnerability.

Provisioning of easily accessible, timely, and decision-relevant information on seasonal climate and crop growth conditions is helping national agencies in making effective contributions to cope with climate variability and limit the economic and social damage.

The solution

ICIMOD, through its SERVIR-Himalaya initiative, and in collaboration with the World Food Programme and the Ministry of Agricultural Development (MoAD), Nepal has established a comprehensive agriculture drought monitoring system. This system analyzes historical climate and crop conditions patterns captured through near-real-time earth observation data, and compares



The Standardized Precipitation Index (SPI) for winter (November, December, and January) in Western Nepal shows ‘extreme’ drought conditions in parts of nine districts, mostly in Mugu, Dolpa, Humla, Jumla, Bajura, and Bajhang. ‘Severe’ drought conditions are found in parts of many districts in the mid-western and far-western regions

this with the current growing season to provide a timely assessment of crop growth conditions.

Using remote sensing data for vegetation indices, temperature, and rainfall, the system generates anomaly maps that are inferred to predict the increase or shortfall in production. Through a user-friendly application, comparisons can be made both spatially and in graphs and figures at district and Village Development Committee (VDC) levels. Timely information on possible anomalies in crop production is later used by institutions like the Ministry of Agricultural Development, Government of Nepal, and the World Food Programme, Nepal to trigger an appropriate management response.

The World Food Programme is using drought analyses to understand the drought onset and severity patterns across the region. Particularly in the case of extreme events (floods/droughts), they are using these products as evidence-based communications to inform the donor community to mobilize relief work and highest-level governmental decision makers in Nepal on the issue.

The system is providing key inputs in the biannual crop status assessment on a regular basis, which feeds into food security-related

decisions. Future potential includes integrating data on agricultural inputs, socioeconomics, demographics, and transportation to holistically assess food security in the region.

Impact and uptake

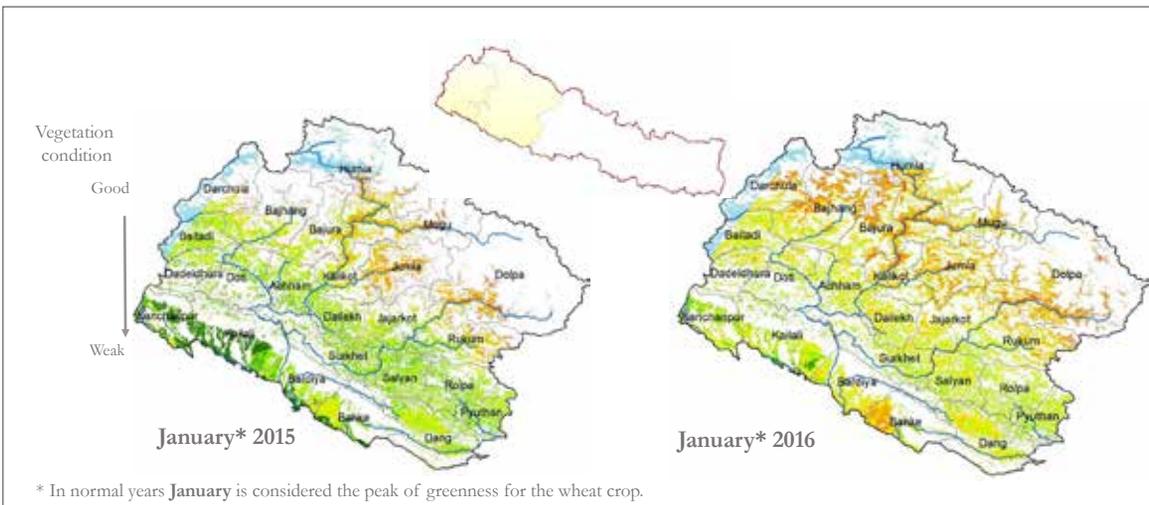
The impact evaluation was conducted by Management Systems International (MSI). In their assessment, Earth observation satellite data and analysis from the agriculture drought monitoring system were used to help target drought areas, directing distribution of \$1M worth of food aid to the areas most in need.

Building from the existing agriculture drought monitoring system, the Pilot Programme for Climate Resilience (PPRC) of the Ministry of Agricultural Development is integrating Earth observation-based data products in the agriculture advisory system being established at Nepal Agricultural Research Council (NARC).

Based on the successful demonstration in Nepal, there are ongoing efforts for enhancing agriculture drought-monitoring systems by integrating Earth observation at the relevant meteorology and agriculture institutions in Afghanistan, Bangladesh, and Pakistan.



People in mid-and far western Nepal face greater water scarcity than the rest of the country



* In normal years January is considered the peak of greenness for the wheat crop.

Weak vegetation conditions in 2016 were more severe and affected a much larger area compared to 2015, according to MODIS (MOD13Q1) NVDI data



<http://apps.geoportal.icimod.org/>

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“The World Food Programme is using earth observation data supported analyses to understand the drought onset and severity patterns across the region. These products are also being used as evidence-based communication to inform the highest level governmental decision makers in Nepal on the issue.”

Kurt Burja, Head VAM Unit, WFP-Nepal



Climate-resilient forest management system

Forest ecosystems in Nepal are experiencing high levels of degradation and facing impacts of climate change that call for urgent adaptation planning and implementation. We conducted this study in Nepal, where we looked at impacts of climate change using past and future climate datasets and the impacts of degradation by using data on demand and supply of forest resources. The study provides “adaptation footprints”, which are areas with varying degrees of adaptation priorities. We also identify a set of regionally-identified and locally-suited climate-resilient solutions and aim to integrate our findings and solutions in the District Forest Management and Operational Plans for different districts falling within the study areas.

In developing countries, many people rely on fuelwood for meeting basic energy needs

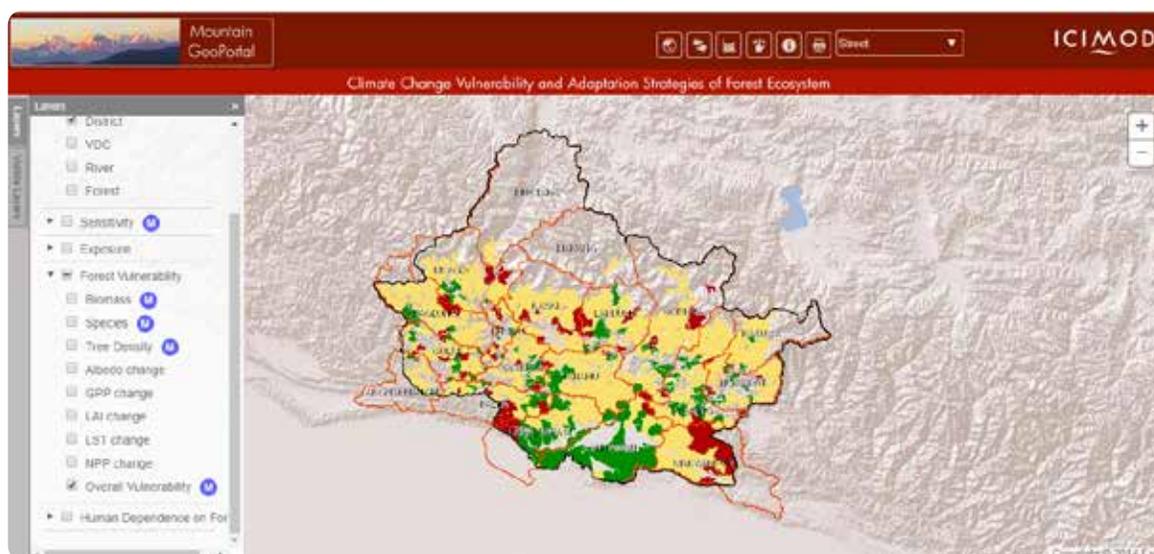
The issue

In the Hindu Kush Himalaya (HKH), forests play a vital role in confronting the challenges of climate change and livelihood options for a growing population. In view of the increasing levels of forest degradation and deforestation rates, the reliable, effective planning and management of forests is crucial. But there is less precise information available in the region on forest degradation, as well as the impacts of climate change on these ecosystems, particularly the detailed information required for district-level planning. Ground-based information about the vulnerable systems and the stressors they are

exposed to, as well as the transfer of resources to vulnerable societies in order to help them to prepare to cope with the inevitable impacts of climate change, are necessary elements of a comprehensive climate policy.

The solution

The current solution uses geospatial tools and techniques. The geospatial framework of the solution oversees the possibility of interaction of different themes as in the format of GIS layers, such as forest cover and changes, the carbon stock of the forest, climatic trends, over the past, socio-economic status of surrounding villages,



population density, and the patterns of resource utilization. A multi-tier approach to vulnerability assessment and adaptation planning is adopted that can support the effective identification of “adaptation footprints”, or the areas requiring the urgent implementation of adaptation options and forest management.

While the quantification of vulnerability and dependence of local communities on these ecosystems follows a “top-down approach”, a “bottom-up” approach is followed to integrate more field-based inputs on assessing the suitability of the adaptation options. The outputs, such as “adaptation footprints” (viz., those forest areas requiring immediate attention due to excessive resource exploitation and which are sensitive to climate change) will help decision makers in pinpointing the locations and enhancing the planning and management.

Impact and uptake

The solution is being developed in close collaboration with Department of Forests, Government of Nepal, and is expected to enhance the planning and management of forests by prioritizing the management and

adaptation decisions based on the outputs of this solution. The products of this solution are intended to be integrated with the District Forest Management and Operational Plans, which are revised regularly at five-year intervals.

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Community-based flood early warning system

In the HKH region, floods and flash floods are the most common hazards, and account for most of the lives lost and damage to property every year. The Community-Based Flood Early Warning System (CBFEWS) is an integrated system of tools and plans, in which upstream communities, upon detecting a flood risk, disseminate the information to vulnerable downstream communities for preparedness and response using local resources and capacities. The project's impact in the field was acknowledged by UNFCCC's Momentum for Change 2014 Lighthouse Activity Award as a shining example of an innovative use of ICT.

CBFEWS preparedness training on the Gagan Khola, Nepal

The issue

The Hindu Kush Himalaya (HKH), with its fragile mountains, unique geology, steep terrain, intense seasonal precipitation, and high seismicity, is one of the most highly vulnerable regions to floods and flash floods. Many mountain and downstream settlements are located on slopes and fluvial fans of rivers that are susceptible to debris flows and water floods. In recent years, frequent flood disasters have adversely impacted lives and livelihoods, agriculture productivity, and property due to increasingly erratic and unpredictable rainfall patterns exacerbated by extreme climate variability.

Though early warning systems have been developed to provide flood information, there are gaps – identified by the Hyogo Protocol and the United Nations Forum Convention on Climate Change (UNFCCC) Special Report on Extreme Events and Disasters (2012) - in getting this information to communities that are most vulnerable so that lives and livelihoods can be saved. The community-based flood early warning system provides real-time warning to the communities so they can be prepared for the coming flood. The extra time given to the communities before the flood occurs, and the preparedness trainings, help them in building their resilience to flood disaster.



A CBFEWS data uploading unit in Bhitamora, Bihar, India

The solution

CBFEWS is an integrated system of tools and plans managed by communities that is capable of providing real-time flood early warnings to reduce flood risks. It is based on people-centered, timely, simple, and low-cost technology in which upstream communities, upon detecting a flood risk, disseminate the information to vulnerable local communities downstream for preparedness and response to save lives and livelihoods. There are four steps in the early warning system – risk knowledge and scoping, community-based monitoring and early warning, networking and dissemination of information, and preparedness and capacity building.

The early warning instrument comprises either a wireless or ultrasonic-based solar powered data uploading and data acquisition unit, which sends SMS to disseminate the flood early warning to the vulnerable communities downstream. The ultrasonic sensor is used for depth measurement, Zigbee (an IEEE 802.15.4-based specification for a suite of high-level communication protocols) for data transfer within the local instrument network, and a GSM (Global System for Mobile Communications) module for uploading data to the cloud (unified object storage for developers and enterprises). The raw data is processed by the server, and the warning message is generated to trigger the alarm units. Fluctuations in water level could also be monitored by a wider audience using internet webpages.



CBFEWS data acquisition unit in Bhitamore, Bihar, India



CBFEWS preparedness training on the Gagan Khola, Nepal

Most recently, the technology has been improved using a telemetry system and it is now able to provide up to eight hours of early warning to the vulnerable communities across the border of Nepal and India to prepare for the inundation, saving untold lives and property in the wake of this disaster.

Impact and uptake

ICIMOD piloted the CBFEWS in Assam, India in 2012, under the Himalayan Climate Change Adaptation Programme (HICAP). During the flood season of 2013, the system installed in the Jiadhhal River, Assam successfully informed community members in Dihiri of pending floods, helping them save assets, including cattle and pigs, worth approximately USD 3,300. A District Disaster Management Authority (DDMA) official from Dhemaji District shared that the flood warning information provided by the system helped the district administration. He writes, *“The information from the community-based early warning system was extremely helpful because it is based on more realistic rises in river water and is more area-specific. We deployed our flood rescue team many times based on the system’s information. After receiving a warning on 5 September 2013, we deployed a national disaster response force to the affected downstream areas of the Jiadhhal River, which helped the district administration prevent a disaster situation.”*

“My fellow villagers like me because I am the source of all the information. I feel important now and panchayat also listens to me.”

Mrs Hoonmoni Doley, Caretaker, Dihiri

The project’s impact in the field was acknowledged by UNFCCC’s Momentum for Change 2014 Lighthouse Activity Award as a shining example of the innovative use of ICT.

From 2015 onwards, CBFEWS has been outscaled in India and Nepal under the Koshi Basin Initiative; in Pakistan under the Indus Basin Initiative; and in Afghanistan under a special project.

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Community-owned pond in Nepal

Inclusive planning for local scale water management

Communities in the HKH have to deal with numerous water management issues to ensure adequate water year-round for domestic, livelihood, and other purposes. The decision on how much water is available, distributed, and used is often made at the district or national level. These decision making process often lack the necessary local, context-specific knowledge, resulting in informal local-level management that is prone to leaving out marginalized individuals from the decision-making process. Local Water Use Master Plans (WUMPs) prepared through an inclusive and participatory process aim to improve access to, and equitable distribution of, water among community members, giving special emphasis to the marginalized, such as women and the poor.

The issue

Like other river basins in the HKH, the Koshi River Basin (KRB) has been undergoing noticeable socioeconomic and bio-physical changes over the past few decades. Rapid changes in demographics and urbanization, changes in land use and agricultural practices, including introduction of water-intensive crops, and the increased workload of women in agriculture are becoming common. These changes are in addition to the climate change-induced variability in water availability and increase in disaster events, impacting the livelihoods of the people. Furthermore, there is evidence of conflicting interests of upstream and

downstream communities for the conservation and use of limited water resources. All these issues directly or indirectly impact the food, water and energy securities in the basin.

The water use in the basin usually does not envision future scarcity situations. The impacts from water insecurity and water-induced disasters are more detrimental to women and the poor, as these groups are more closely linked with water-based livelihoods and have limited adaptation options with which to address these challenges. Conflicts within and between villages can arise as the water demand increases, while in many places, water availability is decreasing. Access to a reliable and sufficient water supply for both



Year-round irrigation is crucial to food security in mid-hills of Nepal

productive and domestic uses will be critical for achieving food security, economic development, and improved rural livelihoods in the KRB.

The solution

ICIMOD's Koshi Basin Programme and HELVETAS Swiss Intercooperation Nepal have supported the development of local Water Use Master Plans (WUMPs) in partnership with local communities, local civil society, and local government in selected villages in the three districts of Koshi basin, Nepal: Sindhupalchowk, Sindhuli and Saptari, representing three distinct ecological zones of the Koshi basin (mountains, mid-hills, and Terai).

Local WUMPs are prepared through an inclusive and participatory process that takes into consideration available water throughout the year and its uses. The 17-step process empowers and builds the capacity of the local community

so that they are able to quantify their available water resources and use local and traditional knowledge to develop a long-term plan that matches their needs. The ownership of the plan by the community and local government enables them to implement the prioritized water management projects in the plan and even request funding based on the plan.

In this particular pilot, HELVETAS is supporting the local communities through capacity development, whereas ICIMOD gives communities up-to-date scientific knowledge on trends such as monsoon, weather and water availability, as well as creative solutions for sustainable water use. In addition, the upstream-downstream relationship on water availability and uses is also examined to understand how upstream and downstream communities can share water resources that would optimize the benefits.



Sustainable use of groundwater during the dry season is crucial for paddy farming in Saptari, Nepal



During springs in upstream areas mean less water available down stream. Infrastructure is key to solving this challenge, like this canal in Sindhuli, Nepal

The key goal is to promote effective, efficient, and equitable water management plans at the local level, with the aim of scaling out at higher hydrological and administrative units. This uniquely collaborated WUMP acknowledged both hydrological and political units, upstream-downstream communities, and gender dimensions.

Impact and uptake

The prepared WUMP plans have been approved during the village council meetings of the respective VDCs held last year. Each VDC committed to allocate at least 5-15% of the VDC's annual developmental budget for the implementation of the proposed WUMP schemes.

“Four VDCs in Saptari have completed the WUMPs. This is a big achievement for the local communities for the planning of the local water resources. Others VDCs have to replicate such plans”.

Nabaraj Khadka, program officer of the Saptari DDC and also the WUMP focal person of Saptari District.

Sindhuli and Saptari districts have acknowledged the importance of the WUMP plan in district-level planning documents. Particularly, in Saptari, the WUMP plan is incorporated into a five-year district periodic plan for irrigation solutions and flood risk reduction at the local level.

In Sindhuli, a deeper understanding of upstream and downstream dimensions in the Adherikhola catchment is likely to bring together both upstream and downstream VDCs more closely to solve the water issues at a catchment level in a more sustainable way.

ICIMOD and HELVETAS are receiving requests from the areas adjoining the pilots to provide technical support for WUMP preparation.

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Information alerts for forest fire management

Forest cover depletion and degradation, of which forest fire is one among the many causes, has direct and indirect impacts on mountain ecosystems and ecosystem services. Timely information about forest fire outbreak is critical to the effective mobilization of response teams. ICIMOD, under the SERVIR programme, has developed a web application to map active forest fires and generate alerts to be delivered to registered users. The system uses an active fire database mapped by a satellite called Moderate Resolution Imaging Spectroradiometer (MODIS), which is available twice a day. The system delivers – within 30 minutes of the satellite overpass – a forest fire alert to forest officials and volunteers of the district.

Growing pressure from livelihood activities is a major cause of forest degradation, aggravating the risk of forest fires

The issue

Forest fire is fast becoming one of the major causes of environmental degradation in countries across the Hindu Kush Himalaya (HKH). Prolonged dry post-winter months and scorching temperatures are conducive to forest fire outbreaks. The loss of canopy cover to forest fire events directly and adversely impacts the biodiversity and stability of the terrain. In a region characterized by harsh climatic and physical environment, the impact of such an event is long-drawn, with far-reaching implications to the socioeconomic conditions of the mountain communities. Mountain communities, marginalized in general, are

heavily dependent on forest-based resources for livelihood, and depleting forest cover implies dwindling livelihood options. Forest fire control and management is therefore important for both social and ecological resilience.

The solution

The forest fire detection and monitoring system is an online web application with a visualization interface to view the spatial distribution of forest fire locations stored as a backend database. The forest fire location data is ingested from the ICIMOD MODIS server, where active forest fires are mapped within 30 minutes of satellite overpass. The system sends out forest fire alerts

through emails and SMS messaging to registered users, many of whom are local forest officials and volunteers. Empowering local actors through timely and actionable information minimizes the extent of damage from forest fire outbreaks and protects ecosystems from degenerating. This translates to protection of mountain communities' livelihood options, to which the resilience of mountain communities is intricately tied.

The system, which has been deployed in Nepal in collaboration with the Department of Forests (DoF), currently sends notifications of fires throughout Nepal to some 180 subscribers. Furthermore, 220 text message subscribers, including District Forest Officers and focal persons of the Federation of Community Forestry Users (FECOFUN) in all districts of Nepal, receive fire alerts on their mobile telephones if a fire incident is detected in the district of their subscription (Table 1).

“When they get the SMS they won't need to be informed from the central office and [that] would save operation time.”

Director, Department of Forest and Park Services

Table 1: **SMS and email subscribers in Nepal by affiliation (as of 2014)**

User Group	Number of SMS subscribers	Number of Email subscribers
District Forest Offices	97	67
FECOFUN	85	3
Department of Forest	15	22
Ministry of Forest	15	9
Other (National Level)	28	82
Other (District Level)	16	7
Unknown	0	21
Total	256	211

“There was a fire I didn't know. I saw the email and I saw the fire. I called my Ilaka office, even they did not know that there was a fire. So he organized the [forest] users.” **District Forest Officer, Kailali**

Impact and uptake

The forest fire alert system has been found very useful and was also piloted in Bhutan in collaboration with the Department of Forest and Park Services (DoFPs). Within three years of its operation, there are now 256 SMS subscribers and 211 email subscribers in Nepal. A total of 12,362 SMS messages were sent in 2012 and 7,902 in 2013 in Nepal (Figure 1).

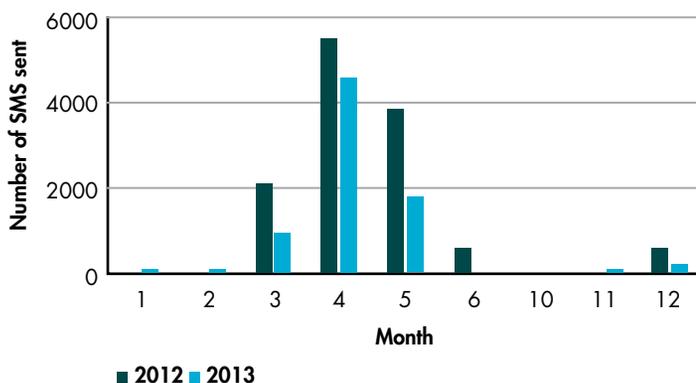
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Figure 1: **Number of fire warning SMS sent to subscribers by month for 2012 and 2013**





Leveraging the water-energy-food nexus at local levels

An innovative adaptation intervention on water management for horticulture development has been successfully piloted in the villages of Gilgit-Baltistan (GB) on the uncultivated community land that spreads along the banks of the Hunza River and its tributaries. Specially-designed solar pumps were used to lift water from the rivers, and water was applied through a highly efficient drip irrigation system combined with mulch to irrigate high-value orchards. The intervention is seen as appropriate for the arid region to address agricultural water management issues and increase its cultivated area and as an effective climate change adaptation option.

Direct current pumps are built to operate even in highly-sedimented rivers

The issue

Gilgit-Baltistan (GB), home of the world's highest mountain ranges in the Upper Indus Basin (UIB), covers 7.24 million hectares. The arable land spreads along the river banks, out of which 50% of the land is uncultivable due to lack of surface water availability. Due to the steep incision and strong currents of the Hunza River and its tributaries, river water has not been used for irrigating the surrounding land. Also, due to the impact of climate change, the lowering of glacier surface and water-related hazards have been disconnecting vital irrigation infrastructures and reducing water availability for agricultural uses.

In the GB, communities have been experiencing water shortages for agriculture for generations due to higher dependence on ice and glacier melt water (>60%) for irrigation. The irrigation water is predominantly made available to agricultural land through irrigation canals, with intakes at glacier tongues and surfaces which are covered with moraines. The traditional irrigation canals (locally called Kuhls), comprised of unlined water conveyance and distribution channels, are inefficient, and water loss from such canals is high. Furthermore, the poor on-farm-water management techniques cause water losses and lower yields. Due to climate change, the lowering of glacier surface has



Drip irrigation and mulch can make more efficient use of water in dry areas like this

been disconnecting vital community irrigation infrastructure, reducing water availability for agricultural uses. People in high water stress areas have even been forced to abandon their agricultural lands due to irrigation water scarcity and water-related hazards such as GLOFs, landslides, accelerated soil erosion, flash floods, and debris flows.

The solution

An innovative adaptation intervention for horticulture development has been successfully demonstrated in Gojal Village. Gojal spreads across 0.85 million ha at an elevation ranging from 2,340m to 4,877m above sea level. According to the nearest meteorological station, temperatures range from -11 °C to 29 °C, and the annual precipitation is merely around 180 mm. The agricultural irrigation water

management demonstration sites have been established in Passu and Morkhun. Passu is home to 717 individuals (358 male and 359 female), out of which only 15% practice farming. Similarly, Morkhun is home to 501 people (253 male and 248 female), and only 13% of the population practices farming. The agriculture is subsistence-based and male outmigration is prevalent in those villages. The literacy rate is high and therefore the community is receptive to innovative ideas.

As an alternative to the irrigation channel made dysfunctional by the lowering of glacier surface, the Khunjerab River water has been lifted with a solar pump to uncultivated community land. This first known use of a solar pump in the high mountains of the HKH required several technological innovations in the solar pumping system, since most of the solar-powered

irrigation technology is designed for use in plain areas, where clean water is lifted from either a pond or bore well. The pioneering of a solar-powered water pumping system in Gojal was a real challenge because of the heavy concentration of suspended sediments as well as salts in the river water. After multiple attempts, the challenges were overcome, particularly after installing Direct Current (DC) pumps capable of working in heavy sediment.

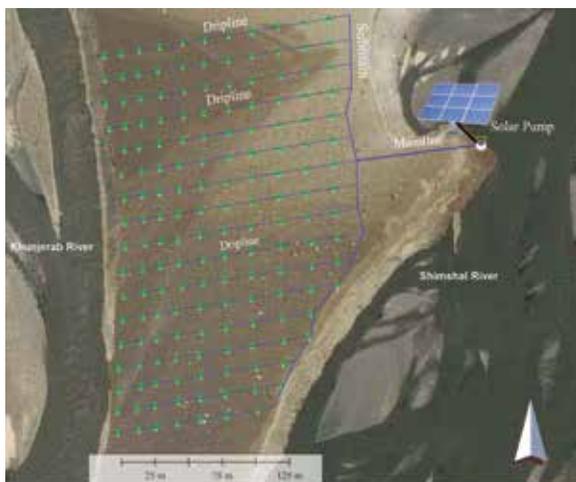
The water lifted from the river is evenly distributed through a highly efficient drip irrigation system to high-value orchards. Furthermore, mulching has also been demonstrated to conserve the valuable moisture and to avoid weed growth. By applying this integrated approach, two demonstration sites have been developed in Gojal: a) a 2.5-hectare orchard of apple and cherry trees at Passu

village and b) a 2.5-hectare orchard of Fuji apples at Morkhun village. About 3,200 apple saplings were planted, of which 100% survived, and the first fruiting with 4-5 apple fruits in one tree was observed in September 2017. This pilot is an example of a water-energy-food nexus at the local level. The solution functions with renewable energy (solar pump) and gravity flow (drip irrigation), is resilient from the dynamic glacier behaviour (lowering of glacier surface does not impact the regular water supply to orchards), and the water application is very efficient, as drip provides water to the root zone of plants and significantly reduces the water loss caused by evaporation.

The project follows the concept of Resilient Mountain Village (RMV) by introducing adaptation measures against the changing climate through agricultural, water, energy, and

A close up view of drip irrigation and mulch applied to a small apple plant





A map of an agricultural irrigation management demonstration site (Popdon-Passul, Gojal, Pakistan)

hazard management for improved livelihood in the GB. A multidisciplinary, multisectoral approach was adopted, forming a local-level consortium of partners to address the issue of water management, hazard management, and energy management together with social mobilization and capacity-building.

The World Wide Fund for Nature (WWF) – Pakistan’s Gilgit-Baltistan office is a lead partner responsible for overall coordination, social mobilization, and monitoring of the project. The Pakistan Council of Research in Water Resources (PCRWR) was the main partner responsible for the implementation of agricultural water management-related innovations.

Impact and uptake

The intervention is considered an effective climate change adaptation option, in which about 1,300 people in the pilot villages are expected to benefit, including about 600 female members after the fruit trees start bearing fruit. The expected impacts of these interventions have motivated the partner organizations to contribute from their own resources for piloting the RMVs. PARC has introduced Angora rabbit farming in

the highlands of GB and provided training to the communities, placing special focus on women. It has also supplied highly productive and new varieties of wheat seeds to the Gilgit-Baltistan Agriculture Research Department for testing and multiplication purposes. Similarly, PCRWR, using its own resources, has piloted a hydro-ram pump for around-the-clock irrigation water supplies. Additionally, the GB Forest Department has contributed irrigation pipes for the sea buckthorn plantation along the Hunza River, as well as fencing to protect the social agroforestry in Morkhun.

The success of this initiative has also appealed to national organizations to give more importance to research and development in GB. After the implementation of this project, PCRWR has approved up-gradation of its water quality lab into a regional research centre in Gilgit, where GB specific research will be carried out. The GB Forest Department has selected the same communities to upscale these interventions under an International Fund for Agricultural Development (IFAD)-funded project to conserve the livelihood base and promote social and agro forestry along Karakorum Highway.

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Promoting mountain perspectives in higher education

Many of the public interventions in the mountains proved ineffective when development professionals and policy makers lacked a mountain perspective. Academic programs in most higher education (HE) institutions in the HKH continue to be heavily influenced by a “plains bias”. Forty researchers, faculty members, and administrators from 20 technical and comprehensive universities and research institutions in eight RMCs formed a Higher Education for Mountain Agriculture Work Group (MAWG) as an initiative by the Himalayan University Consortium (HUC) at ICIMOD. The MAWG identified major problems with academic programs and the higher education system in the respective countries and discussed a strategy to build institutional capacity for higher education in mountain agriculture. In a number of countries, initial actions have been taken to revise, mainstream, and build new course syllabi and academic programs that better serve sustainable mountain development in the HKH.

HUC Academy members visit Panchkhal Kavre, a Resilient Mountain Village, in 2017

The issue

Mountain agriculture is inherently different from that of the plains in that it is conditioned by the five mountain specificities: inaccessibility, fragility, marginality, diversity, and niche and adaptation mechanisms of mountain farming communities. Despite the importance of having a mountain-specific perspective in research and training for mountain agriculture, a current review of existing higher education curricula indicates a serious lack of content and methodologies in

this regard. Academic programs in most HE institutions in the HKH are heavily influenced by plains bias and dominant national perspectives in the respective countries. This has led to a lack of mountain perspective among mountain development professionals and policy makers, which in turn lies at the core of the continued deficiency of public interventions, including policy and planning, research and technological support, and extension services in mountainous regions of the HKH. Paradoxically, while enough knowledge has been generated during the past



The Mountain Agriculture Work Group shares ideas in a meeting at ICIMOD

three decades to meet the need to develop curricula and provide professional training on mountain agriculture, conscious efforts have never been made to address this issue of HRD in and for the mountains.

The solution

The two initiatives of ICIMOD, Himalica, and HUC, jointly brought together a Higher Education for Mountain Agriculture Work Group (MAWG). The group consisted of more than 40 researchers, faculty members, and senior administrators from more than 20 universities and research institutions of eight RMCs. At the Inception Meeting in Kathmandu on 21-22 February 2017, participants reviewed the state-of-the-art research and training in mountain agriculture in higher education in their respective

countries and deliberated on the importance of mainstreaming mountain perspectives in higher education in both technical (agriculture and forestry) and comprehensive universities. Participants identified a series of problems: 1) While the present development discussion emphasizes the need for greater understanding of local environment, resources, knowledge, culture, and adaptation mechanisms, the teaching and research institutions in mountain areas are yet to develop a scholarship and way of thinking that focuses on the local environment and socioeconomic issues. 2) Academic curricula have been designed with a focus on the monoculture of individual commodities and maximizing yield crop production under irrigated conditions, which is largely unsuitable for mountain ecological and socioeconomic conditions. The fragile and marginal aspect of

the mountain environment and integrated crop-livestock-agroforestry farming system are not given adequate focus. Furthermore, 3) campus teaching maintains weak linkages with research institutes, extension organizations, public and private sectors, and local farmers, leading to a weak feedback system.

Group members reached a consensus on the indispensable role of universities in producing competent manpower for mountain agriculture technical and policy research and extension services. The group proposed a strategy to build institutional capacity for HRD in mountain agriculture through mainstreaming mountain perspectives in academic programs in HKH countries. The two-pronged process includes developing guidelines for putting mountain

agriculture academic programs in place in RMCs and determining the subject areas of course curricula of different levels where mountain perspectives should be integrated.

Selected MAWG members took part in two follow-up meetings, “SAARC Regional Expert Consultation Meeting on Water-Energy-Food Nexus: A Basis for Sustainable Agricultural Development”, in Thimphu, Bhutan, 3-5 July 2017, and “Regional Conference on Mountain Agriculture with Focus on Ecosystem Services, Agri-Extension, and Market Linkages” in Kathmandu, Nepal, 9-11 August 2017, where they shared findings and strategy with a large and diversified audience, including local farmers, technical professionals, and national policy makers.

HUC Academy makes a field trip to a Panchkhal Kavre, a Resilient Mountain Village



“The UAP has conducted extensive research on climate change adaptation approaches and strategies, such as carried out trials of eighteen wheat and maize varieties and identified the most appropriate for four agro-climatic zones. We have also published 2011-2040 climate scenarios for seven districts of Punjab and KP and stimulated climate corridors for certain crops and fruits of Chitral and Peshawar. However, the teaching and training, especially concerning the graduate curricula of our own university, are yet to incorporate these cutting-edge research”

Dr. Muhammad Zulfikar,
The University of Agriculture, Peshawar, Pakistan

Impact and uptake

The MAWG Inception and eventual Meets brought mountain agriculture back into the limelight of SMD discussion and practice. Group members have initiated processes at their home institutions in revising course syllabi and curricula in the direction of including a mountain perspective. Senior HE administrators have developed an awareness of the importance of integrating the mountain perspective in the academic programs in their university as parts of an overall strategy to increase the employability of their graduates, as well as the social accountability of their institution. At the HUC Annual Meeting in Chengdu (China) in November 2017, MAWG members renewed their interest in continuing and expanding their network.

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Regional flood outlooks

A regional flood information system has been developed where real-time data is received from the hydromet networks upgraded in four countries: Bangladesh, Bhutan, Nepal, and Pakistan. Flood forecasting and early warning systems in the regional member countries have been enhanced to utilize these advanced tools and techniques to save lives and livelihoods. Real-time data have been utilized in regional and basin-specific flood outlooks, providing timely information on the flood situation. The flood outlooks, along with other forecasts, have been used by hydromet agencies for early warning, helping to reduce flood risks and damages.

A photo from the 2016 floods on the Bhoté Koshi in Nepal

The issue

Every year, devastating floods inundate large areas of the Ganges, Brahmaputra, and Indus basins, crossing national borders. The floods result in loss of lives and livelihoods, as well as in the displacement of millions of people, threatening achievement of the United Nations Sustainable Development Goals. This calls for effective cooperation between the countries concerned: Bangladesh, Bhutan, China, Nepal, India, and Pakistan. However, the bilateral river treaties and data-sharing agreements currently in place are not sufficient to avert flood catastrophes on a transboundary scale.

The solution

More systematic regional cooperation in hydrometeorological (hereafter, hydromet) data collection and sharing is necessary to enable effective and timely forecasting of floods and disaster prevention, as well as flood management, at the regional level. In 2009, ICIMOD, the World Meteorological Organization (WMO), and ICIMOD's partner countries, Bangladesh, Bhutan, China, India, Nepal, and Pakistan, initiated the development of the Hindu Kush Himalayan Hydrological Cycle Observing System (HKH-HYCOS). The project's overall objective is to minimize the loss of human lives and property damage.



A hydrological station in Trashi, Yangtshu, Bhutan

The project helped build the capacity of the partner countries' national hydromet services and modernized the hydromet networks in the region: a total of 38 hydromet stations (nine in Bangladesh, nine in Bhutan, twelve in Nepal, and eight in Pakistan) were upgraded to share real-time data. In addition, an automatic regional flood information system was established to facilitate the transboundary exchange of real-time data, information, and know-how. The new system allows the visualization and extrapolation of real-time data from the hydrometeorological stations to any geographical location by providing information on the river water levels and amounts of rainfall.

The data transmitted in real time is used to develop flood forecast products and to validate model results, such as in satellite-derived products. These products are used by partners

to warn communities of increasing river water levels, helping to reduce risks. In August 2014 and 2017, for example, the flood outlook was used by the Department of Hydrology and Meteorology of Nepal as one of the inputs to issue a flood warning. It did so by means of a flood bulletin which was widely disseminated through the website and through emails to various important stakeholders.

Impact and uptake

With their experience from HYCOS, the hydromet agencies of Nepal, Bhutan, and Bangladesh have been able to attract large amounts of investment for the modernization of their hydromet networks through the climate funds. Activities funded through HYCOS have improved the capacity of the hydromet agencies to take up these projects and contributed to building climate resilience for people at risk.

Koshi Basin Flood Outlook

In 2016, the Koshi Basin flood outlook was developed as a part of ICIMOD's Koshi Basin Programme. Koshi Basin is a transboundary river basin shared between China, Nepal, and India, with over 40 million people dependent on its resources. Flooding is a recurrent disaster in the basin, particularly affecting parts of Nepal and northern Bihar, India. The number and severity of extreme weather events such as floods is expected to increase in the basin. Thus, the Koshi flood outlook, which provides three days' forecasts, is critical for the people in the basin to prepare in advance. The flood outlook is being used in Nepal and India, along with other forecast models, to provide flood prediction and bulletins for relevant government agencies and communities. The Department of Hydrology and Meteorology of Nepal used the outlook information during the 2017 floods to monitor the flood situation and provide early warning.



Participants learn how to stream gauge on the Rosi Khola, Nepal



Hydrological Station in Trashigangtshe, Bhutan

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Sustainable livelihoods for the marginalized

Many marginalized population groups in the HKH are located in remote locations and are faced with challenges related to livelihood security and diversification, access to improved technology and productive inputs, and so on. As forest dwellers, many of these groups lack tenurial rights over their land holdings, which makes it even more challenging to design appropriate development interventions. The solution being discussed here is an example of a package of interventions that has been tailored to context.

A Van Raji woman planting fruit

The issue

The Van Raji are a forest-dwelling primitive tribe that resides in the central Himalayan region of Uttarakhand in India. Van Rajis are distributed in nine villages of the Pithoragarh district, which falls in the Kailash Sacred Landscape. Another 18-20 households of Van Rajis reside in a village located in Champawat district. The villages are in a remote area with limited access to facilities and are vulnerable to natural calamities. Limited livelihood options, poor educational status, and lack of medical facilities created hardships and challenges to their very existence. Van Rajis are by nature shy, prefer to live in isolation, have an orthodox attitude to adopting modern technologies, and are busy in their forest-based

livelihoods, with enormous drudgery and difficult situations. The major problem in bringing them into the mainstream with better facilities is that, as forest dwellers, they still do not own land holdings and even now only 40-45% of households have land titles as per the Schedule of Tribes and Other Forest Dwellers (Recognition of Forest Rights) Act, 2006, of India.

The solution

Since 2012-2013, ICIMOD has been implementing a programme under KSL-CDI, in partnership with NABARD and SP Group, for livelihood improvement of Van Rajis. An agri-horti-silvi system (Wadi) was introduced among 120 Van Rajis with select fruit plants,



A water storage tank in a Van Raji village



A Van Raji woman harvesting kidney beans

and plantation of bamboo in the boundaries was done to have an additional source of raw material that would reduce their dependency on forests. Scarcity of water has always been a big challenge, so alternative water resources have been created in all nine Van Raji villages. Overall, 141 roofwater-harvesting and poly-lined tanks are being used to fulfill their water needs. Now each household has an average of 20 fruiting trees, along with a rainwater-harvesting tank, irrigation accessories, poly-lined tanks, and solar lantern (lights). Cultivation of pulses, vegetables, and spices under wadi for maximizing land use is well-adopted, and 70-80 households are selling the surplus for added income.

Training and regular facilitation motivated 65 Van Raji women to undertake bamboo crafting and resulted in improved skills as potential bamboo artisans. Tailoring workshops were organized for 20 Van Raji families with support from NABARD. Awareness-building has led to improvements in sanitation behaviour – around 60% of households are using either permanent or temporary toilets and also keeping their area clean. Various supporting interventions were introduced through convergence with government agencies, leading to the promotion

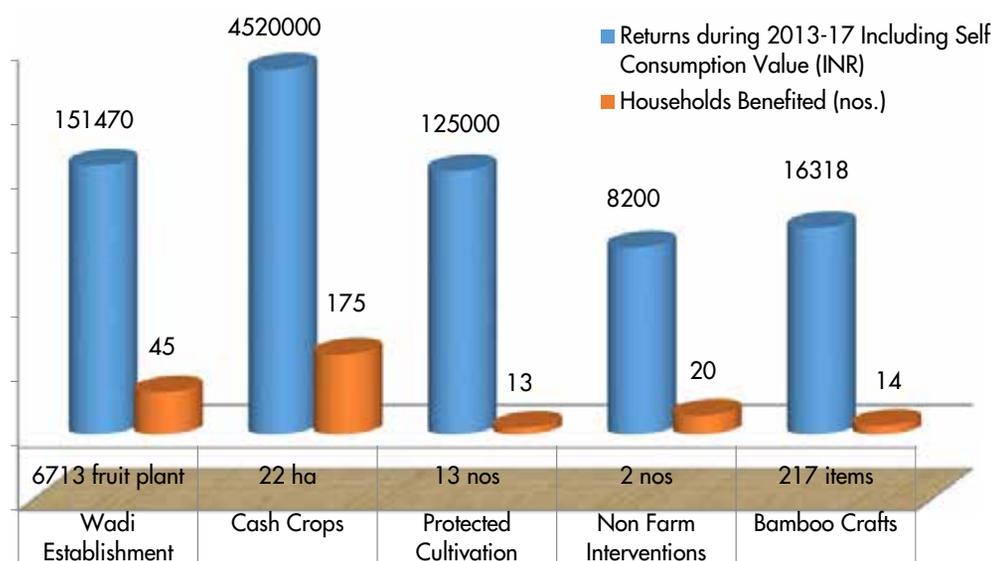
of livelihood options, better education and health, improved skills, linkages with financial institutions, diversity in activities and, most importantly, exposure to different places/institutions for sustainable development.

Impact and uptake

During the last four to six years, a positive change in terms of attitude, livelihood practices, and lifestyle has been visible among 169 households. In all, 22.2 hectares have been converted to cultivation from fallow land and have provided agro production of around 28 tonnes in the last four to five years.

A positive change that is visible now is that members of the tribe have started frequently visiting line departments, discussing their needs with officials, and putting forward their claim to various welfare programs. Van Rajis now also frequently visit health centers for checkups in the event of medical problems. Each household has a bank account and is also using the right to vote, which was previously not a common practice. It clearly shows that Van Rajis are now more open and aware about their rights and the social system, which is needed for resilience.

Village	Total Water Tank numbers	Total Water Storage Capacity KL (3 Times in a Year)	Time Saving Hrs/Year
Aultari	7	105	1,050
Kulekh	16	240	2,400
Madanpuri	7	105	1,050
Kuta Chaurani	25	375	5,000
Gainagaon	8	120	1,600
Chifaltara	9	135	1,800
Bhagtirwa	11	165	2,200
Kimkhola	26	390	5,200
Jamtari	32	480	6,400
Total	141	2,115	26,700



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