

BUILDING BACK SAFER AND GREENER

A Guide to Sound Environmental Practices for Disaster Recovery in Nepal



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Hariyo Ban Program



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Published by

WWF Nepal

PO Box: 7660

Baluwatar, Kathmandu, Nepal

T: +977 1 4434820, F: +977 1 4438458

hariyobanprogram@wwfnepal.org, www.wwfnepal.org/hariyobanprogram

Authors

Judy Oglethorpe

Chandra Laxmi Hada

Sandesh Hamal

Missaka Hettiarachchi

Shant Raj Jnawali

Jagannath Joshi

Prasan Karmacharya

Keshav Khanal

Jagadish Chandra Kuikel

Madhuban Lal Maskay

Sanjaya Uprety

Anita van Breda

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WWF US for the figures on upper watershed conservation and restoration of rivers in Chapter 13 (WWF 2016)

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United Nations Office for the Coordination of Humanitarian Affairs for the disaster symbols used throughout the guide, and for the Cluster System figure in Annex 3 (UNOCHA 2016b)

Citation

Please cite this guide as: WWF Nepal. 2016. Building Back Safer and Greener: A Guide to Sound Environmental Practices for Disaster Recovery in Nepal. WWF Nepal, Kathmandu, Nepal.

Disclaimer: This report is made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of WWF and do not necessarily reflect the views of USAID or the United States Government.

Dedication

This guide is dedicated to all those who were affected by the 2015 earthquake and 2014 floods in Nepal.



Government of Nepal MINISTRY OF URBAN DEVELOPMENT



Phone : { 4211693
4211883
4211673
Fax : 977-1-4211873

Ref. No.:-

Singhadurbar,
Kathmandu, Nepal

FOREWORD



The 2015 earthquakes in Nepal resulted in tragic loss of life, economic damage, and adverse impacts on the environment. Nepal has extremely high risk for disasters, and building back better and safer is imperative in order to increase resilience. While constructing buildings and infrastructure to code is really important for this, it is also essential to consider the environment in recovery and reconstruction. Minimizing adverse environmental impacts during reconstruction will help to conserve natural resources and ecosystem services like water supplies for future livelihoods and wellbeing, and help to avoid future disasters such as landslides and floods. For example, the 2015 earthquake took a particularly hard toll on housing. Reconstruction of housing involves procuring building materials such as sand, stone and timber. The sourcing of these materials on a large scale has the potential for huge environmental damage if it is done inappropriately. This guide helps policy makers and practitioners to think through the stages of recovery and reconstruction, and determine ways to reduce adverse environmental impacts of actions such as material procurement, as well as other stages in reconstruction of buildings and infrastructure. It promotes the use of bioengineering, in combination with hard engineering when needed, to stabilize slopes and reduce the risk of landslides in the future.

The Ministry of Urban Development has collaborated with WWF and the Hariyo Ban Program on mainstreaming environmental aspects into mason training, and on training central level and district-based urban development engineers in concepts and practices of green recovery and reconstruction. We have also collaborated on the physical planning of reconstruction in Barpak, at the epicenter of the first earthquake. We have appreciated this opportunity to collaborate, and trust that this guide will continue to provide guidance on these important approaches in the future.

.....
Deependra Nath Sharma
Secretary
Ministry of Urban Development

Acknowledgments

This guide is the culmination of the Hariyo Ban Program's work on green recovery during 2014-2016, and draws on the work of very many dedicated people. I would like to thank all those who played a role in this work.

The Environment and Forestry chapter in the 2015 Earthquake Post-Disaster Needs Assessment (PDNA) and the Rapid Environmental Assessment (REA) provided a strong foundation for this guide, and we are very grateful to all those involved.



We would like to thank all those in other sectors who collaborated with us and worked to incorporate green practices into their sectors after the 2015 earthquake, especially Mr. Deependra Nath Sharma, Secretary of the Ministry of Urban Development (MoUD); Mr. Padma Kumar Mainalee, Deputy Director General, Department of Urban Development and Building Construction (DUDBC); Mr. Shiva Hari Sharma, Director, Central Level Project Implementation Unit, MoUD; Ms. Mira Gyawali, Senior Division Engineer, DUDBC; Mr. Ram Chandra Devkota, Director General, Department of Water Supplies and Sewerage; Mr. Sushil Gyawali, Chief Executive Officer, National Reconstruction Authority (NRA); Mr. Uddab Prasad Timilsina, Chief District Officer of Gorkha District; Mr. Bishwa Prakash Subedi, Chief District Officer of Dhading District; Mr. Bishnu Pokhrel, Chief District Officer of Nuwakot District; Mr. Krishna Prasad Adhikari, Chief District Officer of Rasuwa; Mr. Jhappar Singh Bishwakarma, Senior Division Engineer, Department of Education; Mr. Dilip Shekhar Shrestha, Deputy Director, Central Level Project Implementation Unit, MoE; Ms. Marian Hodgkin, UNICEF; Mr. Diwat Kumar Shrestha, Director, Technical Division, Council for Technical Education and Vocational Training (CTEVT); Ms. Akim Shrestha, Executive Director and Ms. Pramila Malakar, Chief of Marketing Department, Training Institute for Technical Instruction (TITI); Mr. Avani Dixit, World Bank; Ms. Mona Laczó, Ms. Heidi Wilson and team in BBC Media Action; Mr. Kamal Subedi, Chairman and Mr. Mani Pokharel, Advisor of National Federation of Youth NGOs; and Mr. Sahaj Man Shrestha, President of NEFEJ.

Purna Chandra Lal Rajbhandari (United Nation Environment Program) convened environmental sector actors after the earthquake. The Center of Resilient Development provided inputs to green recovery and reconstruction (GRR) work after the 2014 Terai floods; thanks go to Hari Shrestha, Ram Bhattarai and Nirmal Sharma. Deepak Paudel provided inputs on climate change and disaster risk reduction.

Dr. Madhuban Lal Maskay provided extensive inputs to Hariyo Ban Program on soil bioengineering. Mr. Shankar Prasad Koirala, Mr. Kishore Thapa, Mr. Sanjay Rana, Mr. Dinesh Manandhar, Dr. Sanjaya Uprety, Mr. Diwat Kumar Shrestha, Mr. Debesh Raj Bhattarai, the Chief District Officers and District Disaster Relief Committee members in several earthquake recovery districts supported the GRR training program. Dr. Sanjaya Uprety undertook an evaluation of Hariyo Ban's green recovery work.

In the Hariyo Ban core team those who played an important part at central level or in the field include: Chandra Laxmi Hada, Hisila Maharjan, Sandesh Hamal, Shant Jnawali, Keshav Khanal, Jagannath Joshi, Sunil Regmi, Deepak Rijal, Jagadish Chandra Kuikel, Sabitra Dhakal, Mahendra Shakya, Kapil Khanal, Suman Dhakal, Anjana Shrestha, Amit Pradhan, Jyoti Shrestha, Prasan Karmacharya, Purna Kunwar, Lila Gurung, Hari Krishna Bhattarai, Rupendra Ghale, Arun Belbase, Rajendra Lamichhane, Radhika KC, Shweta Dhoubadel, Shova Shilpakar, Divya Karki, Mamta Shrestha, Kanti Adhikari, Gita Bham, Umi Joshi and Sanju Gurung. In WWF we thank Santosh Nepal, Ghana Gurung, Ravi Singh, Gautam Paudyal, Rajan Rijal, and Shailesh Bhattarai.

In CARE we thank Lex Kassenberg, Cathy Riley, Popular Gentle, Lora Wuennenberg, Dev Raj Gautam, Bishnu Pokharel, Santosh Sharma, Thakur Chauhan, Madhav Dhakal, Umesh Shrestha, Gupta Bahadur KC, Bal Krishna Jamarkattel, Man Bahadur BK, Bijay Bagale, Pabitra Jha, Shreedhari Pandey, Santosh Chaudhary, Shyam Bhandari, Thir Bahadur Thapa, Binita Khanal, Arun Adhikari, Sandeep Sharma, Kamana KC, Yashodha Sunar, Lekha Nath Adhikari, Shekhar Bahadur Adhikari, Samjhana Wagle, Jagadish Bhatta, Laxmi Malla, Ram Bahadur Mijar, Dala Bdr BK, Nabin Dhungana, Bishnu Bahadur Nepali, Gyanendra Subedi, Deependra Raj Joshi, Kamal Paudel, Deepa Gurung, Deepa Shrestha, Suresh Bhandari and Prabha Koirala.

In the Federation of Community Forest Users Nepal (FECOFUN) thanks go to Ganesh Bhadur Karki, Bhim Prakesh Khadka, Bharati Pathak, Birkha Bhadur Shahi, Thakur Bhandari, Suvas Chandra Devkota, Ram Prasad Poudel, Sunita Shrestha, Krishna Khadka, Poonam Bhatta, Ramesh Siluwal, Anil Prajapati, Shovakar Sapkota, Dilli Giri, Kamala Gyawali, Shyam Kattel, Lila Nath Neupane, Naryan Nepal, Bhakta Bhadur Simkhada, Tulashi Adhikari and Naryan Rijal.

In the National Trust for Nature Conservation (NTNC) we are grateful to Ganga Jang Thapa, Megh Dhoj Adhikari, Shyam Kumar Thapa, Sikshya Adhikary, Naresh Subedi, Raj Kumar Gurung, Bishnu Singh Thakuri, Ajit Tumbahagphe, Bhim Prasad Upadhaya and Hira Bahadur Chhetri.

We would like to thank Sita Ram Shrestha, Arjun Tamang and Kamal Lamichhane of the Shree Swanra Integrated Community Development Center, who implemented field activities in Gorkha.

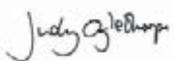
From WWF US Anita van Breda, Missaka Hettiarachchi and Shaun Martin provided valuable global experience and advice, and peer reviewed parts of the document. Hung Nguyen provided contractual and financial support.

We would like to thank all those who contributed sections to this guide – they are listed on the credits page.

We are extremely grateful to USAID for allowing us to realign existing funds for disaster work, and then providing additional funds after the earthquake. Special thanks to Netra Sharma Sapkota, Bronwyn Llewellyn, Karolyn Upham and Karl Wurster.

We would like to say a big thank you to the one thousand plus participants in the Hariyo Ban GRR training program. We appreciate your time and interest at a time when everyone had many other pressing priorities, and hope you have been able to apply the training in your recovery and reconstruction work.

Finally, and most important, we would like to recognize the local communities who took part in Hariyo Ban's relief, recovery and reconstruction work in the field after the 2015 earthquake and 2014 Terai floods. We admire your resilience and wish you well as you continue to recover and restore your lives.



Judy Oglethorpe

Chief of Party

Hariyo Ban Program (first phase)

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Abbreviations and acronyms

CAPA	Community Adaptation Plan for Action
CARE	Cooperative for Assistance and Relief Everywhere
CEPT	Centre for Environmental Planning and Technology
CNDRC	Central Natural Disaster Relief Committee
CTEVT	Council for Technical Education and Vocational Training
DDRC	District Disaster Relief Committee
DHM	Department of Hydrology and Meteorology
DoF	Department of Forests
DRR	Disaster Risk Reduction
DUDBC	Department of Urban Development and Building Construction
EOC	Emergency Operation Centre
FAO	Food and Agriculture Organisation
FECOFUN	Federation of Community Forestry Users Nepal
GESI	Gender Equality and Social Inclusion
GLOF	Glacial Lake Outburst Flood
GoN	Government of Nepal
GRR	Green Recovery and Reconstruction
GRRT	Green Recovery and Reconstruction Toolkit
Ha	Hectare
ICIMOD	International Centre for Integrated Mountain Development
ICS	Improved Cooking Stove
IFRC	International Federation of Red Cross and Red Crescent Societies
IoE	Institute of Engineering
IOM	International Organization for Migration
ISP	Integrated Settlement Planning
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resource Management
Km	Kilometer
LAPA	Local Adaptation Plan of Action
LDRMP	Local Disaster Risk Management Plan
LED	Light-emitting Diode
LPG	Liquefied Petroleum Gas
LR	Land Readjustment
M&E	Monitoring and Evaluation
MoFSC	Ministry of Forests and Soil Conservation

MoHA	Ministry of Home Affairs
MoSTE	Ministry of Science, Technology and Environment
MoUD	Ministry of Urban Development
MUS	Multiple Use Water System
NAPA	National Adaptation Programme for Action
NGO	Non-Government Organization
NRA	National Reconstruction Authority
NTNC	National Trust for Nature Conservation
PDNA	Post-Disaster Needs Assessment
PDRF	Post Disaster Recovery Framework
RDRRC	Regional Disaster Relief Committee
REA	Rapid Environmental Assessment
SEA	Strategic Environmental Assessment
SIDA	Swedish International Development Cooperation Agency
SMART	Specific, Measurable, Achievable, Relevant and Time-bound
TITI	Training Institute for Technical Instruction
UDDT	Urine Diversion Dehydration Toilet
UN-HABITAT	United Nations Human Settlements Programme
UNDP	United Nations Development Programme
UNHCR	United Nations High Commissioner for Refugees
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs
USAID	United States Agency for International Development
VDC	Village Development Committee
WASH	Water, Sanitation and Hygiene
WFP	World Food Programme
WHO	World Health Organisation
WWF	World Wildlife Fund

Executive summary

Nepal is a highly disaster prone country, with a long history of earthquakes resulting from its location on the subduction zone where the Indian subcontinent tectonic plate is slowly moving underneath the Eurasian plate, creating the Himalayas. In addition, it is highly prone to floods and landslides, especially in light of its highly dissected topography and extreme elevation range. Parts of the country are prone to periodic drought. Climate change exacerbates the risk of some hazards through more extreme weather events and climate warming (e.g. avalanches, drought, landslides and floods).

Many people in Nepal are highly dependent on locally available natural resources and ecosystem services for their livelihoods and security. Natural resources include firewood, building materials, forest foods, grazing, and medicines. Ecosystem services include clean, reliable water supplies; and protection from soil erosion, landslides and extreme flooding. In order for Nepal to become more resilient to future disasters and reconstruct in a way that will not over-exploit natural resources or damage ecosystem services, it is essential to 'build back safer and greener' after disasters, ensuring environmentally responsible practices. This includes, for example, avoiding clear-felling of trees for construction timber on steep slopes which may risk future landslides; or polluting local water supplies with sewage from temporary settlements. After disasters there is also often an opportunity to tackle previously existing environmental problems (for example, better land use to promote recharge of aquifers, hence conserving or improving water supplies).

This guide outlines many ways in which adverse environmental impacts can be avoided after disasters, and good practices can be promoted. It is written for government and non-government organization (NGO) technical staff including engineers and architects; humanitarian, development and environmental workers; field staff; policy makers; the private sector; academics; and donor agency staff. It covers many different sectors including settlements and land use planning; building construction; waste management; energy; infrastructure; water, sanitation and hygiene; agriculture and livelihoods; and education. It highlights the importance of flood risk management, landslide prevention and treatment, and management of forests after disasters.

Since gender equality and social inclusion (GESI) are critical during recovery and reconstruction, and it is important to take climate change into account during the process to allow for future climate extremes, these two issues are covered as cross-cutting issues in each chapter. Finally, the guide outlines key players in Nepal disasters, ways to work with others to promote safer and greener recovery, and the importance of training and outreach in promoting green recovery and reconstruction.



Minimizing adverse environmental impacts during post-disaster recovery and reconstruction, and restoring ecosystem services, helps to reduce risk from future disasters and ensure natural resources for local communities in the long term.
© Karine Aigner/WWF

What is green recovery and reconstruction?

Green recovery and reconstruction means:

Adopting environmentally sound recovery and reconstruction practices after a disaster that do not place additional pressure on the environment, and help to strengthen ecosystems that safeguard livelihoods and reduce disaster risk in the future.

Green recovery and reconstruction supports the environmental elements of the “Do No Harm” principle, the SPHERE project, the Code of Conduct for Disaster Relief, the Sendai Framework, the Sustainable Development Goals and the United Nations Cluster system (The SPHERE Project 2011, International Federation of Red Cross and Red Crescent Societies and International Committee of the Red Cross 1992, United Nations Office for Disaster Risk Reduction 2015, United Nations 2015 and United Nations Office for the Coordination of Humanitarian Affairs 2016a).

In Nepal several policies and regulations related to the environment are relevant or required during post-disaster recovery and reconstruction – many of them are listed in the following chapters.

Why this guide?

After the 2014 Terai floods and 2015 earthquake, there were strong opportunities to build back both safer and greener for a more resilient Nepal. But it was also clear that there was a big risk of inappropriate practices during recovery and reconstruction which could damage the environment and put people at greater risk in the future.

In order to promote good practices and help avoid bad ones, WWF Nepal and the Hariyo Ban Program collaborated with Government, United Nations agencies, NGOs and other organizations to promote environmentally sensitive recovery and reconstruction practices. The work drew substantially from initial work undertaken by WWF US and the American Red Cross after the 2004 East Indian Ocean tsunami. At that time the *Green Recovery and Reconstruction: Training Toolkit for*

Humanitarian Aid (GRRT) (WWF and American Red Cross 2010) was developed based on recovery and reconstruction work in Indonesia, Thailand Sri Lanka and the Maldives, and later applied in several other post-disaster situations including in Haiti, Pakistan, Chile and Mozambique. While the GRRT is very valuable internationally we realized that it would be useful to have a specific guide on green recovery and reconstruction (GRR) for Nepal that would be relevant for the many different sectors involved in disaster recovery and reconstruction, covering the main types of disaster that Nepal is prone to. This guide draws on the GRRT, as well as experiences, successes and challenges from the Nepal GRR work between 2014 and 2016. It is designed for all types of disaster that Nepal is prone to.

Who is this guide for?

The guide is written for government and non-government organization (NGO) technical staff including engineers and architects; humanitarian, development and environmental workers; field staff; policy makers; the private sector; academics; and donor agency staff. It covers many different sectors including settlements and land use planning; building construction; energy; waste management; water and sanitation; agriculture and livelihoods; forestry; education; and infrastructure; as well as climate change, landslide prevention and treatment, and flood management. Since gender equality and social inclusion (GESI) are critical during recovery and reconstruction, and it is important to take climate change into account during the process to allow for future climate extremes, these two issues are covered as cross-cutting issues in each chapter.

How to use the guide

The guide is designed so that you can skim through it for the concepts that are most important to you. If you work in a sector such as housing or water, we recommend that you read the chapters most relevant to your sector or situation. If you are an environmentalist working to promote green recovery and reconstruction across other sectors, we recommend that you read the chapters for those sectors, as well as the introduction and sectors on capacity building and working with others. If you work for a donor organization, we recommend you read the introduction and other chapters that are most relevant.

This introductory chapter is followed by chapters on several sectors that can impact the environment during and after disasters, and ways to reduce impacts. Then come three chapters on tackling hazards and reducing environmental impacts through forestry, soil bioengineering and flood risk management. The remaining chapters cover monitoring and evaluation, major actors in Nepal disasters, capacity building, and working with others to reduce environmental impacts.

When to use the guide

The guide can be used when preparing for, responding to, or recovering from a disaster; and also for reducing the risk of future disasters. The more it is used beforehand, the more prepared people can be, and the more likely that environmental impacts can be avoided when disasters do happen, but it is also important to use it after disasters occur.

The following symbols are used in the guide to show what stage of a disaster an action is most appropriate:

Symbols for disaster management cycle

	Relief
	Early recovery/transition
	Reconstruction
	Risk and Vulnerability Assessment
	Risk Reduction
	Disaster preparedness

(Source: UN Office for the Coordination of Humanitarian Affairs (UNOCHA) (<https://thenounproject.com/ochaavmu/>))

Background

Nepal is a highly disaster prone country, with a long history of earthquakes resulting from its location on the subduction zone where the Indian subcontinent tectonic plate is slowly moving underneath the Eurasian plate, creating the Himalayas. In

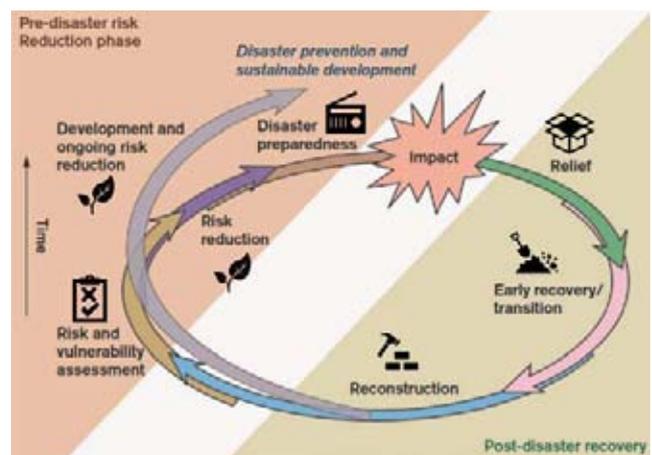
addition it is highly prone to floods and landslides, especially in light of its very dissected topography and extreme elevation range. Parts of the country are prone to periodic drought. Climate change exacerbates the risk of some hazards through more extreme weather events and climate warming (e.g. avalanches, drought, landslides and floods).

Many people in Nepal are highly dependent on locally available natural resources and ecosystem services for their livelihoods and security. Natural resources include firewood, building materials, forest foods, grazing, and medicines. Ecosystem services include clean, reliable water supplies; and protection from soil erosion, landslides and extreme flooding. In order for Nepal to become more resilient to future disasters and reconstruct in a way that will reduce risk by not over-exploiting natural resources or damage ecosystem services, it is essential to 'build back greener' after disasters, ensuring environmentally responsible practices. This includes, for example, avoiding clear-felling of trees for construction timber on steep slopes which may risk future landslides; or polluting local water supplies with sewage from temporary settlements. After disasters there is also an opportunity to tackle previously existing environmental problems, and build back better, safer and greener (for example, better land use to promote recharge of aquifers, hence conserving or improving water supplies).

Disaster management cycle

The diagram below illustrates the places in the disaster management cycle (or ideally, spiral) where we can promote sound environmental practices.

Points of intervention in the disaster management spiral



(Source: adapted from Lloyd-Jones and Kalra 2010, and Monty et al. 2016)

Post-disaster recovery

Relief phase: Obviously, in the immediate aftermath of a major disaster the priority is on saving lives and alleviating suffering. There may be a role for conservation organizations along with rapid response teams, government and humanitarian assistance organizations and citizens, in providing immediate relief. Since conservation organizations work with remote communities they may have better access and engagement with them than humanitarian organizations.

In the relief stage there are some opportunities for sound environmental practices, especially if planned beforehand. This includes, for example, minimizing environmental impacts of relief materials during production, packaging, distribution, and disposal; and reducing demand for fuel wood for cooking/warmth, and poles for temporary shelters.

After the immediate emergency is managed, depending on the specific disaster context various assessments may be

undertaken by government and/or NGOs. This is the time to contribute to assessments such as the post-disaster needs assessment (PDNA) if one is being undertaken. Government departments, UN agencies and NGOs working on the environment should assess direct environmental damage and loss due to the disaster; whether people's immediate response affected the environment; potential environmental impacts due to recovery and reconstruction; and ways to eliminate or minimize them. Since PDNAs are designed to focus more on preliminary estimates of loss and damage and move very quickly, it may also be necessary to do a separate rapid environmental assessment. For more information please see the GRRT module on environmental impact assessment tools and techniques (WWF and American Red Cross 2010), and the United Nations Environment Programme/UNOCHA Joint Unit's website¹.

Recovery phase: Recovery is the phase that returns people and built infrastructures to minimum living/operating

Role of conservation organizations in bringing relief to remote communities

Immediately after the 2015 earthquake, the Hariyo Ban consortium partners undertook relief work, taking food, tarpaulins, blankets, dignity kits and other supplies to communities they partnered with. The National Trust for Nature Conservation (NTNC) played an important role in reaching remote communities in Manaslu Conservation Area which was badly affected by the earthquake.

(Source: NTNC, Hariyo Ban Program)

Nepal's 2015 Post-disaster Needs Assessment and Rapid Environmental Assessment

Post-disaster Needs Assessment: After the Nepal earthquake in 2015 a large team came together led by the Ministry of Forests and Soil Conservation (MoFSC) to produce the Environment and Forestry chapter in the post-disaster needs assessment (PDNA). Major efforts were made to rapidly obtain as much data as possible. This included damage and loss due to: forests destroyed in landslides; impacts on ecosystem services; damage to Government of Nepal (GoN) forestry and protected area installations and operations; impacts on community forest management; risk of encroachment and illegal extraction; risks from solid and hazardous wastes; and impacts on alternative energy and brick factories. A set of ten environmental principles was developed to reduce impacts of recovery and reconstruction. Efforts were made to mainstream the environment in other sectors' PDNA chapters, but this was a chaotic time with much haste and pressure, and it was difficult to get the attention of other sectors.

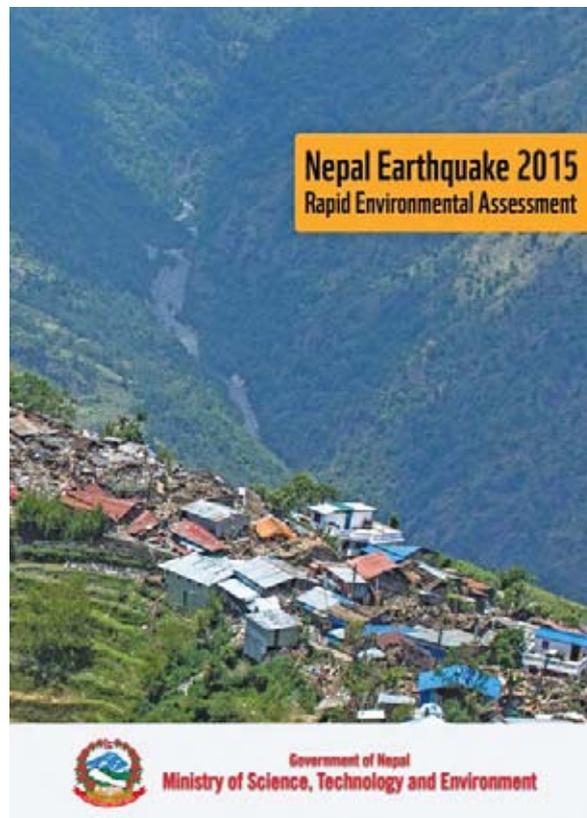
Rapid Environmental Assessment: Since the PDNA was an extremely rapid process that mainly focused on quantifying loss and damage and estimating the cost of recovery in the run-up to a donor conference a couple of months after the earthquake, the Ministry of Science, Technology and Environment (MoSTE) led a separate assessment based on the rapid environmental assessment (REA) methodology, in partnership with WWF and Hariyo Ban Program. Through a multi-disciplinary team, the environmental assessment reviewed direct damage to the environment, looked at how people were using the environment differently as a result of the earthquake, and assessed potential impacts of recovery and reconstruction. This REA and its Action Plan (MoSTE 2015) provided a strong base for subsequent green recovery and reconstruction efforts.

(Source: Hariyo Ban Program)

¹ <http://www.unocha.org/what-we-do/coordination-tools/environmental-emergencies>



The Rapid Environmental Assessment team conducting interviews in the field after the 2015 earthquake, seen here at the District Forest Office in Nuwakot.
© WWF Nepal, Hariyo Ban Program



The 2015 Nepal Earthquake Rapid Environmental Assessment report.
© Ministry of Science, Technology and Environment

standards and guides long-term rebuilding efforts. Depending on the nature of the disaster, there are often many ways in which environmentally sound practices can be promoted during the early recovery stage: for example, helping restore environmentally responsible livelihoods or developing alternative livelihoods in order to reduce dependence on and avoid overuse of forests; and providing environmental inputs to a post-disaster recovery framework. If capacity building is needed in green practices, this may be a good time to do it, after the immediate emergency of relief is over. While capacity building should ideally be done before a disaster, often further training is needed after the disaster occurs because new humanitarian actors come in at that time, who do not know the country or its environment. In addition, people are more likely to prioritize the training after a disaster, when they can see its immediate relevance. On the other hand, the early recovery stage is a very busy time with many priorities and environmentalists need to time the training carefully for when the trainees are ready and available for it.

If a post-disaster recovery framework is being prepared it is important that environmental aspects are addressed, both for the environment and forestry sector's own recovery, and to ensure that green practices are mainstreamed by other sectors.

Reconstruction phase: Reconstruction is the long-term response to a disaster, when permanent infrastructures are rebuilt, ecosystems are restored and livelihoods are rehabilitated. Many environmental impacts can be avoided or reduced during reconstruction across several sectors, as long as people understand the risks and there are viable alternatives that people are motivated to take. Alternatives that cause less damage and build future resilience are often practical to implement, and can often save time and money overall. Awareness raising, training, technical assistance and policy interventions are needed to promote viable alternatives. Many of the recommendations in this guide cover the reconstruction period.

Pre-disaster risk reduction phase

Disaster risk reduction and prevention: Disaster risk reduction is very important to help break out of the disaster cycle and promote more sustainable development, as indicated in the previous figure. This may be done in various ways, including preventing or mitigating the hazards themselves (e.g. reducing the risk of landslides by restoring forests). Alternatively, exposure to hazards can be reduced (e.g. by zoning areas prone to flooding as no-settlement zones so that people are not exposed to risk). Third, people's capacity can be built to withstand the hazard, for example by providing lifejackets and teaching women and girls in flood-prone communities to

Timing of GRR training after the 2015 earthquake

Since reconstruction largely halts during the monsoon, the Hariyo Ban Program was able to undertake a lot of GRR training workshops in Kathmandu and affected districts during the monsoon months.

(Source: Hariyo Ban Program)

Nepal's 2016 Post-disaster Recovery Framework

The Post Disaster Recovery Framework (PDRF), based on the PDNA, was prepared almost a year after the earthquake. It aims to provide a structured and prioritized framework for implementing recovery and reconstruction by sector, for government, national and international partners, affected population and other recovery stakeholders. Preparation of the environment and forestry chapter was led by MoFSC, and major efforts were made to work with other sectors to mainstream environmental aspects. Strategic Recovery Objective 3 of the PDRF aims to restore and improve access to services, and improve environmental resilience. This includes:

Promoting environmentally-sensitive measures across all sectors involved in recovery and reconstruction to build back better, safer and greener. It will also focus on restoring ecosystem functionality, improving the resilience and sustainability of ecosystems and the sound management of environmental hazards and risks. (NRA 2016)

The Environment and Forestry Team made stronger efforts to reach out to other teams this time, especially those that had the greatest risk of negative environmental impacts during reconstruction (mainly those involved in buildings since this was the area with greatest damage – especially the rural and urban housing and education sectors). Team members used personal contacts in other government ministries and departments, and this time the other sectors were much more receptive to incorporating green recovery practices.

(Source: Hariyo Ban Program)

swim. In many cases ecosystem services can help to reduce vulnerability to disasters, and maintaining or restoring them can help protect communities and investments (Monty et al. 2016).

Disaster preparedness: it is not possible to prevent all disasters, and disaster preparedness is very important in order to reduce the impact of a hazard when it occurs. Preparedness embraces the knowledge and capacity developed by governments, recovery organizations, communities and individuals to anticipate, respond to and recover from the impact of hazard events (UNOCHA 2016b). It is a good time to identify potential adverse environmental impacts of

disasters and disaster response during the relief, recovery and reconstruction phases, and build capacity of actors across different sectors to understand them and work out strategies to reduce them.

Principles for green recovery and reconstruction

The two teams undertaking the environment/forestry part of the PDNA, and post-earthquake Rapid Environmental Assessment, worked on a set of ten principles for post-disaster recovery. They are listed in the box below; this guide is based on these principles.

Principles for Green, Resilient Recovery and Reconstruction

The following principles apply across all sectors and clusters involved in the Nepal 2015 earthquake recovery and reconstruction. They were developed jointly by the PDNA Environment and Forestry team, and the Rapid Environmental Assessment team.

- Conduct land use planning, including zoning, before finalizing the locations of resettlement areas to minimize risks from landslides and floods, and ensure adequate land and natural resources to meet community needs, while minimizing environmental impacts.
- Ensure that building design and construction is environmentally sustainable, appropriate to the region, and will withstand future disasters.
- Ensure that fuel wood collection complies with existing forest management plans, and promote alternative energy and energy efficient technologies to reduce pressure on forests.
- Recycle and reuse debris as much as possible, and ensure that solid waste disposal during the reconstruction phase is managed using environmentally sound practices, including the introduction of new systems.
- Design water and sanitation interventions to reflect post earthquake changes in water resources and future climate change scenarios, and promote integrated water resource management (IWRM).
- Ensure that reconstruction of roads and hydropower take the opportunity to build back safer and greener, and take account of increasing climate variability.
- Prioritize support for rapidly restoring livelihoods in order to take pressure off forests and biodiversity after the earthquake; in the longer term ensure livelihood restoration projects reflect principles of resilient development.
- Take into account the specific rights, needs, and vulnerabilities of women and marginalized people in relation to natural resources during recovery, promote equitable access to recovery support, and strengthen community institutions and participation.
- Enforce environmental impact assessment/initial environmental examination regulations during reconstruction in order to avoid future disasters; and ensure enforcement.
- Build capacity for green recovery and reconstruction, and ensure consultation/coordination with relevant stakeholders in recovery and reconstruction.

(Source: National Planning Commission (NPC) 2015; Ministry of Science, Technology and Environment 2015)

Possible environmental implications of resettlement

Potential adverse environmental impacts from resettlement can include:

- loss of natural habitat such as forest, grassland or wetland; if the area is in an environmentally sensitive site, or in or near a protected area, it may have a big environmental impact
- disruption to wild animal populations, and cause of human-wildlife conflict for resettled people from species such as elephant, tiger or bear
- environmental damage from infrastructure, e.g. if new access roads have to be opened
- over-extraction or pollution of water resources, affecting downstream habitats, communities and wildlife
- overuse of forest resources, e.g. for firewood and building materials
- increased soil erosion and landslide risk
- reduced resilience of natural systems to climate change and climate variability, which can also affect their ability to provide services for the settlement

Sometimes settlements are redesigned in the same place rather than relocated after a disaster. This should generally cause less environmental impact.

The environment can also pose problems for settlements, if they are not carefully sited and planned. For example:

- natural hazards such as landslides, floods, and wildfire
- inadequate water supplies or agricultural land
- exposure to pests and disease
- exposure to extreme climate conditions
- remoteness – settlements located far from markets and social connections

Key principles for environmentally responsible resettlement

1. Undertake integrated settlement planning (ISP) in a two-step process: land use planning which focuses on designating and regulating the use of land; and physical planning that includes the planning of optimum physical infrastructure based on the land use plan
2. Make planning decisions in consultation with the affected people and relevant stakeholders
3. Undertake initial environmental assessments of potential sites early in the planning processes, and be prepared to abandon sites, or mitigate for potential adverse environmental impacts
4. Include an environmental management plan in the resettlement planning
5. Mitigate any adverse impacts on natural resources and ecologically sensitive areas that may result from the development of infrastructure and movement of people into or within potential sites
6. Take into account drainage and surface water flows by observing flows in the monsoon and/or consulting with local people; avoid sites which may flood
7. Consider climatic factors, including monsoon, heavy rains, temperature extremes and drought in site planning; allow for the intensification and increased frequency of climate extremes as climate change advances.
8. Ensure that sites for housing projects meant for poor and marginalized people are given equal emphasis and are not located near areas which will pose health, safety or environmental risks

The following diagram summarizes the key steps in the project cycle for environmentally sound land-use planning (grey) and physical planning (green):

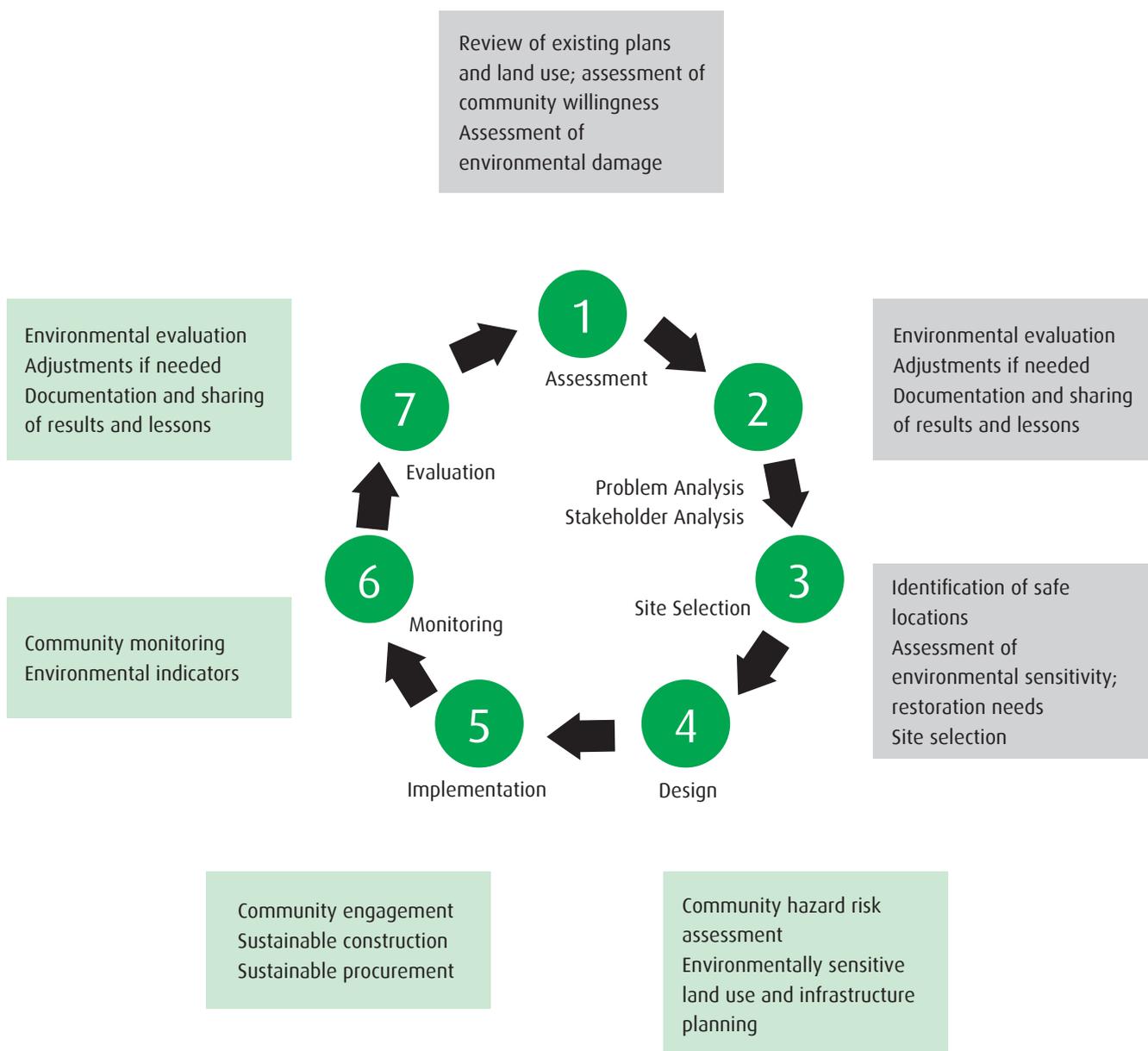


Local communities temporarily displaced by the 2014 floods, taking refuge in a community forest in Kamdi corridor in Dang district. If communities relocate in ecologically important forest corridors they may disrupt wildlife movements, and be vulnerable to human-wildlife conflict.
© WWF Nepal, Hariyo Ban Program/Judy Oglethorpe



Temporary camp in Dhunche, Rasuwa district, after the 2015 earthquake. Displaced people may place extra pressure on the environment as they meet their daily needs: for example, demand for firewood may increase, and water and sanitation may be an issue.
© WWF Nepal, Hariyo Ban Program/Ram P. Chaudhary

Key steps in the project cycle for sound land use planning and physical planning



The following table summarizes the main steps towards ensuring environmentally responsible integrated resettlement planning. Annex 1 provides a more detailed description; we encourage anyone embarking on resettlement planning to read it.

Key Steps to Achieve Environmentally Responsible Integrated Resettlement Planning

Stage of project cycle	Activities	Stage of disaster cycle
Initial Assessment	<p>Initial Planning Assessment/Preparation: Disaster Damage Assessment including damage to natural environment and community infrastructure, and future vulnerability of the existing settlement</p> <p>Assessment of the affected communities including prioritizing communities on the basis of need and willingness for reconstruction or resettlement. Assessment of their awareness of and interest in their environment, community environmental networks and institutions, and issues such as gender, poverty, livelihood etc. affecting the environment.</p>	
Problem Analysis and Stakeholder Analysis	<p>Environmental Assessment: environmental impact assessment of potential resettlement areas to understand local environmental values, direct damage by the disaster, and potential environmental impacts of resettlement, possible mitigating measures, and ways to integrate them in settlement planning at both regional and local levels for sustainable living. No-go decision at this stage if necessary, and seek alternative areas.</p> <p>Preparation of illustrative maps and drawings: compilation of cadastral information (e.g. land size, boundary, ownership) and geospatial information (e.g. land use, infrastructure, slope, elevation, conservation values including vegetation, corridors, wildlife distribution) contributing to a geospatial data set. Identification of possible resettlement site locations.</p> <p>Stakeholder Mapping and Analysis: identification of possible stakeholders likely to affect or be affected by proposed settlement planning. They are prioritized according to their impact on the ISP process and the impact the process will have on them. Stakeholders include people identified for resettlement; people living in or near the affected area; GoN officials, development partners. Special attention is paid to including the most vulnerable and disadvantaged people.</p> <p>Disaster Preparedness: including vulnerability analysis and community based risk assessments for natural disasters and climate change, taking into account vulnerable groups; integrate results from these analysis into the ISP process.</p>	
Site Selection	<p>Site Selection for reconstruction/relocation: based on the principles of sustainable settlements, which require an understanding of the context of the site, the local ecosystems and ecosystem services, hazards, and implications of the proposed development.</p>	
Planning/Design	<p>Planning stage that integrates with both regional and local socio-economic infrastructure and ecosystem processes through:</p> <p>Land Use and Infrastructure Planning to identify and organize the preferred land uses through the allocation and zoning of land for specific uses based on regulation of and intensity of use, ensuring environmental aspects are taken into account.</p> <p>Site Planning to locate building footprints along with physical infrastructures in such a way as to minimize adverse impacts on the surrounding environment and ecosystems.</p>	

Implementation - Construction and Operation	Plan Implementation: Using the most appropriate planning techniques (e.g. land readjustment technique), and promoting sustainable practices (many of them outlined in the rest of this guide)	
Monitoring and Evaluation	Monitoring and Evaluation: monitoring and evaluation to ensure compliance with the participatory process needed to prepare the plan, and evaluation of the plan's effectiveness and outcomes during implementation. Include environmental indicators in the monitoring and evaluating (M&E) plan.	



Any new settlement should be located near to existing access roads and trails, avoiding opening up access to new areas wherever possible in order to avoid indirect environmental impacts such as illegal logging and poaching.

© Karine Aigner/WWF



Resettlement areas should have adequate agricultural land and natural resources for the resettled people as well as any communities already living there. Natural resources include water, firewood, fodder and construction materials, and they should be harvested sustainably.

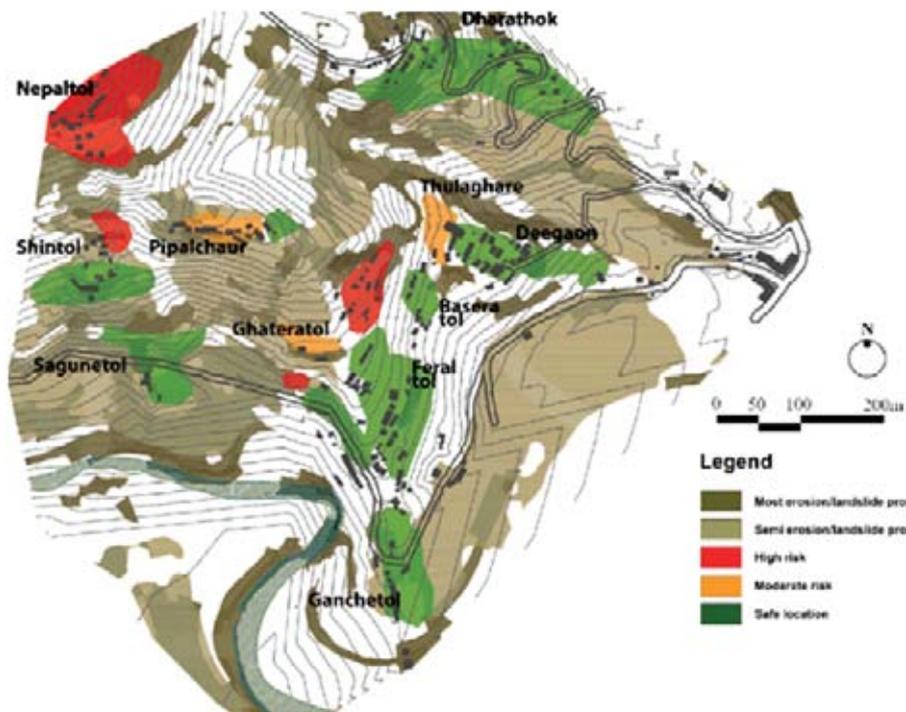
© Karine Aigner/WWF

Majhigaon Re-cluster Project

Community willingness and commitment to post disaster reconstruction is important for timely and successful integrated settlement planning. Many devastated communities in Sindhupalchok district, one of the worst affected by the 2015 earthquake, remained unsettled and undecided after the disaster. However, Majhigaon in ward no. 8 of Melamchi municipality, which has 221 households mostly belonging to the underprivileged Majhi (fisher) community, was proactive in making a formal request for resettlement to the municipality soon after the earthquake. A joint study team from Nepal's Institute of Engineering (IoE); Tribhuvan University, Nepal; Center for Environmental Planning and Technology (CEPT) University, India; United Nations Development Program (UNDP); and the Ministry of Urban Development (MoUD), Nepal prepared a re-clustering plan for the affected community in 2016 using the land readjustment (LR) technique in which the affected community participates in the project cycle of plan preparation. In the plan, due consideration was given to environmental concerns by carrying out detailed environmental analysis, and proposing sustainable construction of housing and infrastructure. Through the equitable contribution of land by landowners, community land was created for open space and livelihood opportunities like fish ponds and pig farms. Based on the project experience, a manual for re-clustering was also prepared (UNDP 2016). The pilot project is now being discussed for implementation.

Source: Sanjaya Uprety

Vulnerability map of Majhigaon, Sindhupalchowk District



(Source: UNDP 2016)

Three-dimensional view of the proposed recluster plan for Majhigaon



(Source: UNDP 2016)

Barpak Reconstruction and Rehabilitation Project

The Central Level Project Implementation Unit of the Department of Urban Development and Building Construction and the National Reconstruction Authority (NRA), with support from WWF Nepal, are carrying out a project for Barpak Reconstruction and Rehabilitation in Barpak Village Development Committee (VDC). At the epicenter of the 2015 Gorkha Earthquake, Barpak suffered extensive damage to housing, public buildings and community infrastructure. This has put immense pressure on the natural resource base in terms of demand for building materials and livelihood requirements of the forest-dependent community. Some areas are now unsafe, and the community does not have adequate open spaces for future disasters.

The government aims to develop an integrated resettlement plan using land readjustment (LR) to develop approximately 37 ha of private land located in wards 4-9 in the VDC. In the proposed LR approach, land belonging to affected people in the project area is temporarily pooled so that a new climate-responsive settlement can be planned along with the appropriate service infrastructure development required to support the proposed density of the LR scheme. This is a participatory process where the community of landowners voluntarily participates in the project conception and development by contributing land for open public spaces and infrastructure, and government develops the standard infrastructure by making public investments. The developed land is then returned to the landowner after deducting the percentage of land contributed by each owner for the infrastructure. The development is expected to provide integrated service infrastructure and encourage the affected people to move to the newly planned settlement.

Though originally intended to take an integrated approach, a large amount of attention has been focused on reconfiguring the pooled land, and not enough on integrating other land uses. Hopefully that situation can still be rectified.

(Source: Sanjaya Uprety)

GESI considerations

Resettlement planning should take into account the needs of the poorest and most marginalized people in the community, and women. This includes their land, water and natural resource needs, and livelihood activities. Their housing should not be located disproportionately far from forests, fields or water sources, and they should not be pushed to marginal areas where they may be at risk from natural hazards such as landslides or floods. Settlements should be laid out in a way that takes into account women's and girls' safety.

Climate change considerations

Resettlement provides an opportunity to take future climate change into account. Since more extreme weather events will occur as climate change advances, people should not be settled in possible future flood zones or beneath steep slopes that may develop landslides in the future. Infrastructure should be built to withstand more extreme events, and settlements should be well drained with control of runoff below the settlement. Selection of tree species for planting programs should consider which species are likely to thrive in the area in the future, given increase in temperature and more extreme weather events. See later chapters for more specific information by sector.

Relevant policies and legislation²

Settlement Development, Urban Planning and Building Construction, Basic Bylaws (2072)
National Reconstruction and Rehabilitation Policy (2072)
Nepal Earthquake 2015: Post Disaster Recovery Framework (2016-2020) (2016)
Land Registration Working Policy for Earthquake Victims (2072)
Housing Grant Distribution Policy for earthquake victims (2073)
Working policy for Resettlement for Disaster Victim Resettlement Operation (2071)

Further reading

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Majhigaon, Part B. UNDP 2016. (unpublished report)

Green Recovery and Reconstruction Toolkit. Modules 4 and 9. World Wildlife Fund & American National Red Cross. 2010. <http://green-recovery.org/>.



New settlements should be located near to fields and community forest where possible, so that people do not have to walk long distances.
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² Titles translated from Nepali by the chapter author

Possible environmental implications of recovery in the building sector

In the aftermath of a disaster, in the haste to reconstruct housing for affected populations, and buildings for offices and social services such as schools and healthcare, there are often unintended environmental impacts that harm communities over both the short and long term. The 2015 Nepal earthquake damaged or destroyed over 700,000 houses, 8,000 school buildings, 6,000 government buildings and 1,000 health facilities, requiring a huge amount of reconstruction over the space of a few years. The buildings that the earthquake destroyed had been built over decades with gradual consumption of building materials; now there is an intense demand for materials. Building construction is on such a scale that it will likely have the greatest environmental impact of any reconstruction activity.

Inappropriate sourcing of sand, gravel and stone from hill areas can cause landslides. If they are extracted harmfully from rivers they may cause erosion of the riverbed and collapse of river banks and infrastructure up- and downstream, as well as increased sedimentation, changing river courses, loss of land, increased flooding, and loss of dry season surface water sources downstream (WWF Nepal 2014). Increased brick

production increases air pollution. With the increased demand for timber there is a risk that steep slopes will be logged and forests cleared or degraded, with increased risk of landslides and flooding. Environmental damage may occur at and near construction sites (for example, destruction of vegetation, soil erosion and changing drainage patterns near the site, damage to water sources, and impacts on downstream wetlands and agriculture). Cement production requires large amounts of energy, often coming from fossil fuels which emits greenhouse gas, as well as extraction of other raw materials which may cause damage. Poorly designed or constructed buildings can lead to a costly waste of building materials. Possible environmental impacts of building materials in Nepal are outlined in more detail in WWF Nepal (2016a) and WWF and American Red Cross (2010).

Inappropriate disposal of building debris and construction waste is another potential environmental impact: this can destroy wetlands, block drainage lines and pose a hazard to people and wildlife (waste management is covered in more detail in Chapter 4).

However, there are also opportunities during reconstruction to adopt sound environmental practices and construct sustainable buildings, building back both safer and greener.

Sustainable building

Sustainable building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Green buildings are also known as sustainable or high performance buildings.

(Source: U.S. Environmental Protection Agency, <https://archive.epa.gov/greenbuilding/web/html/about.html>)

It is easier to integrate green practices during design and construction, rather than trying to retrofit them, so the reconstruction phase provides good opportunities to promote best practices. This includes taking advantage of appropriate new technological developments. Green buildings provide:

Environmental benefits: lower water and energy consumption; improved air and water quality; and better conservation of natural resources and biodiversity

Economic Benefits: reduced operating costs; improved occupant productivity; and markets for green products and services

Social Benefits: improved quality of life; reduced strain on local infrastructure; and improved health and comfort



Bricks are mainly manufactured in kilns which have been a major source of air pollution in the Kathmandu valley, burning imported coal and using outdated technology. Alternative building materials include compressed stabilized earth blocks (WWF 2016a). See also Chapter 6 for improvements in the brick kiln industry after the 2015 earthquake.

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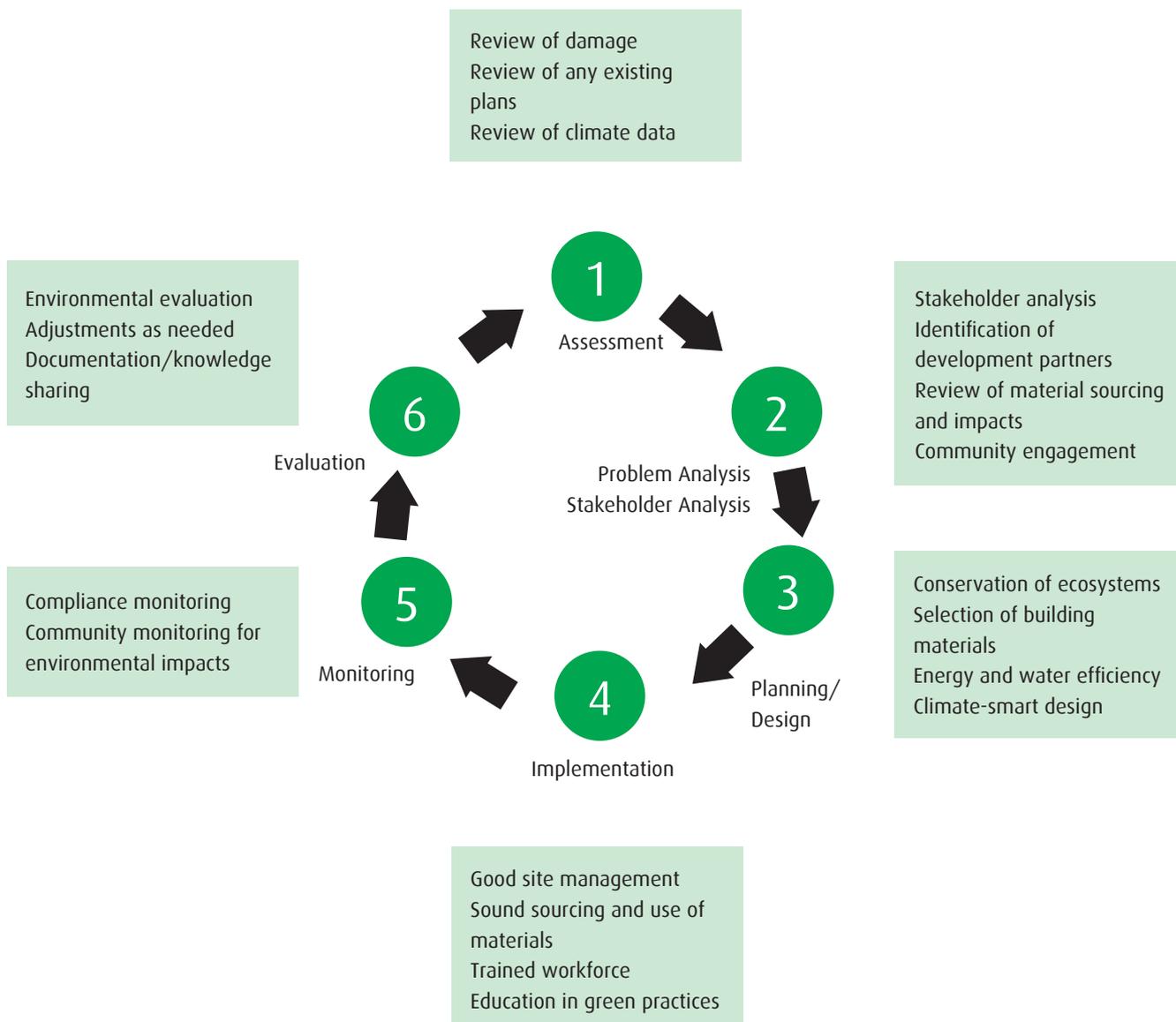
The brick industry consumes large amounts of clay, often removing valuable topsoil from agricultural land. Reusing and recycling building materials after a major disaster helps reduce demand for new bricks for reconstruction.

© WWF Nepal, Hariyo Ban Program/Judy Oglethorpe

Key principles for environmentally responsible building construction

1. Consider the whole life cycle of a building when designing it: construction, maintenance, reuse, demolition and recycling phases, and design to reduce environmental impacts
2. Select construction materials to minimize environmental impacts during the life cycle
3. Consider the local appropriateness of building materials, including legality, cost, transport distance, climate variability, energy efficiency and cultural aspects
4. Seek ways to lengthen the lifespan of the building, and its flexibility for various uses
5. Reuse, recycle and repurpose construction materials from debris where possible
6. Minimize the amount of waste from construction, and dispose of it responsibly; plan for minimizing waste when the building is occupied
7. Ensure adequate water supplies are available and sewage is disposed of without causing unacceptable impact; promote water efficiency
8. Promote energy efficiency in building design and operation
9. Promote other measures to protect occupant health and improve productivity
10. Ensure community/user participation and analysis of existing building practices to minimize environmental impacts and ensure acceptable design

Project cycle and environmental intervention points for building construction





Large amounts of sand, stone and gravel are required for reconstruction. They should be procured from legal and well-managed sites, avoiding adverse environmental impacts such as landslides, erosion, additional runoff, increased sedimentation, flooding, and loss of forest.
© WWF Nepal, Hariyo Ban Program/Judy Oglethorpe



Extraction of sand, gravel and stone from rivers can destabilize the substrate and result in river bed material being scoured out during the next monsoon; the extra sediment is transported and deposited downstream where it can worsen flooding and river cutting.
© WWF Nepal, Hariyo Ban Program/Nabin Baral

Key Steps to Achieve Environmentally Responsible Recovery, Reconstruction and Disaster Risk Reduction in Building Construction

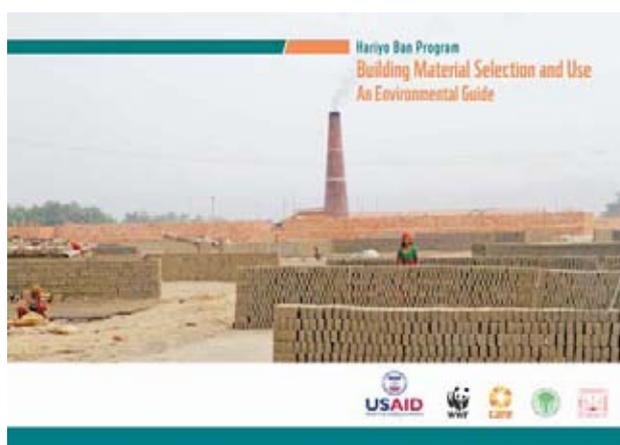
Stage of project cycle	Activities	Stage of disaster cycle
Initial Assessment	<ol style="list-style-type: none"> 1. Undertake broad-level assessment of damage in the sector including environmental factors. 2. Participate in PDNA and REA if carried out. 3. Review any existing integrated settlement plans or other plans prepared for the area to understand the context of site selection in terms of: <ul style="list-style-type: none"> ▪ safe and risk free areas for settlement development ▪ environmental criteria of site selection ▪ Type of conditions needed for locating infrastructure and buildings ▪ Guidelines/bylaws for housing construction, local technology, and construction materials 4. Collect information on local climate and any studies on the socio-cultural nature of housing in the area 	 
Problem Analysis and Stakeholder Analysis	<ol style="list-style-type: none"> 1. Undertake stakeholder analysis with full community engagement 2. Identify community cultural groups and their housing types, infrastructure use, construction technology, materials used, and public space needs 3. Prioritize affected groups/individual households by the urgency of their needs 4. Identify development partners and relevant public agencies operating in the area, including those promoting sustainable construction practices 5. Understand the environmental context of material sourcing and debris management 	 
Planning/Design	<p>Look for planning and design guidelines for sustainable buildings in post-disaster comprehensive or integrated settlement plans, and in building guidelines (e.g. for housing, health and education). Key considerations are:</p> <p>General</p> <ol style="list-style-type: none"> 1. Conserve ecosystem functions (e.g. water supplies; protection from landslides, soil erosion and flooding; shelter) around the construction site 2. Contribute to managing the local watershed to ensure future water supplies 3. Incorporate locally and culturally appropriate designs 4. Install efficient chimneys in kitchens or cooking spaces with indoor fires to reduce indoor air pollution 5. Incorporate safety features to lessen the impact of hazards, such as raised floors if flooding is a risk, adherence to building safety codes, and use of light building materials in case of earthquakes <p>Appropriate construction materials</p> <ol style="list-style-type: none"> 1. Make a life cycle inventory of possible construction materials to understand their potential environmental impacts, and select materials that are environmentally friendly with low embodied energy requirements (refer to WWF 2016a) 	   

	<ol style="list-style-type: none"> 2. Avoid building materials with high environmental impacts, including those containing toxic materials (e.g. paint with volatile organic compounds or lead) 3. Optimize building material use and minimize waste through optimizing building design <p>Energy efficiency and building comfort</p> <ol style="list-style-type: none"> 1. Take into account site microclimate; locate buildings in favorable sites where possible (e.g. sheltered areas in cold climates, and exposed to prevailing wind direction in hot climates) 2. Orient buildings with the sun according to energy needs: in cold locations make maximum use of south-facing aspect for warmth and light; minimize this in hot locations and use air circulation to keep buildings cooler, thus reducing the need for heating and cooling. 3. Install openable windows and doors to the exterior in all regularly occupied spaces and bathrooms to allow natural ventilation 4. Use reflective roofing material to keep buildings cool in summer (or even green roof technology if the building is strong enough – seek expert inputs for this) 5. Plant deciduous trees (trees that shed their leaves in winter) to provide shade in summer and allow sunlight to reach the ground in winter 6. Optimize daylight in building design, and use compact fluorescent lamps and light-emitting diode (LED) lights which consume less electricity 7. Use local renewable energy sources, e.g. solar, micro-hydro, wind, as much as possible and aim for technologically closed production cycles 8. Reduce firewood consumption through use of fuel-efficient stoves, or replace it with biogas and where feasible electricity (see energy chapter for more information) <p>Water efficiency</p> <ol style="list-style-type: none"> 1. Install rainwater harvesting system to capture at least 25% of run-off from roof and non-roof areas 2. Use selected state-of-the-art water-efficient plumbing fixtures such as aerators on sink faucets and low-flow showerheads to reduce water consumption 3. Promote multiple-use water systems (see Chapter 6 for more information) <p>Climate change aspects</p> <ol style="list-style-type: none"> 1. Take climate change into account in reconstruction by allowing for more extreme weather events like heavy rain, floods, droughts, heat and cold waves, and changes in snow load and wind speed 2. Plant trees and other vegetation to provide shade, and install green roofs to help control heat gain and minimize cooling demands 	
<p>Implementation: Construction and Operation</p>	<p>Sourcing, use and disposal of construction materials</p> <ol style="list-style-type: none"> 1. Reuse, repurpose and recycle as much old building material as possible, to reduce disposal problems and extraction of new materials 2. Use local skills and materials, and purchase materials locally where practical 3. Procure sand, gravel, boulders and other construction materials from legal, well managed areas with minimum environmental impact 	

	<ol style="list-style-type: none"> 4. Ensure that timber is harvested legally and responsibly from national and/or community forests or private land (Chapter 11) 5. Treat softwood timber against insect attack for longer life using safe products 6. Promote efficient use of building materials to cut costs and reduce waste 7. Dispose of building debris safely (Chapter 4) <p>Good Construction Practices</p> <ol style="list-style-type: none"> 1. Ensure good management of building sites and protect against soil erosion and stream sedimentation 2. Provide training to the workforce including masons and carpenters in the best construction practices for health, safety, and the environment 3. Making provisions to store hazardous materials appropriately (e.g. oils, paints) during construction 4. Raise awareness about green practices among house-owners responsible for owner-led reconstruction 5. Safeguard buildings from moisture through overhangs, porches, apron drains etc. and use termite barriers 	
<p>Monitoring and Evaluation</p>	<ol style="list-style-type: none"> 1. Ensure compliance with legal and sustainable sourcing of materials 2. Ensuring compliance with construction codes and guidelines 3. Ensure effective community monitoring, including for environmental impacts 4. Evaluate the effectiveness of environmental measures, and any adverse impacts that occur 5. Make adjustments as needed 6. Document the process and communicate results and lessons, contributing to improvements in future design and construction 	

Promoting green practices in building reconstruction in Nepal

There is growing awareness about the importance of green buildings, and incorporating environmental aspects into site planning and management. After the earthquake the Department of Education (DoE), Asian Development Bank and Japanese International Cooperation Agency included a section on environmental sustainability in their guidelines for post-earthquake school design. The Department of Urban Development and Building Construction (DUDBC) incorporated environmental modules into the training curricula for rural and urban masons. WWF produced an environmental guide to building materials.



(Sources: Department of Education et al. (2016), DUDBC (2016 a and b), WWF (2016a)



Reconstructing a building in Rasuwa district after the 2015 earthquake with a mixture of old and new building materials.
© WWF Nepal, Hariyo Ban Program/Judy Oglethorpe

GESI considerations

Men and women have different priorities and are differentially engaged in post-disaster reconstruction; these priorities should be taken into account. Post-disaster reconstruction should ensure inclusion of marginalized and underprivileged people in the process, with sectoral projects prioritized by marginalized groups, such as housing for the poor and income generation for female-headed households. Some key considerations and opportunities include:

- Men's and women's needs should be taken into account in building design
- Ensure that women and poor people can benefit from cash-for-work opportunities as well as men, on an equal basis
- Ensure safety of women and marginalized groups during recovery and reconstruction, including measures to reduce the risk of gender-based violence
- Ensure that poor and marginalized people are given equal priority with others when allocating sites for shelter

Climate change considerations

See climate change measures in the key steps table for this chapter.

Relevant policies and legislation

National Urban Policy 2006

Nepal Building Act 2007

National Shelter Policy 1996

Building Bylaws and Regulations Planning Norms and Standards, 2013

Settlement Development, Urban Planning and Building Construction, Basic Bylaws, 2072

Forest Act 1993 and Forest Regulations 1995

Timber Production, Import and Management Guideline for Earthquake Affected People 2016

National Parks and Wildlife Conservation Act 1973

Conservation Area Government Management Regulations 2000

Solid Waste Management Act 2011

Local Self Governance Act and Regulations, 1999

Further reading

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Building materials retrieved from damaged buildings for reuse in Rasuwa district.
© WWF Nepal, Hariyo Ban Program/Judy Oglethorpe



Stone from damaged buildings stacked up in Rasuwa district, awaiting reconstruction.
© WWF Nepal, Hariyo Ban Program/Judy Oglethorpe

Possible environmental implications of solid and hazardous waste

Major disasters may generate large amounts of solid waste and hazardous materials, which can cause environmental degradation and seriously impede relief efforts. For example, the 2015 earthquake generated a huge amount of debris from destroyed buildings. Hazardous waste released into the environment included electrical wastes; chemicals from laboratory spills; industrial chemicals; and petroleum products. Lead and mercury were released including lead in paint, potentially posing long-term health hazards. Some toxic chemicals likely ended up in ground water and rivers; some are persistent pollutants. Dead bodies and livestock carcasses contaminated the environment (MoSTE 2015).

Extra waste can be generated in the aftermath of an emergency. Large amounts of medical waste may come from hospitals and clinics if they are treating people injured in the

disaster. Emergency camps generate waste and often dump it or burn it, which causes air pollution. Relief activities often generate large amounts of plastic waste which is particularly difficult to dispose of safely since it does not decompose; and burning plastics may release harmful substances such as dioxins. Recovery and reconstruction also generate waste, including plastics; construction waste; and spoil from reconstruction sites.

Disposal of wastes in many municipalities and VDCs in Nepal is unsatisfactory in normal times, and during disasters environmental problems are exacerbated. Wetlands, stream banks, rivers and forests are often used for dumping waste, which can block streams, contaminate surface and ground water including drinking water supplies, and cause problems for water users downstream. Human-wildlife conflict may increase if wild animals scavenge on dump sites, and disease may be transmitted between wildlife, people and livestock as a result.

Hazards from dumping post-earthquake wastes

The only dumping site of Bhimeswor Municipality, Biruwa, in Dolakha district is in a populated area on the way to Jiri. All sorts of solid wastes collected in the quake aftermath were dumped in the site, which the local people found environmentally “very harmful.” They reported that the resulting leachate polluted the nearby Charnawoti river.

In Sipaghat, Kavre, local people complained of river pollution due to dead bodies and dead livestock.

Wastes from Gorkha Bazar were collected and dumped in the nearby Guthi forest. After the earthquake local people became very concerned about the health hazard of the wastes and volunteered to segregate them, at least into degradable and non-degradable wastes, so that they could be more effectively disposed of.

(Source: MoSTE 2015)

Toxic substances used in metal working

Kathmandu is known for handicrafts, and has a large number of metalcraft cottage industries. According to the Handicraft Association of Nepal, metal crafting industries use mercury, cyanide based chemicals, alkali based chemicals, lead, nitric acid, sulphuric acid, and cupric oxide. Many cottage industry sites were damaged or destroyed in the 2015 earthquake, with possible release of toxic chemicals and heavy metals into the environment. They are required to have pollution control certificates as per the Environmental Regulation but none do. Hence industries were hesitant to report on their losses. These sites require special attention for waste management.

(Source: MoSTE 2015)



Many municipalities and villages in Nepal have inadequate disposal facilities for solid waste; this village in Gorkha district dumps garbage in an open site in an adjacent forest. Reconstruction offers an opportunity to improve disposal systems for solid waste and hazardous materials.
© WWF Nepal, Hariyo Ban Program/Judy Oglethorpe

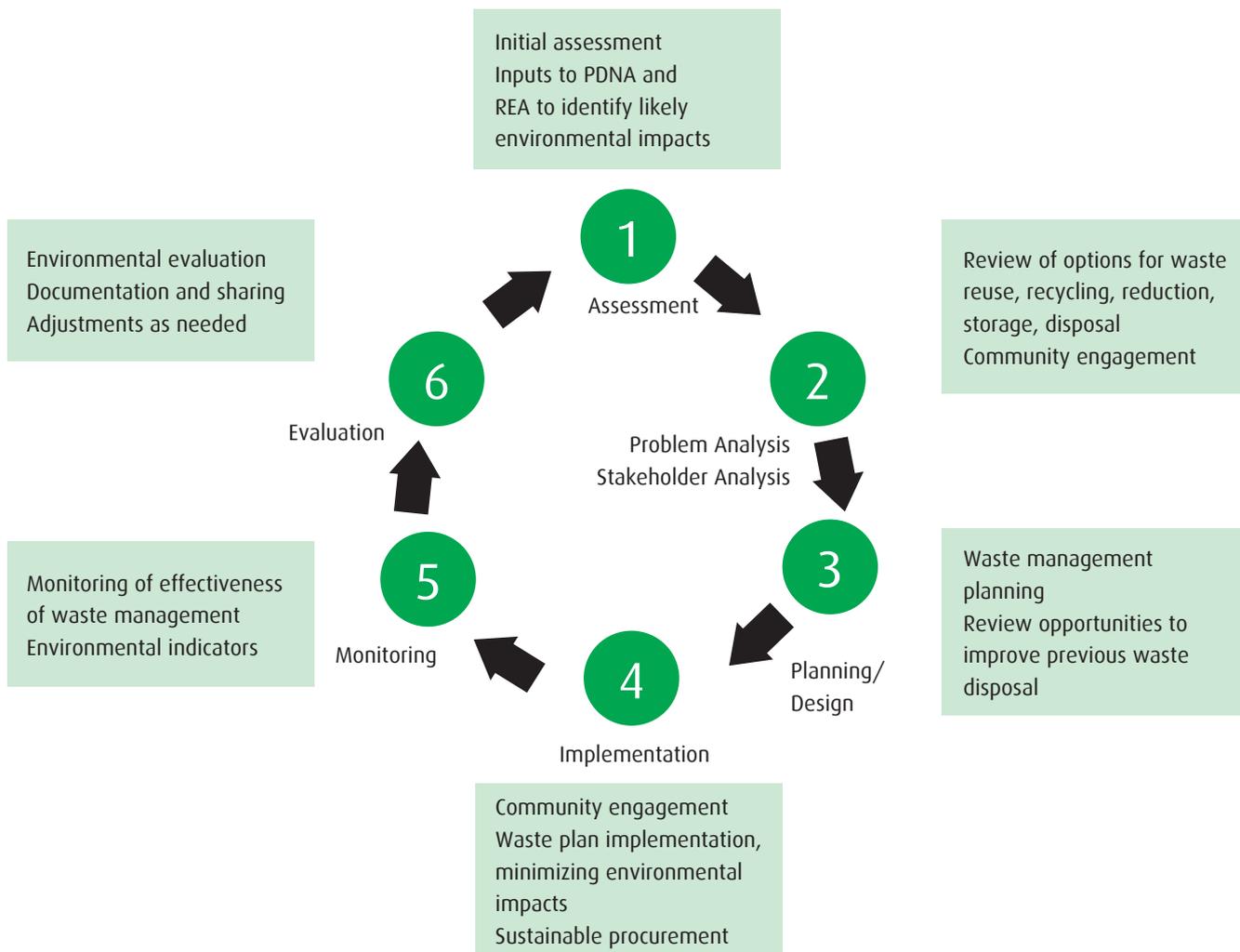


After the 2015 earthquake, garbage collection continued in Dhunche, Rasuwa District. Post-disaster relief operations often generate additional solid waste, including hospital wastes and plastics which need to be safely disposed of.
© WWF Nepal, Hariyo Ban Program/Ram P. Chaudhary

Key principles for environmentally responsible waste management

1. Reuse, recycle or repurpose (use for a different purpose) as much disaster waste as possible, when it is safe to do so – this saves reconstruction costs and reduces the amount of waste to be disposed of
2. When storing waste (e.g. building rubble) for future use, make sure that the waste does not pose a safety hazard or cause environmental damage
3. Dispose of remaining waste safely in ways that minimize adverse environmental impacts
4. Reduce waste in relief, recovery and reconstruction operations (e.g. packaging on relief and reconstruction materials; building reconstruction waste)
5. Take advantage of reconstruction opportunities to improve solid and hazardous waste disposal in municipalities and village development committees (VDCs), in industry, and in health facilities
6. For disaster preparedness, secure hazardous materials safely to reduce risk of leakage to the environment in the event of a major disaster
7. Follow building and construction codes to minimize the risk of building and infrastructure damage
8. Develop plans to manage solid and hazardous waste in the event of a disaster

Project cycle and environmental intervention points for waste management



Key Steps to Achieve Environmentally Responsible Recovery, Reconstruction and DRR in Waste Management

Stage of project cycle	Activities	Stage of disaster cycle
Initial Assessment	<ol style="list-style-type: none"> 1. Undertake broad level assessment of debris, other solid waste and hazardous waste generated by disaster itself, and waste likely to be generated by relief, recovery and reconstruction activities; and identify potential environmental impacts 2. Participate in PDNA and REA if carried out, drawing attention to likely environmental impacts from solid and hazardous waste <p style="color: #008000; margin: 5px 0;">If preparing for future disasters:</p> <ol style="list-style-type: none"> 1. For disaster preparedness projects, predict environmental impacts from possible debris and waste scenarios in future disasters and their likely relief/recovery/reconstruction efforts 2. Include a rapid inventory of sources of hazardous materials, including healthcare, industrial, agrochemical, and household hazardous wastes, and associated risks 	
Problem Analysis and Stakeholder Analysis	<ol style="list-style-type: none"> 1. Undertake stakeholder analysis 2. Review with stakeholders the options for managing solid and hazardous disaster waste, including reuse, recycling, repurposing, and reducing 3. Review options for storage of waste materials intended for later use such as building rubble; minimize environmental damage 4. Review options for safe disposal of remaining solid and hazardous waste that minimize environmental impacts, including contamination of air, soil and water bodies 5. Look for opportunities to improve the previous waste disposal arrangements at different levels during reconstruction 	
Planning/Design	<ol style="list-style-type: none"> 1. Produce waste management plans at appropriate levels in different sectors that cover reuse, recycling, handling, storage, and disposal of wastes 2. For disposal, develop environmentally sound solid waste management plans for all settlements and housing construction projects in affected districts at the municipality and VDC levels that include proper siting of waste disposal sites, minimize the potential for human-wildlife conflict, avoid impacts to vulnerable populations, and avoid water and soil pollution 	
Implementation - Construction and Operation	<ol style="list-style-type: none"> 1. Implement waste management plans, working to minimize environmental impacts during operation 2. Deal with hazardous disaster wastes to reduce risk of them entering the environment; in the case of spillage during the disaster, take remedial action to reduce environmental impacts, seeking expert advice where needed 3. Ensure that emergency medical personnel remove their used medical equipment, instruments and chemicals from sites and ensure their safe disposal 4. Encourage households, office managers, schools, health facilities, and private sector managers to minimize reconstruction waste and deal with as much as possible on the premises, e.g. through reuse, recycling, and composting/vermiculture; waste waiting for collection should be properly stored 5. Promote recycling schemes; these can also help to restart household economies by providing employment and economic activities 6. Continue to enforce the ban on import, sale, distribution, storage and use of asbestos and products containing asbestos 	

Monitoring and Evaluation	<ol style="list-style-type: none"> 1. Monitor and evaluate the effectiveness of waste management, including safety and environmental impacts 2. Document and share results and lessons 3. Make adjustments as needed to reduce environmental impacts 	
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GESI considerations

Poor and marginalized people are often more at risk from wastes: they may live near to landfill sites and dumps, and may rely on water sources that are at risk of contamination by wastes. They may also depend on sorting and recycling wastes for their livelihoods. They should be taken into account when planning disaster waste management, taking care not to put them at greater risk. There may be livelihood opportunities from disaster waste, for example in sorting and recycling waste. Safe working and living conditions should be promoted for them during recovery and reconstruction.

Climate change considerations

Greater weather extremes as a result of increased climate variability may cause worse flooding, making waste disposal more difficult. Flooded landfill sites and waste dumps may result in waste being washed downstream, where it may block channels and exacerbate flooding, or cause other environmental impacts. Higher temperatures may create additional waste-related health and hygiene problems in the future. Planning for waste treatment and disposal, and design of facilities, should take this into account.

Relevant policies and legislation

Solid Waste Management Rules 2013

Solid Waste Management Act 2011

National Policy on Solid Waste Management 1996

Healthcare Waste Management Guideline 2014

Further reading

Disaster Waste Management Plan. United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA), United Nations Environment Programme (UNEP). 2011.

Planning Centralised Building Waste Management Programmes in Response to Large Disasters. Shelter Centre, ProAct Network and Disaster Waste Recovery. 2014.

Technical Guide for Debris Management: The Haitian Experience 2010-2012. UNDP. 2013.

Plastic Sheeting: A Guide to the Specification and Use of Plastic Sheeting in Humanitarian Relief. International Federation of Red Cross and Red Crescent Societies (IFRC), and Oxfam. 2007.

Green Recovery and Reconstruction Toolkit. Module 5. World Wildlife Fund & American National Red Cross. 2010. <http://green-recovery.org/>



Rubble from buildings damaged and destroyed by the 2015 earthquake, stored in Kathmandu's Ratna Park.
© WWF Nepal, Hariyo Ban Program/Judy Oglethorpe



Newly constructed garbage pit for waste management in Jeevan Jyoti Lower Secondary School, Simjung 9, Gorkha district, part of a program to promote green recovery and reconstruction in schools after the 2105 earthquake. The garbage is collected in the pit and burned periodically.
© CARE Nepal, Hariyo Ban Program/Binita Khanal

Possible environmental implications in the energy sector

Disasters may directly disrupt existing energy systems including supplies of hydropower-generated electricity and liquefied petroleum gas (LPG), as well as solar power, biogas and improved cook stoves (ICSs). This can result in many households and institutions collecting firewood from forests for cooking and heating. Limited collection for a short time may be sustainable, and forests can provide an important buffer after a disaster. However, if demand for firewood is high or prolonged, they may become degraded and the ecological services they provide may be disrupted, for example increasing the risk of landslides and floods, and affecting water supplies.

If large hydropower projects are damaged by hazards such as extreme precipitation events or earthquakes, storage dams may cause downstream flooding if the dam is damaged. Streamflow through settling basins past damaged dams may have higher sediment loads and log debris as the settling basins are scoured. There may be risk of damage to downstream infrastructure and streambanks, and sediment deposition in fields, forests and floodplains. Hydropower plants may require repair and some may even need to be demolished. In order to repair or reconstruct plants, additional construction materials will be required; possible environmental impacts of sand, gravel and boulder extraction are outlined in chapter 3 and WWF (2016a).

Increased use of firewood after the 2015 earthquake

Immediately after the 2015 earthquake many people had to seek alternative fuels as grid and micro-hydro electricity supplies were disrupted, biogas plants were damaged, and improved cook stoves were buried under collapsed buildings. A rapid assessment by the Alternative Energy Promotion Centre and its partner network revealed that 146,767 ICSs, 16,721 domestic biogas installations and 70,000 solar installations were destroyed (NPC 2015). Some people turned to liquefied petroleum gas (LPG) when they could get it; LPG is a fossil fuel and contributes to carbon emissions. Many people started off burning damaged timber retrieved from collapsed buildings; when this was finished they collected firewood for cooking from private land or forests. Since many people were living in the open because their houses were destroyed or unsafe, additional firewood was likely used to keep warm, especially at high altitudes. Increased use of firewood placed additional pressure on forest resources, particularly in areas near to settlements. Cooking over open stoves inside temporary accommodation exposed women and young children to indoor air pollution. Increased use of open fires may have increased the risk of uncontrolled forest fire, as the earthquake occurred at the end of the dry season during peak fire season.

(Source: MoSTE 2015)

Innovation for shelter and warmth

Many rural households who lost their homes in the 2015 earthquake were able to take temporary shelter in polythene tunnels (greenhouses) on their farms. This reduced both the demand for firewood to keep warm, and poles and other forest products for building materials, hence limiting pressure on local forests.

(Source: MoSTE 2015)



After the 2015 earthquake many families took shelter in greenhouses like this one; they provided warmth and reduced the need for firewood.
© Karine Aigner/WWF



Improved cook stoves distributed after the 2015 earthquake helped reduce demand for firewood, cutting pressure on forests and saving women time and work in collecting firewood. In the higher altitude areas in Gorkha and other districts, metallic stoves like this one were distributed as part of winterization; these energy-efficient stoves are used to heat the house as well as for cooking.
© WWF Nepal, Hariyo Ban Program/Judy Oglethorpe

Resilience through improved cook stoves

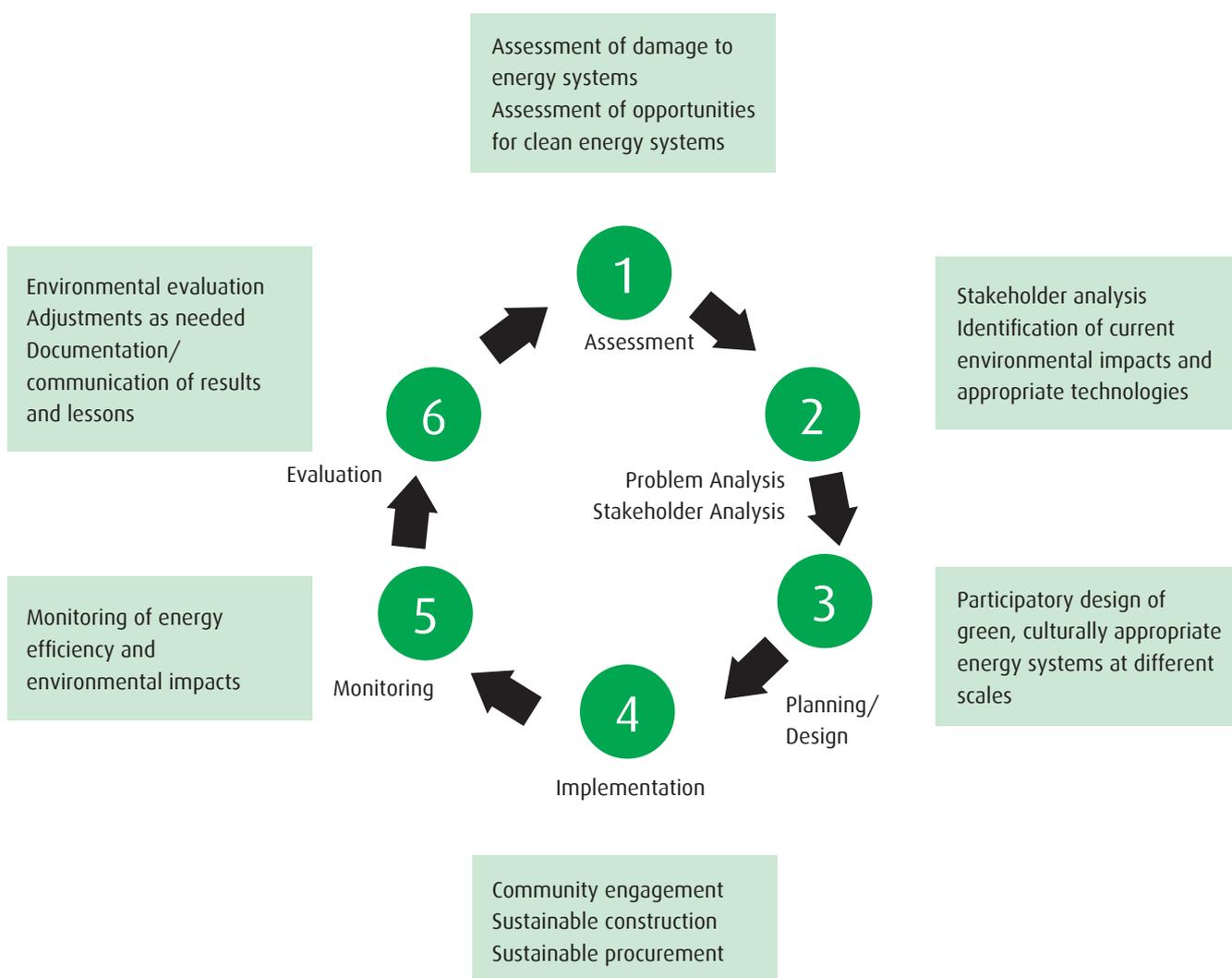
Some rural households reported that they were able to salvage improved cook stoves from damaged buildings and continue to use them outside, hence reducing firewood consumption and women's time and work collecting firewood.

(Source: Hariyo Ban Program)

Key principles for environmentally responsible energy recovery and reconstruction

1. Prioritize energy recovery after disasters in order to minimize pressure on forests for fuel.
2. Promote clean energy technologies during reconstruction of housing, offices, schools and hospitals to reduce future carbon emissions, pressure on forests and women's work loads.
3. Promote environmentally sound, clean technologies during reconstruction in industry.
4. Promote environmentally sound practices in hydropower development in order to reduce disaster risk.
5. During reconstruction of damaged hydropower projects, take the opportunity to mitigate any adverse environmental impacts that occurred previously.

Project cycle and environmental intervention points in energy systems



Key Steps to Achieve Responsible Recovery and Reconstruction in Energy Systems

Stage of project cycle	Small-scale community energy system activities	Large-scale hydropower and industrial activities	Stage of disaster cycle
Initial Assessment	<ol style="list-style-type: none"> Undertake an initial assessment of damage to community-level energy systems, community vulnerability, short-term alternative energy options, and likely environmental impacts Participate in the PDNA and REA as relevant 	<ol style="list-style-type: none"> Undertake an initial assessment of damage to hydropower plants and transmission lines with involvement of expert team; assess safety and vulnerability; do rapid assessment of environmental issues Participate in the PDNA and REA as relevant 	
Problem Analysis and Stakeholder Analysis	<ol style="list-style-type: none"> Undertake rapid stakeholder analysis and baseline survey of energy systems including disaster damage, with community engagement Identify options for appropriate local-level energy technologies for reconstruction, switching to clean or more efficient energy use where feasible Consider cultural aspects, resource limitations, maintenance needs, environmental impacts, and climate change 	<ol style="list-style-type: none"> Undertake rapid environmental assessment ((initial environmental examination (IEE) or environmental impact assessment (EIA) for reestablishment of hydropower projects, identifying ways to mitigate impacts in design and implementation Undertake supplementary EIA in case of partial redesigning of hydropower schemes, especially, for example, if additional land is needed Undertake stakeholder assessment 	
Design	<ol style="list-style-type: none"> Promote use of multiple green energy sources/types for greater resilience, including local sources where possible (e.g. biogas, ICSs, solar, micro-hydro) Try to minimize extra firewood consumption Plan any firewood use in accordance with community forest operational plans, buffer zone management plans, conservation area management plans or other forest plans Take environmental factors into account when planning micro-hydro 	<ol style="list-style-type: none"> Minimize environmental and social impacts during redesign of hydropower projects, avoiding forest fragmentation and loss, impacts on wetlands, disruption of environmental flows³, and impacts to local communities Take into account geological, topographical, ecological and social factors and ensure resilience of dams and other works to natural and manmade disasters to reduce risk of exacerbating downstream floods in future 	

³ An environmental flow is the water regime provided within a river, wetland or coastal zone to maintain ecosystems and their benefits where there are competing water uses and where flows are regulated. Environmental flows provide critical contributions to river health, economic development and poverty alleviation. They ensure the continued availability of the many benefits that healthy river and groundwater systems bring to society (Dyson et al., 2008).

	<ol style="list-style-type: none"> 5. Where feasible, install chimneys for improved cook stoves to reduce indoor air pollution 6. In light of disaster impacts on poor communities, consider providing energy systems without loans to avoid additional burden 7. Design energy systems that are appropriate for the needs of different types of households, including poor households (where, for example, biogas may not be appropriate if they do not have land or livestock) 8. Consider climate change patterns and extremes including more intense cold snaps in the future, and make the designs climate-smart 9. Ensure design includes responsible selection and use of construction materials as appropriate 	<ol style="list-style-type: none"> 3. Plan hydropower on the basis of river basin rather than individual projects; undertake strategic environmental assessments (SEAs) of basin hydropower development once SEA legislation is introduced, allowing for environmental flows 4. Take the opportunity while reconstructing hydropower projects to ensure designs are climate-resilient, allowing for more extreme and more frequent weather events including heavy rain and snowfall, and drought 5. Promote the transfer of environmentally sound and cleaner technologies in industry such as improved technologies in the brick kiln sector; and improved energy efficiency in cement, and iron and steel industries 	
Implementation - Construction and Operation	<ol style="list-style-type: none"> 1. Follow the principles of Sustainable Construction 2. Source and procure material locally if environmentally and socially responsible 3. Follow the principles of Sustainable Procurement 4. Create local employment by training local technicians in energy technology installation 5. Engage community in construction in keeping with GESI principles 6. Develop an operation and maintenance plan with the community (e.g. for community micro-hydro schemes) 	<ol style="list-style-type: none"> 1. Promote environmentally sound and sustainable reconstruction approaches, and maintain minimum flows during construction and operation 2. Plan, collaborate and communicate with government, local communities, other dam operators in the same watershed, and other stakeholders as part of integrated river basin management 3. Avoid unnecessary clearing of forest areas for reconstruction 4. Reuse construction material as far as possible 5. Source new construction materials so as to minimize environmental impacts (WWF 2016a); use sand, gravel and stone only from well managed sites authorized by local authorities 6. Restore sites after completion of construction activities and maintain greenery 	

		<ol style="list-style-type: none"> 7. Promote soil bioengineering techniques to stabilize unstable areas around the project area, as well as in erosion and landslide prone areas of the watershed 8. Provide employment opportunities for local communities in construction activities including women and marginalized households 	
Monitoring and Evaluation	<ol style="list-style-type: none"> 1. Monitor energy efficiency, technical issues, and environmental impacts 2. Monitor cultural acceptance of energy technologies by women and men, and any social impacts 3. Evaluate energy efficiency, technical issues and impacts; make adjustments if necessary 4. Document and share results and lessons 	<ol style="list-style-type: none"> 1. Undertake frequent monitoring as prescribed in environmental assessment report (impact and compliance monitoring) 2. Monitor construction materials, energy use and technology and their environmental consequences 3. Ensure active participation and consultation of local community during monitoring 	

Delivering metal ICSs to high altitude areas

The Hariyo Ban Program funded metal ICS distribution in high altitude areas in Manaslu Conservation Area and Langtang National Park. This helped with winterization for people living in temporary conditions after the earthquake. Access was a problem especially in Manaslu because landslides continued to disrupt foot trails, but ICSs were eventually distributed by NTNC with mule trains.

(Source: NTNC, Hariyo Ban Program)

Reducing energy consumption and air pollution in brick kilns in the Kathmandu valley

Brick kilns in the Kathmandu valley are a major source of air pollution, burning mainly coal (a fossil fuel producing greenhouse gas) with outdated technology leading to inefficient combustion. The 2015 earthquake damaged over 100 brick kilns in the Kathmandu valley, and others outside. There were concerns that air pollution might increase during reconstruction, given the huge demand for bricks (NPC 2015). However, the earthquake also provided an opportunity to introduce better brick kiln technology. Fortunately, work was already underway with stakeholders and experts on a new design manual to promote cleaner kilns that would reduce harmful air pollutant emissions and improve fuel efficiency: the *Design Manual for Improved Fixed Chimney Zig-Zag Brick Kilns* (MinErgy and Federation of Nepal Brick Industries 2015). In 2016 the UK Department for International Development provided funding through the International Centre for Integrated Mountain Development (ICIMOD) to support the modification, mechanization and upgrading of technology for cleaner brick production in Nepal. The funding is promoting alternative building materials and energy sources, support environmental policy development, and work on building the capacities of stakeholders, and evaluating the impacts of a cleaner brick industry in the country. This is a great example of an opportunity to build back safer and greener after a disaster.

(Source: www.icimod.org; MinErgy and Federation of Nepal Brick Industries 2015)



Many micro-hydro schemes were damaged by the 2015 earthquake. This one in Simjung, Gorkha district, was repaired with support from the Hariyo Ban Program, enabling families once again to have electricity in their homes.
© WWF Nepal, Hariyo Ban Program/Nabin Baral

GESI considerations

Since women and girls spend considerable time collecting firewood in many parts of rural Nepal, post-disaster energy systems designed to reduce environmental impacts from firewood will also improve the lives of women and girls, saving both time and energy that can be used for other household tasks, education, and economic activities. Also, alternative energy technologies that avoid indoor open fires reduce indoor air pollution, helping the health of women and young children.

Climate change considerations

Reducing heavy pressure of firewood collection in forests helps to improve forest condition; healthy forests are more resilient to climate change, and should continue to provide ecosystem services for longer as climate change advances. (However, note that firewood collection may reduce fuel loads for uncontrolled forest fires; forests may be more susceptible to forest fires if dead plant material accumulates on the forest floor.)

Using reconstruction as an opportunity to advance alternative energy

There is an overall trend in rural areas in Nepal, as households develop, for them to progress through a sequence of different forms of household energy. Starting with open fires, this progresses as follows for cooking (note that some stages may be skipped, and households may use more than one form at once):

- Open wood or dung fires (high resource consumption)
- Improved cook stoves (reduced resource consumption; may burn briquettes)
- Biogas (normally no firewood consumption)
- Liquefied petroleum gas (LPG) (no firewood consumption, though LPG is a fossil fuel and emits greenhouse gas)
- Electricity (micro-hydro or main line) (no firewood consumption; Nepal is increasing large-scale hydropower production and electrification of rural areas, and is becoming less dependent on fossil-fuel generated electricity)

For lighting, solar power is replacing kerosene which reduces indoor air pollution; solar power is also increasingly being used to operate other appliances.

During recovery and reconstruction there may be opportunities for households to jump to more advanced types of renewable energy, taking advantage of new clean energy technology to reduce carbon emissions, indoor air pollution and work for women (e.g. more efficient designs of improved cook stoves (WWF 2015a) and latest developments in solar power).

(Source: Hariyo Ban Program)

Relevant policies and legislation

National Energy Strategy 2009

Rural Energy Policy 2006

Biomass Energy Strategy 2017

Hydropower Development Policy 2001

Electricity Act, 1993 and Electricity Regulation 1993

Environmental Protection Act 1997

Environmental Protection Rules 1997

Water Resources Act, 1992 and Water Resources Regulation 1993

Water Resource Strategy 2002

Aquatic Animal Protection Act 1961

Plant Protection Act 1992

Further reading

Beyond Firewood: Fuel Alternatives and Protection Strategies for Displaced Women and Girls. Women's Commission for Refugee Women and Children. 2006.

Analysis of Available Models of Improved Cook Stoves and their Suitability in Different Ecological Zones in Nepal. WWF Nepal. 2015.

Green Recovery and Reconstruction Toolkit. Module 5. World Wildlife Fund & American National Red Cross. 2010. <http://green-recovery.org/>

Possible environmental implications from recovery in the infrastructure sector

Infrastructure is a major component in the overall development of the nation, as the social and economic wellbeing of communities depends upon their access to infrastructure such as trails, roads, irrigation canals, domestic water supplies, and so on. Reconstruction of critical infrastructure is key to disaster recovery. The 2015 earthquake affected many roads, trails, bridges, and small-scale irrigation canals. Of the 5,159 landslides mapped in 17 districts, 464 landslides in 11 districts affected roads, hydropower projects, bridges, irrigation systems, and/or buildings (ICIMOD 2016).

Infrastructure recovery and reconstruction activities may have significant environmental impacts if environmentally sound reconstruction approaches are not promoted. Debris disposal (chapter 4) and demand for reconstruction materials (chapter 3) are two of the main environmental impacts. If infrastructure has to be resited or rerouted it may cause loss of farmland or forest, and if it does not have adequate engineering design and drainage it may trigger erosion and landslides.

Key principles for environmentally responsible infrastructure reconstruction

1. Ensure good management of debris, including reuse of debris as construction material as far as possible and proper disposal of unused material to avoid environmental risks
2. Promote labor-based reconstruction as much as possible, which is often more environmentally appropriate and helps household recovery
3. Identify and mitigate for environmental impacts during extraction of construction materials, and ensure materials are extracted legally with local authority permission and environmental assessments as needed (initial environmental examination (IEE) or environmental impact assessment (EIA)).
4. Consider geographical and ecological features during reconstruction; avoid unstable slopes, core and dense forest, sensitive wildlife habitat, corridors and wetlands; and prevent habitat fragmentation.
5. Promote low energy use technology and minimize waste generation during reconstruction activities.
6. Promote soil bioengineering using locally available materials for slope stabilization when construction is complete (chapter 12).
7. Ensure that legal requirements for environmental assessment are met before implementing reconstruction work.

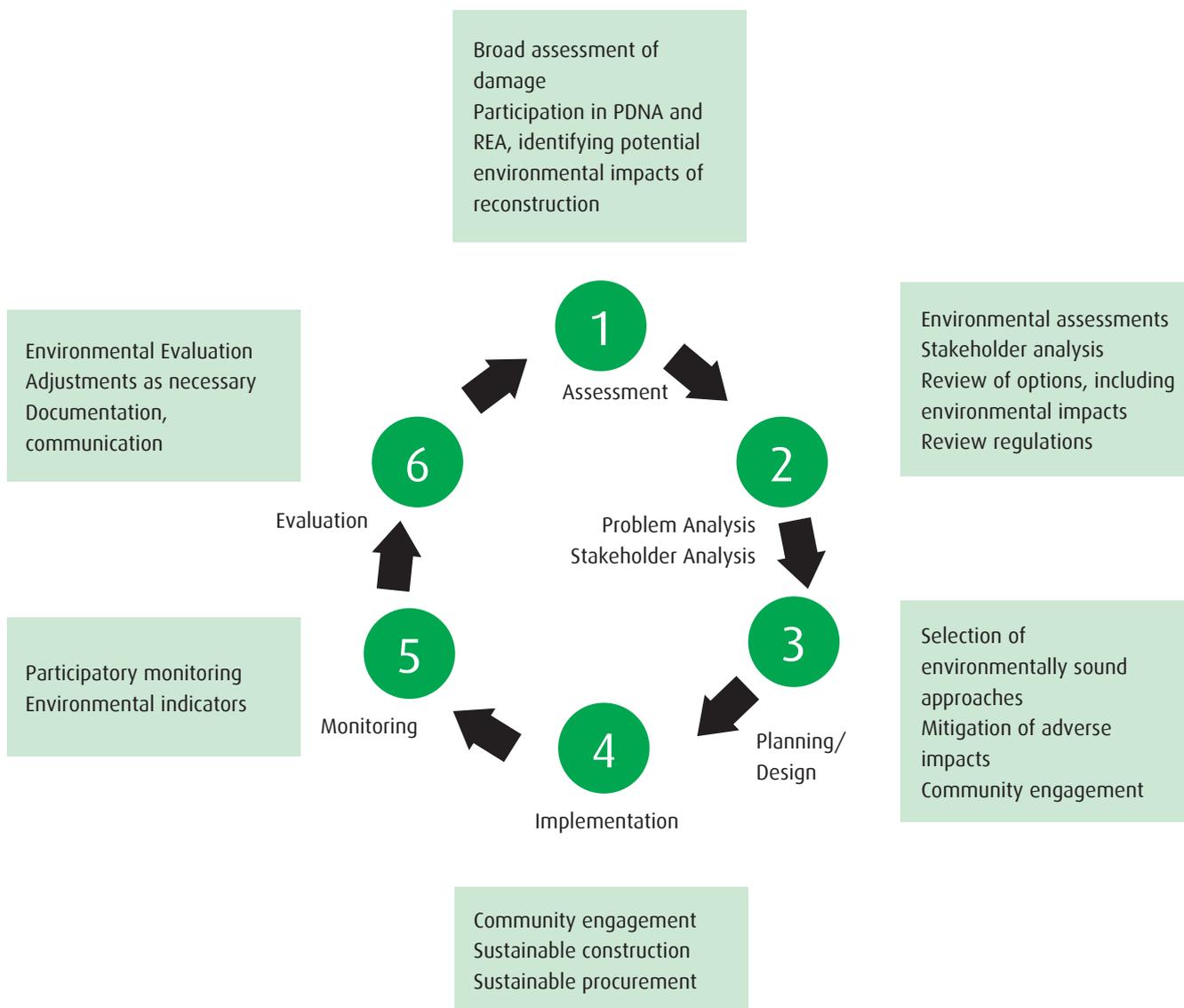


Roads traverse rugged terrain in Nepal, like this one in Rasuwa district.
© Samir Jung Thapa



The earthquake exacerbated many existing landslides that were started by poorly designed and inadequately constructed roads.
© WWF Nepal, Hariyo Ban Program/Ram P. Chaudhary

Project cycle and environmental intervention points for sustainable infrastructure reconstruction



Key steps to achieve environmentally responsible recovery, reconstruction and DRR in infrastructure

Stage of project cycle	Activities	Stage of disaster cycle
Initial Assessment	<ol style="list-style-type: none"> Undertake broad assessment of damage and likely cause (slope instability, water flow, rough terrain, human induced, etc.) Participate in Post Disaster Needs Assessment (PDNA) and Rapid Environmental Assessment (REA) if carried out, and identify potential environmental impacts in reconstruction. Undertake Environmental Assessment (EIA or IEE) if needed 	 
Problem Analysis and Stakeholder Analysis	<ol style="list-style-type: none"> Review alternative sites and routes when needed for reconstruction, assessing environmental, safety, social, economic and financial factors Avoid protected areas, core and dense forest areas, wetlands, and key biodiversity areas; avoid causing habitat fragmentation as much as possible; look for alternative sites/routes in degraded areas and forest edges Avoid wildlife areas, especially of endangered and threatened species, and avoid wildlife corridors in order to reduce human-wildlife conflict Avoid steep terrain and select the most stable slopes Look for opportunities to build back safer and greener to rectify previous problems With participation of local communities and taking the above factors into account, select routes/sites that allow use for as much of the year as possible, and maintain ecological diversity 	  
Planning/Design	<ol style="list-style-type: none"> Undertake site planning of reconstruction activities with community engagement Ensure sound drainage provision to avoid sloughing and erosion Plan to reuse debris as much as possible Where new materials are essential, give priority to locally obtained construction materials, and select materials with low environmental impact (WWF 2016a) Plan only for new construction materials whose extraction is permitted by the local authority; avoid extraction from dense forest and core habitat areas, and minimize local environmental impacts Plan for greenery along reconstruction sites 	  
Implementation: Construction and Operation	<ol style="list-style-type: none"> Avoid unnecessary clearing of vegetation in vicinity of construction site Ensure adequate drainage of the site Minimize earthworks during reconstruction to reduce sediment runoff and erosion Promote low energy approaches such as labor-based reconstruction work, which also reduces erosion Reuse construction materials as much as possible. Maintain cut slope angle and fill the vacant space to avoid erosion and maintain ecological balance Promote revegetation along cut slope and slope edge to prevent erosion Avoid exploitation of forest and wetland resources including illegal tree felling and wildlife poaching by the labor force during reconstruction activities Undertake reclamation of the work site after completion of construction activities Select and promote appropriate soil bioengineering techniques and plant species (chapter 12) 	 

Monitoring and Evaluation	<ol style="list-style-type: none"> 1. Undertake regular monitoring of reconstruction activities with participation of local communities, including environmental impacts arising from material extraction, construction, and operation of the infrastructure 2. Evaluate results including any negative environmental impacts 3. Document and share results 4. Implement appropriate mitigation measures 	
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Mitigation hierarchy for minimizing adverse impacts of infrastructure development

For infrastructure reconstruction, the mitigation hierarchy concept is crucial to avoid negative impacts to the environment and ensure infrastructure is sustainable.

Avoidance: The first option involves measures to avoid impacts to the greatest extent possible (e.g. avoiding a route through a core forest area). It is the first priority and an effective option to reduce potential impacts.

Minimization: Includes all measures designed to reduce the immediate and long-term impacts that cannot be completely avoided (e.g. minimizing vegetation clearing as much as possible during construction activities).

Compensation: Includes all measures designed to offset the residual adverse impacts after avoidance, minimization and other mitigation measures have been taken (e.g. afforestation and revegetation along a road).

GESI considerations

Cash-for-work schemes can be very effective in helping households to restart their lives, and can particularly benefit poor and marginalized people. Women and differently abled people should be included in schemes; there should be equal pay and people should contribute as they are able to (chapter 8). Hence labor-based construction work should be prioritized

as far as possible. Effective site restoration after construction reduces the risk of future disasters to marginalized people who often live in some of the most vulnerable locations, and may be at greater risk because of the construction. Soil bioengineering with plants selected by local communities brings additional benefits from harvesting plant resources once the vegetation is mature.

Climate change considerations

Infrastructure is often vulnerable to climate hazards (e.g. glacial lake outburst floods (GLOFs), landslides, snowmelt, more intense rainfall and flooding). Post-disaster reconstruction should take the opportunity to build back allowing for greater climate extremes in the future, and higher average temperatures. Avoiding reconstruction work in landslide and flood prone areas is an initial step. Many landslides occurred in the proximity of roads after the 2015 earthquake; the proliferation of local roads opened by bulldozer without adequate survey, design and drainage should be avoided. Infrastructure should be carefully sited and designed, avoiding unstable slopes and clearing of forests. It should be designed for more intense rainfall and higher flood levels, with provision of adequate side drainage for runoff from trails and roads, and frequent maintenance, to control erosion and downstream sedimentation. Restoration of forests and subwatershed management above drinking water and irrigation sources should be undertaken during reconstruction to help maintain water quality and quantity, and to reduce future drought impacts.



Repairing foot trail bridge at Sirdibas, Manaslu Conservation Area, using local materials. The bridge provides a vital connection for local communities.
© National Trust for Nature Conservation, Hariyo Ban Program/Bishnu Singh Thakuri

Reconstruction of trail infrastructure in Manaslu Conservation Area, Gorkha

It was a pleasant Saturday noon, serenely calm until suddenly the earth shook from its depths like they had never known before. Stones rolled down from steep slopes, houses collapsed and dust obliterated vision. For the first few seconds there was a sense of utter daze, and then the elders cried out: "Earthquake, Earthquake! Get to the open field."

"What a terrible day," Mr. Gopal Lama recollected in Chumchet VDC in Gorkha.

As a result of the 2015 earthquake the trail to upper Gorkha was severely damaged in several places by landslides and flood washouts. This disrupted a vital lifeline connecting remote mountain communities with family, friends and markets. It also hit a burgeoning tourism trekking industry. To restore local livelihoods and tourism, NTNC, Hariyo Ban Program supported local communities to rebuild 13.5 km of trail including 12 wooden bridges. Mr. Bishnu Gurung, Hariyo Ban Program's local resource person for Sirdibas, said that this provided an opportunity for the communities to improve the quality of the trails, making them safer, wider and more attractive for trekkers. By using carefully extracted local materials like stone and mud, and reusing timber, the trail building was environmentally friendly as well as cost effective.

Wooden bridges installed at Yarubagar and Sardi near Lokpa in Chumchet VDC have served over 6,900 local people in Tsum and Nubri Valley, in addition to more than 2,000 trekkers by the end of 2016. Mule trains, vital for livelihoods and for transporting recovery and reconstruction materials, used the bridge at Yarubagar until an alternative route was built. At Sardi Bhir two wooden bridges continue to serve more than 1,900 local people in Tsum valley. Mr. Tashi Dorje Lama, a local from Chhekampar 1, smiles at the thought of these bridges. Without them most people in Tsum would not have been able to migrate to lower areas during the last two winters – a time when heavy snowfall covers the area for about three months each year. The traditional seasonal migration enables people to make ends meet and avoid the harsh winter in Tsum. Without the bridges they would have been stranded – the bridges ensure the people's future.

(Source: NTNC, Hariyo Ban Program)

Relevant policies and legislation

Environmental Protection Act 1997
Environmental Protection Rules 1997
Nepal Environmental Policy and Action Plan 1993
Water Resources Act, 1992 and Water Resources Regulation 1993
Soil and Watershed Conservation Act 1982
Forest Act, 1993 and Forest Regulation 1995
Forestry Sector Policy 2000
Plant Protection Act 1992
National Land Use Policy 2012
Mines and Minerals Rules 2000
Public Road Act 1974
Local Self-Governance Act 1999
Aquatic Animal Protection Act 1961
Irrigation Policy 2060
National Parks and Wildlife Conservation Act 1973

Further reading

Beyond Investment: Developing sustainable green infrastructure in Nepal. WWF Nepal. 2014.

Green Recovery and Reconstruction Toolkit. Modules 5, 6 and 9. World Wildlife Fund & American National Red Cross. 2010. <http://green-recovery.org/>



Trail reconstructed by the Naukunda Users Committee at Ghatte Khola, Rasuwa district, after the 2015 earthquake. Trails like this one provide vital access for remote local communities, and also enable trekking tourism to restart, helping to revive local economies.
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Possible environmental implications from recovery and reconstruction in the water, sanitation and hygiene sector

The water, sanitation and hygiene (WASH) sector usually suffers serious impacts after any major disaster. Total damage caused to the WASH sector in 2015 Nepal earthquakes exceeded Rs. 11 billion. A disaster's impacts on the WASH sector are quickly transformed into social and environmental impacts. In a disaster aftermath, inadequate WASH facilities lead to serious social issues (e.g. break-out of waterborne diseases, security and privacy issues for women and children) and environmental issues (e.g. contamination of waterways and groundwater). Reconstruction of WASH infrastructure can also lead to many environmental pressures. These include the risk of water over-extraction, which can impact ecosystems and fisheries downstream, as well as affecting supplies for downstream users. In the 2015 earthquake some water sources dried up, forcing people to seek other sources further afield. As for buildings, repair or reconstruction of WASH facilities needs construction materials and which can have environmental impacts (see Chapter 3).

Therefore, it is important to plan and implement post-disaster recovery and reconstruction of WASH to meet community requirements, in a timely and environmentally responsible manner.

Key principles for environmentally responsible post-disaster WASH recovery

1. Take an **integrated** planning approach for WASH recovery and reconstruction with a **watershed** perspective to promote clean and reliable water supplies while ensuring other ecosystem functions.
2. Plan both **hard** (physical infrastructure) and **soft** (capacity building, awareness) measures.
3. All stages of post-disaster WASH recovery project-cycle should include full **community engagement**.
4. Consider the special needs of different social groups including women and marginalized households.
5. Consider the **environmental impact and cost-benefit analysis** in planning and implementing WASH projects.
6. Consider **climate change impacts and uncertainties** in planning design.
7. Promote **water use efficiency**.
8. Consider **multiple technology and material choices** in planning, design and construction.

Shifting water supplies in Ramche, Gorkha District

Thulo Ban Community Forest User Group identified drought as a major climate vulnerability for Ramche village in Gorkha district, a small settlement of 15 households. The Group incorporated the construction of a drinking water tank into its community adaptation plan of action, and a 10,000 l tank was constructed at the source which lies 50 m below the village. The work was completed shortly before the earthquake. The water was used for domestic use, livestock, and vegetable farming. After the earthquake the original water source dried up, and there was an acute water shortage. Women in particular suffered for a month and a half as they struggled to run their households; sanitation became poor in the village. After six weeks water started to flow again from the source, but at a lower rate. The villagers identified another water source to meet their needs, 200 m below the first one, and the Hariyo Ban Program supported construction of another water tank there as part of its earthquake recovery program. Now, this 5,000 l tank collects water which is pumped up using electricity to the first tank. The village again has an adequate water supply.

(Source: WWF, Hariyo Ban Program)

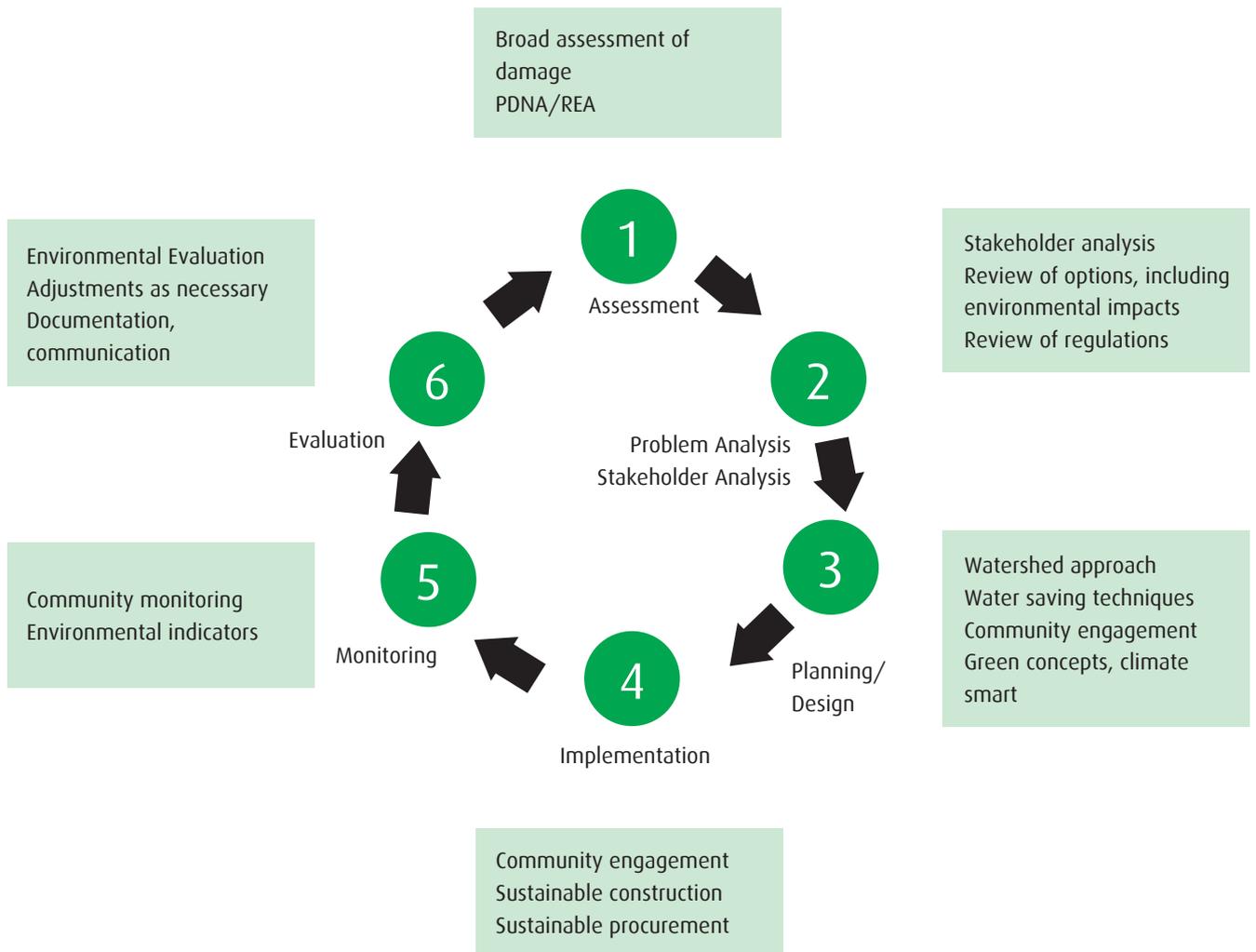


Water source affected by the 2015 earthquake in Dihi village, Bhimeshwor Municipality, Dolakha district. The earthquake reduced the flow of water to this source, although it did not dry up completely and people were able to continue using it. In some places people had to seek new water sources.
 © WWF Nepal, Hariyo Ban Program/Jagannath Joshi



Roadside toilet block affected by the 2015 earthquake in Rasuwa district. In many places toilets were destroyed or damaged, and sanitation was a problem in temporary settlements.
 © WWF Nepal, Hariyo Ban Program/Judy Oglethorpe

Project cycle and environmental intervention points for water and sanitation reconstruction



Key Steps to Achieve Responsible Recovery and Reconstruction of Water Supply and Sanitation Facilities			
Stage of project cycle	Water Supply Activities	Sanitation Facility Activities	Stage of disaster cycle
Initial Assessment	<ol style="list-style-type: none"> 1. Broadly assess extent of damage, identifying existing environmental impacts and potential ones from recovery 2. Participate in post-disaster needs assessment (PDNA) and rapid environmental assessment (REA), if done 	<ol style="list-style-type: none"> 1. Broadly assess extent of damage, identifying existing environmental impacts and potential ones from recovery 2. Participate in post-disaster needs assessment (PDNA) and rapid environmental assessment (REA), if done 	
Problem Analysis and Stakeholder Analysis	<ol style="list-style-type: none"> 1. Undertake stakeholder analysis for WASH with full community engagement 2. Consider multiple water sources and multiple technologies, and their cumulative environmental impacts and select the most appropriate 3. Consider upstream-downstream issues and develop a Water Safety Plan (World Health Organization 2005) 4. Check and adhere to local regulations (WaterAid 2005) 	<ol style="list-style-type: none"> 1. Undertake stakeholder analysis for WASH with full community engagement 2. Consider multiple sanitation technologies (septic tanks, biogas toilets, urine diversion dehydration toilets (UDDTs), bio-filters), and their environmental impacts and select most the appropriate (e.g. Esrey et al. 1998) 3. Check and adhere to local regulations 	
Planning/Design	<ol style="list-style-type: none"> 1. Use traditional practices and local knowledge positively in planning 2. Evaluate and select sources and technologies with the community and local government official based on: resource limitations, environmental impacts, cultural acceptance, climate change 3. Plan for complementary water sources such as rainwater harvesting 4. Plan for optimal water extraction, keeping provisions for future expansion and environmental flows⁴ 5. Consider climate change patterns and extremes, and allow for greater and more frequent extremes in the future 6. Plan for: water source protection, conserving the watershed and controlling pollution sources 	<ol style="list-style-type: none"> 1. Use traditional practices and local knowledge positively in planning 2. Evaluate and select technologies with the community and local government officials based on: resource limitations, environmental impacts, cultural acceptance, climate change 3. Design according to humanitarian standards and local government regulations 4. Consider the applicability of small de-centralized treatment systems (cluster systems) 5. Consider ecological sanitation options (e.g. urine diversion toilets, bio-gas toilets) (Esrey et al. 1998) 6. Provide facilities and easy access to people with special needs 	

⁴ An environmental flow is the water regime provided within a river, wetland or coastal zone to maintain ecosystems and their benefits where there are competing water uses and where flows are regulated. Environmental flows provide critical contributions to river health, economic development and poverty alleviation. They ensure the continued availability of the many benefits that healthy river and groundwater systems bring to society (Dyson et al., 2008).

	<ol style="list-style-type: none"> 7. Improve the safety and sustainability of the source and the watershed, for example through restoring forests and stabilizing landslides 8. Ensure optimal design of the water conveyance system with minimal waste of water and energy, and build to be more resilient to future disasters 9. Introduce water saving and reuse devices at household level (e.g. water saving faucets, household water reuse systems) 10. Ensure responsible selection and use of construction materials (WWF Nepal 2016a) 	<ol style="list-style-type: none"> 7. Consider the special requirements and security of women and children; especially menstrual health 10. Consider the impacts of climate extremes (e.g. probability of flooding/drought) in design, and allow for greater and more frequent extremes in the future 11. Design for minimum water requirement (e.g. dry toilets, dual flush cisterns) 12. Take design measures to prevent vector breeding in toilets and treatment systems 13. Design to minimize sludge production and facilitate optimum sludge handling 	
Implementation - Construction and Operation	<ol style="list-style-type: none"> 1. Follow the principles of sustainable construction 2. Source and procure material locally if environmentally and socially responsible 3. Follow the principles of sustainable procurement 4. Engage community in construction, in keeping with GESI principles 5. Develop an operation and maintenance plan with the community; it should be community driven where possible (e.g. community water supply schemes) 6. Provide awareness to community on water safety and integrated water resource management (IWRM) 7. Provide technical and environmental training to technicians and volunteers 	<ol style="list-style-type: none"> 1. Follow the principles of sustainable construction 2. Source and procure material locally if environmentally and socially responsible 3. Follow the principles of sustainable procurement 4. Engage community in construction, in keeping with GESI principles 5. Provide awareness to community on hygiene, menstrual health and maintenance of latrines 6. Develop operation and maintenance plans with the community for treatment plants and sludge handling 7. Provide technical and environmental training to technicians and volunteers 	
Monitoring and Evaluation	<ol style="list-style-type: none"> 1. Ensure regular monitoring of: water safety, water quality, financial indicators, technical issues of treatment plants, community acceptance, environmental indicators 2. Conduct periodic evaluations with the community; document and communicate results and lessons; make adjustments as needed 	<ol style="list-style-type: none"> 1. Ensure regular monitoring of: community acceptance, technical issues in sewage treatment plants, environmental indicators 2. Conduct periodic evaluations with the community; document and communicate results and lessons; make adjustments as needed 	

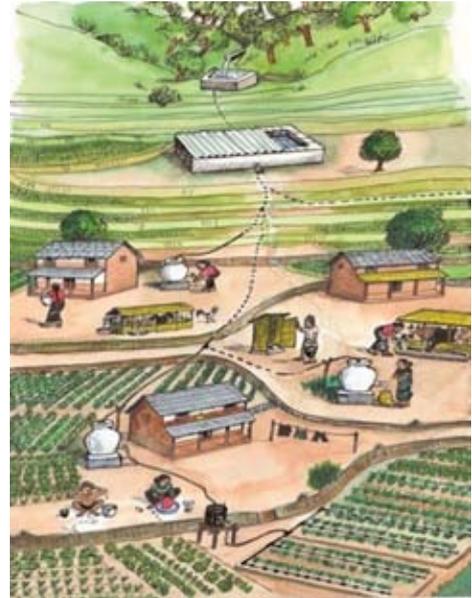
Multiple Use Small Water Systems - Nepal

Multiple use water systems (also referred to as MUS) are community based water schemes (10-80 users) distributing water from a single or multiple small upland sources for both domestic uses and small scale cultivation (International Development Enterprises (IDE) and International Centre for Integrated Mountain Development (ICIMOD) 2013). They promote more efficient use of water, and hence less consumption. There are many MUS schemes in 25 districts of Nepal, implemented by government agencies and NGOs. These schemes normally include 1) protected sources, 2) watershed conservation, 3) small storage tanks, 4) filtration (if necessary), 5) distribution lines and stand-posts and 6) irrigation off-take lines for small/micro-irrigation systems (drip or micro sprinkler).

Community benefits: Minimum conflict between water users, livelihood security, reduces burden on women, community empowerment

Environmental benefits: Efficient water consumption, community based watershed protection

Advantages in post-disaster context: Fast community-based recovery after disasters, reduced risks compared to major water supply schemes (e.g. dams, large pipelines)



Single tank MUS with domestic and crop use
(Source: IDE-Nepal and ICIMOD (2013))

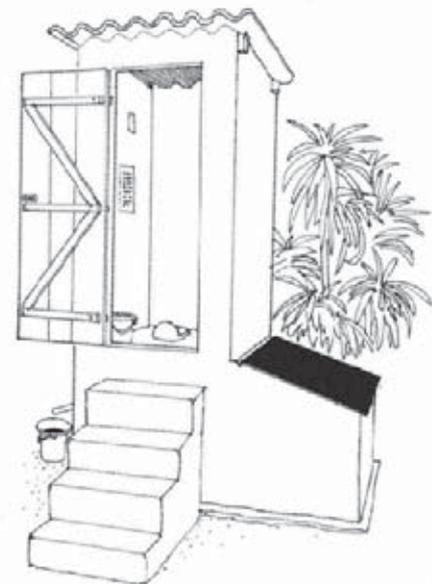
Urine Diversion Dehydration Toilets (UDDT) – Vietnam and India

The Urine Diversion Dehydration Toilet (UDDT) is a domestic latrine design which has provisions to collect urine and feces separately (Esrey et al. 1998). With adequate maturation periods feces can be composted while urine can be diluted (2-5 times) and applied to household crops. Normally UDDTs have two composting chambers, where one is used while feces in the other are allowed to compost for a period of 6 months or more. There are many NGO and government driven domestic UDDT projects in Vietnam, India, and Sri Lanka.

Community benefits: Cost is lower than septic tank systems; applicable in communities used to washing or wiping for anal cleansing; complements home gardening

Environmental benefits: Low water use, no ground water pollution, promotes nutrient recycling

Advantages in post-disaster context: applicable in flood prone and high-groundwater areas, easy to rebuild in case of disasters



UDDT with solar heated composting chamber - Vietnam
(Source: Esrey et al. (1998))



Small-scale drip irrigation schemes like this one in Kaski district can greatly reduce water consumption in agriculture, compared with open-channel irrigation systems. They are portable and can be used in remote areas.
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GESI considerations

Women play a huge role in managing water for their households. It is particularly important to consider work loads of women and girls, and the impact that water supply has on them. Marginalized women may face problems in accessing water due to social exclusion, or because they have to live further away from water sources. If women can participate in water and forest management decision-making they can advocate for practices that protect and improve water supplies. Sanitation and hygiene are also particularly important for women and adolescent girls, including menstrual health.

Climate change considerations

One of the most common vulnerabilities documented in Hariyo Ban's community-level climate adaptation work is changes to water sources. Many communities report that sources now have lower flow or are drying up completely in the dry season, compared with previous decades. Since climate extremes are expected to intensify in the future this problem is likely to worsen. Reconstruction can take this into account, diversifying water sources and promoting water efficiency to build resilience (e.g. incorporating rainwater harvesting, and promoting drip irrigation). The effect of climate extremes on sanitation should also be taken into account: for example, a precaution against greater flooding could be to construct toilets on higher ground where they are less likely to contaminate ground water.

Relevant policies and legislation

Environmental Protection Act and Rules 1997
Water Resources Act 1992
Drinking Water Supply Rules, 1998
National Drinking Water Quality Standards 2005
Solid Waste Management Act 2011

Further reading

Sphere Handbook: Minimum standards in water supply, sanitation and hygiene promotion. <http://www.spherehandbook.org/en/how-to-use-this-chapter-1/>

Designing water-supply and sanitation schemes to meet demand in rural and peri-urban communities: Book 1. Devrill, P. et al. 2002. UK: WEDC, Loughborough University. <https://wedc-knowledge.lboro.ac.uk/details.html?id=19141>

Tutorial. Integrated Water Resources Management Tutorial. http://www.cap-net.org/wp-content/uploads/tutorials/iwrm_tutorial/1_1.htm

Green Recovery and Reconstruction Toolkit. Module 7. World Wildlife Fund & American National Red Cross. 2010. <http://green-recovery.org/>

Water, Sanitation and Hygiene (WASH) Environmental Considerations. WWF Nepal, Hariyo Ban Program. 2016. www.wwfnepal.org.

Possible environmental issues during recovery in the agriculture and livelihoods sector

As people struggle to restore their lives and livelihoods after disasters, there can be several types of environmental impact. Forest resources are likely to be heavily used for food and livelihood activities if farming and local enterprises are disrupted or people lose jobs, especially for poor and vulnerable people who have no other alternatives. While forests can serve as an important buffer for people, if their use is heavy or prolonged it may result in forest degradation, for example from extracting firewood for sale, or poaching of wildlife for food.

Opening of new farmland in resettled areas may result in forest loss and disruption of ecosystem services and processes. Livestock may escape or be turned loose in forests because their enclosures have collapsed or there is nobody to care for them. Again, while forests can provide a buffer, excessive trampling and browsing in forests may damage young trees. Introduction of new crop varieties and animal breeds as part of recovery efforts may displace native varieties and breeds, resulting in loss of traditional landraces that can withstand local conditions. Or they may be lost if traditional farming ceases due to labor shortages or changing priorities in the household after a disaster. Livestock restocking and distribution of seeds from other areas may introduce pests, invasive alien species and livestock diseases. Farm land may be used for extraction of construction materials such as soil, sand, and boulders, and fertile topsoil may be lost due to increased demand for brick-making and other building materials. There is a risk that restricted pesticides may be provided to farmers as part of the recovery effort, at a time when they are less well equipped to handle them safely. If water sources have dried up as a result of the disaster (as occurred in several places after the 2015 earthquake) new sources may be sought to rehabilitate irrigation schemes, with possible impacts on freshwater biodiversity and wildlife.

People often have to spend much time caring for their families, finding food and shelter, and recovering their livelihoods after a disaster. They may have to take

employment to earn cash to restart the household economy – and there are often many job opportunities during the reconstruction phase. There is a risk after major disasters that local communities may not have time to manage their forests. It is well recognized that illegal loggers and hunters often become more active during such times, taking advantage of the situation. Tourism often acts as a deterrent to illegal activities because it increases the presence of people in remote areas, but tourism also often drops drastically after a major disaster, especially if accommodation and infrastructure such as roads, trails and airports are affected.

Post-disaster relief and recovery opportunities are usually designed to return the community to pre-disaster conditions. However, experience shows that merely returning rural communities and households to their pre-disaster state can leave them vulnerable to future hazards. Also, previous livelihood activities may have been environmentally unsustainable. There may be an opportunity to address these issues during recovery, helping to build back better, safer and greener.

Therefore, it is important to plan and implement post-disaster relief and recovery of livelihoods to meet community requirements in a timely and environmentally responsible manner.

Key principles for environmentally responsible post-disaster livelihood recovery

1. If livelihood activities involve the harvesting of natural resources, ensure that harvesting is sustainable and will not degrade forests, aquatic systems or watersheds
2. If livelihood activities involve development of new land, or new farming practices are introduced, ensure there are no unacceptable impacts such as forest loss, increased risk of landslides, downstream sedimentation, or impacts on water supplies
3. Encourage farmers to avoid releasing excess nutrients into the environment, for example through over-use of chemical fertilizer (which may be used if livestock have died in the disaster and manure is no longer available), in order to conserve water quality



Wetlands and forests can help provide temporary food sources after a disaster, a buffer until people can restart damaged food production systems. However, if too many people are dependent on natural resources, or the recovery period is prolonged, the resource base may be depleted. This can cause problems for local communities in the future, especially poor and marginalized people who may be particularly dependent on them.

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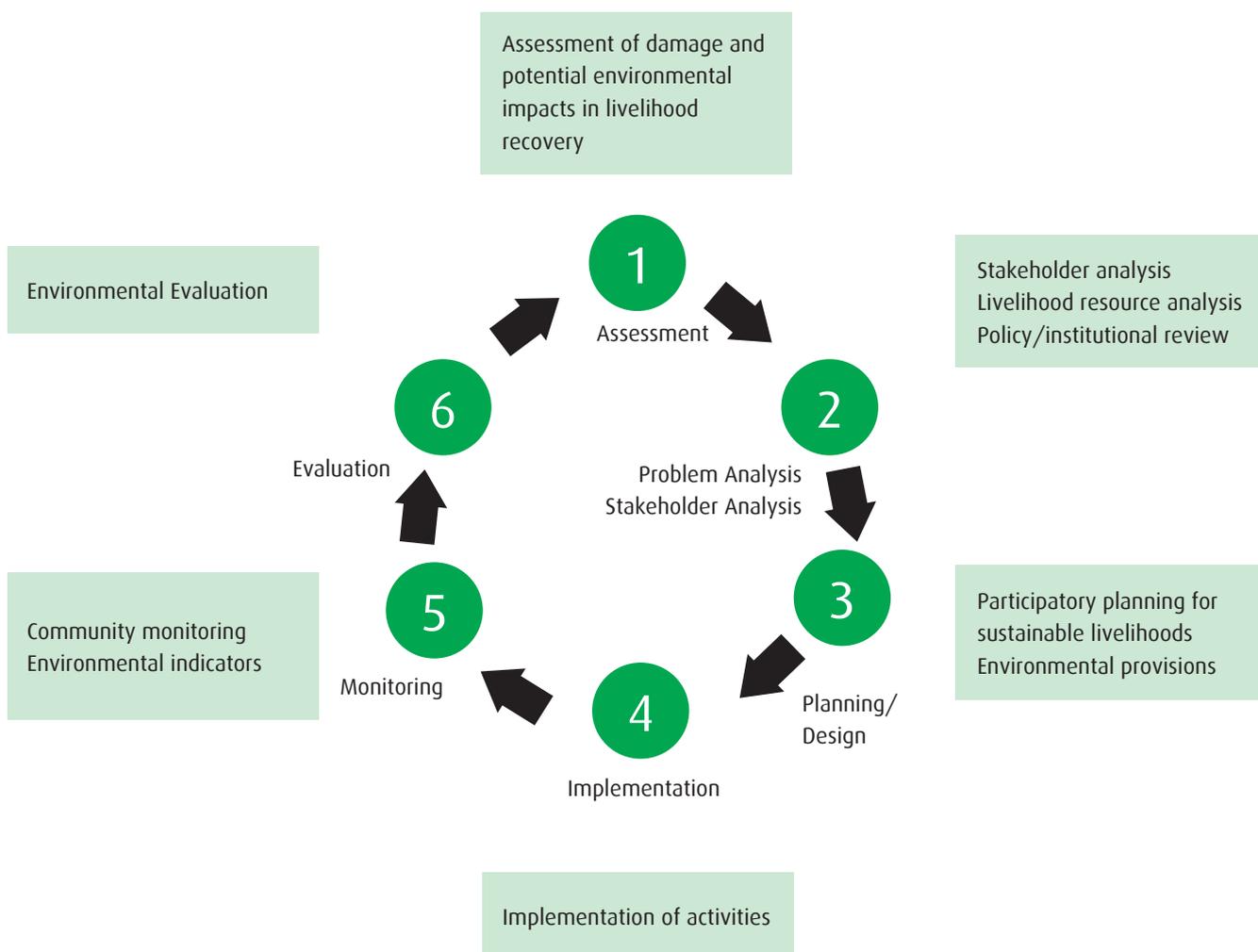


Supporting people to re-establish farming quickly after a major disaster can help reduce pressure on the environment. In the 2015 earthquake many households lost stored crop seed when their buildings collapsed. When supplying new seed, it is important to distribute only tested and government-approved crop varieties that are suitable for the area.

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4. Promote alternatives to pesticides wherever possible including integrated pest management; if pesticides are used, ensure they are legal and train farmers to use them responsibly
5. Promote in-situ conservation of landraces where possible; distribute only tested and government-approved crop varieties and appropriate livestock breeds for the area, ensuring livestock are vaccinated and people have adequate facilities and food for them
6. Avoid introducing new species to an area (whether intentional or unintentional); species may become invasive in new habitats
7. Promote labor saving technologies when there is a labor shortage and to reduce women's work loads
8. Introduce activities that help restore household economies and small businesses and reduce pressure on forests (e.g. cash for work; grants and small loans)
9. Revitalize the tourism sector by supporting repair or reconstruction of damaged tourism infrastructure, ensuring safety of tourists
10. Take climate change into account when redeveloping livelihoods.

Project cycle and environmental intervention points for agricultural and livelihoods



Key Steps to Achieve Environmentally Responsible Recovery, Reconstruction and DRR in Agriculture and Livelihoods

Stage of project cycle	Activities	Stage of disaster cycle
Initial Assessment	<ol style="list-style-type: none"> Undertake broad level assessment of damage including environmental factors Participate in PDNA and REA if carried out 	
Problem Analysis and Stakeholder Analysis	<ol style="list-style-type: none"> Undertake stakeholder analysis Undertake participatory livelihood review including livelihood resources, stakeholder aspirations and options for socially appropriate, environmentally sound livelihoods in the future that take potential future climate change impacts into account Review relevant policies, institutions and development partners 	
Planning/Design	<ol style="list-style-type: none"> Develop a livelihood support strategy based on needs, aspirations, size and capacity of labor force, and resource base, ensuring that they are economically and environmentally sound and responsive to future climate variability and change. Ensure priority for those most seriously affected by the disaster, especially poor and marginalized people and women. Depending on the situation opportunities may include: <ul style="list-style-type: none"> ▪ Cash for work or food-for-work ▪ Provision of seeds (local, tested crop varieties and other farm inputs) ▪ Replacement of stall-fed livestock (poultry, cattle, buffalo, goats and sheep) and fish lost in the disaster, ensuring appropriate breeds/species; healthy, vaccinated livestock; and adequate food and housing/ponds ▪ Provision of soft loans to farmers and entrepreneurs to promote value addition, processing and agribusinesses as well as micro, small, and medium sized enterprises ▪ Addressing farm labor shortages and women’s workloads by promoting technologies like mini tractors, planters and harvesters ▪ Repair/reconstruction of damaged irrigation canals and water storage ponds so that agriculture can resume next season, taking into account changes in water sources and environmental/downstream impacts ▪ Addressing climate vulnerabilities (e.g. if irregular rainfall or cold snaps were affecting crops in the area before the disaster, consider introducing drip irrigation or greenhouses (poly tunnels), or more resilient crops) ▪ Bringing back jobs in the tourism sector by repairing damaged infrastructure and facilities using mechanisms such as cash for work or food-for-work, and restarting tourism in safe areas ▪ Vocational training with a focus on skills that will be needed for recovery and reconstruction, and long-term economic development; mainstream environmental principles in training institutes/programs 	
Implementation - Construction and Operation	<ol style="list-style-type: none"> Rapidly promote livelihood activities through agricultural restoration (including traditional production systems with short season crops and early maturing varieties), cash for work, green enterprises, and rehabilitation and creation of on- and off-farm micro-enterprises so that people can rebuild their lives and reduce dependency on forests, following the principles above. Specific activities to minimize adverse environmental impacts and build resilience to future disasters and to climate change may include: <ul style="list-style-type: none"> ▪ Community based seed production system with seed storage in community seed banks that are earthquake resistant 	

	<ul style="list-style-type: none"> ■ Ensuring that agricultural practices have minimum negative impacts on water quality and do not have negative impacts on the watershed ■ Ensuring compliance with environmental regulations such as minimum flow downstream to conserve aquatic diversity, irrigation system and livelihoods ■ Employing production practices that reduce soil erosion, pesticide use, and water pollution, and better manage production wastes ■ Promoting stabilization of agricultural land which has been cracked or affected by landslides, and recommending appropriate management 	
Monitoring and Evaluation	<ol style="list-style-type: none"> 1. Conduct participatory monitoring of progress and project impacts on livelihood assets (natural, physical, financial, social and human) 2. Monitor the supply of appropriate variety of seeds and chemicals, and ensure no negative impact on the environment 3. Ensure the project is transparent and accountable by putting in place strong coordination, financial and monitoring mechanisms through a multi-stakeholder team 4. Evaluate project results and make adjustments as needed 5. Document results and lessons 	

GESI considerations

Women-headed households, poor, socially excluded, and other seriously affected people should be prioritized to receive livelihood support. They often have few or no resources to help them withstand the impacts of major disasters. Support must be tailored to their abilities and needs, and is likely to change over time.

Climate change considerations

Post-disaster recovery and reconstruction may provide an opportunity to build people's resilience to climate change. If a climate vulnerability assessment and adaptation plan were previously done in the community or VDC, use them to see how agriculture and livelihoods are vulnerable to climate,

and what adaptation measures were identified. Where feasible, consider incorporating these measures into the design of recovery and reconstruction projects for livelihoods and agriculture. If there is no information, work with local communities to find out how conditions have been changing over the years, and how they may be affected in the future if there are greater and more frequent climate extremes. If the quantity of irrigation water has been declining, for example, or some crops have been failing because of irregular rainfall, build in adaptation measures such as water efficiency (e.g. drip irrigation) or alternative crops which are less dependent on regular rainfall. Or this could be an opportunity for people to learn a new skill and change their occupation to make them more resilient to climate change.

Cash-for-work schemes helping to rebuild lives

Hariyo Ban Program supported several cash for work schemes in earthquake affected districts, providing 101,380 person days of employment. Activities included building debris removal, trail reconstruction, soil bioengineering, and repair of water supplies and irrigation systems. Hariyo Ban was fortunate that one of its consortium partners, CARE, had prior experience of cash for work in earthquake affected areas, and was able to advise the rest of the partners and develop sound procedures. The schemes gave priority to poor and marginalized people, and women. There was equal pay for men, women and disabled; people worked based on their abilities.

There are many stories of how cash-for-work wages enabled people to restart their lives after the earthquake (for example, see the next box), and the work that was undertaken also contributed to livelihood recovery: for example, reconstruction of trails for the transport of products and the return of tourism, and repair of irrigation systems for agriculture to restart.

There were also several challenges in implementing cash for work. These included:

- Unrealistically low wages set by some districts, especially for remote areas
- Shortage of labor in remote places like Manaslu and Langtang
- Time taken to set up cash-for-work projects
- Complaints from able-bodied men that they did more work than others, yet were paid the same wage

(Source: Sanjaya Uprety 2016)



Goats are popular in livestock restocking programs after a disaster. However, it is important to ensure that there is an adequate fodder source for them and other livestock, and they are stall-fed to avoid damage to local forests from browsing and trampling.
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Sensitive sites such as soil bioengineering sites on landslides need to be protected from livestock. Here members of the Legleni Pakha Community Forest Users Group construct a fence to protect planting in their forest against livestock, in Lahare Pauwa VDC, Rasuwa.
© WWF Nepal, Hariyo Ban Program/Nabin Baral

Cash for work helped Sapana Pariyar and her family after the 2015 earthquake



Ms. Sapana Pariyar (right) receiving cash-for-work payment
© CARE Nepal, Hariyo Ban Program

Sapana Pariyar, from Budhathum VDC, recounted her story: “The earthquake of April 2015 badly damaged my house. We were compelled to live in a tent. There was no source of income. At this critical time, we got an opportunity to be involved in the cash-for-work program. We received cash payments in return for labor, allowing us to purchase supplies and clothes, build a temporary shelter, and pay school fees for our children. This was valuable support to my family.”

Engaging people in community infrastructure projects through cash-for-work schemes helped rebuild communities, encouraging neighbors to work together, while also giving people an opportunity to make decisions and invest their household earnings in the way that was best for them.

(Source: CARE Nepal, Hariyo Ban Program)

Relevant policies and legislation

Agricultural Development Strategy 2014, Nepal Ministry of Agricultural Development

National Seed Vision 2013 – 2025 (Seed Sector Development Strategy)

National Agrobiodiversity Policy, 2007

Irrigation Policy (2002)

Nepal Agro-Biodiversity Strategy and Action Plan (2014)

National Agricultural Policy (2004)

Land Use Policy (2012)

National Fertilizer Policy (2002)

Herbs and Non-Timber Forest Product Policy (2004)

Rangeland Policy (2012)

Agro-business Promotion Policy (2006)

Seed Act (1988)

Animal Health and Livestock Service Act (1998)

Pesticide Act (1991)

Plant Protection Act (2007)

Industrial Enterprise Act (1992)

Organic and Bio-fertilizer Regulation Procedures (2011)

Further reading

Green Recovery and Reconstruction Toolkit. Module 8. World Wildlife Fund & American National Red Cross. 2010. <http://green-recovery.org/>

Nepal Earthquake 2015: Environmental Considerations for Food Security. 2015. WWF Nepal, Hariyo Ban Program. www.wwfnepal.org



Tourists returning after the earthquake: a group of visitors rests at Ghyangphedi. Restoring the tourist industry under safe conditions helps to restart local economies in remote areas where there are few other economic opportunities.
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Possible environmental implications of recovery in the education sector

The main adverse environmental impacts of recovery and reconstruction in the education sector after a major disaster are likely to be from debris disposal, and reconstruction of educational institution buildings. Over 8,000 community (public) schools alone were affected by the 2015 earthquake, with classrooms either destroyed or damaged (NPC 2015). A large amount of debris was generated, and a very significant amount of construction material is required for rebuilding. Good building practices and selection of building materials are covered in detail in Chapter 3, and are very relevant to educational institutions. Debris disposal is covered in Chapter 4. In addition, temporary learning centers could have adverse environmental impacts through extraction of building materials such as poles and timber from forests (Chapter 11), extraction of sand and gravel (Chapter 3), inadequate sanitation (Chapter 7), and inadequate waste disposal (Chapter 4).

There are many opportunities for the environment and education sectors to work together to promote green recovery and reconstruction. After the 2015 earthquake youth immediately mobilized to support relief and early recovery work. Involving children and youth in recovery work through schools and other educational institutions can provide them with an outlet to help to rebuild their communities and country, help them come to terms with the disaster, and reduce environmental impacts of reconstruction in their communities. Schools can use recovery and reconstruction as a learning opportunity, and involve students in promoting environmentally sound recovery approaches in their communities to build back safer and greener.

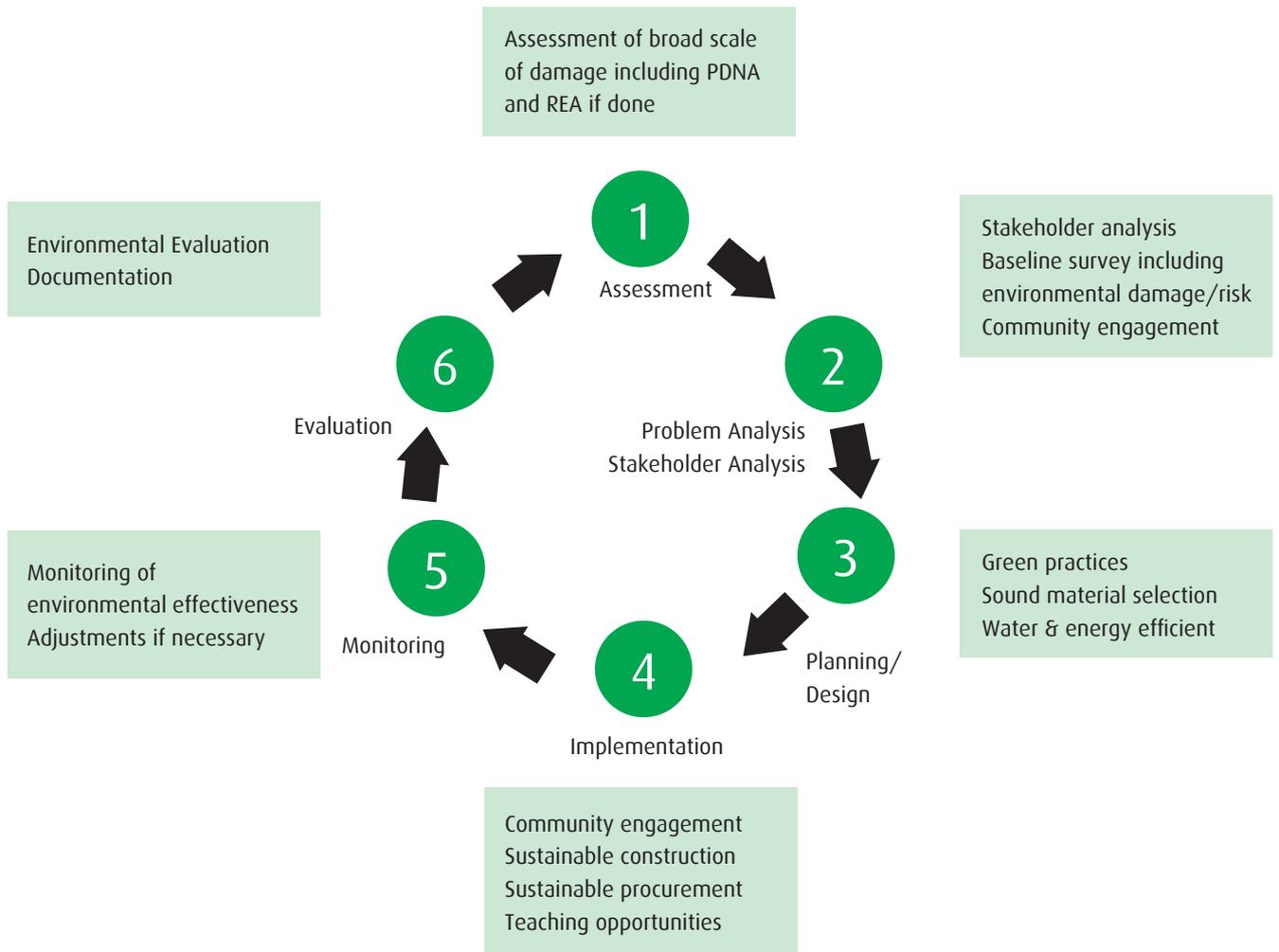
Key principles for environmentally responsible education recovery

1. If an education institution needs to move to a new site because the old site is no longer safe or feasible, follow the guidance in Chapter 2 (resettlement) to minimize adverse environmental impacts.
2. Recycle as much building debris from damaged educational institutions as possible; and dispose of remaining debris in a responsible way.
3. Select and procure new building materials for temporary learning centers and longer term education buildings in ways that minimize environmental impact.
4. Make new education buildings as energy and water efficient as possible.
5. Ensure that WASH installations are appropriate for the staff and for the number, age and sex of students, and link water supply and sewage disposal with sound management of the local watershed.
6. Manage and dispose of solid waste from the school/college/university using environmentally sound practices.
7. Involve students in environmentally sound recovery, reconstruction and disaster risk reduction processes for the school/college/university buildings and grounds as much as possible, appropriate to their age, using this as a teaching and healing opportunity.
8. Encourage students to promote environmentally sound recovery, reconstruction and disaster risk reduction practices within their community and watershed, using this as a teaching opportunity.



Involving students in reconstruction of their schools, including ensuring environmentally sound practices, can be used as a teaching opportunity and can also help them psychologically after a disaster by playing a positive role in reconstruction.
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Project cycle and environmental intervention points in education recovery





Restoring safe water supplies to schools plays a major role in getting students back to school after a disaster. There may be an opportunity to improve water supplies during reconstruction, linked with sound management of the watershed.
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Key Steps to Achieve Environmentally Responsible Recovery, Reconstruction and DRR in Education

Stage of project cycle	Activities	Stage of disaster cycle
Initial Assessment	<ol style="list-style-type: none"> 1. Undertake broad level assessment of damage including environmental factors 2. Participate in PDNA and REA if carried out 	
Problem Analysis and Stakeholder Analysis	<ol style="list-style-type: none"> 1. Undertake stakeholder analysis and baseline survey (including environmental and safety factors) with full community engagement 2. If relocation is needed, follow guidance in Chapter 2 on site selection to minimize environmental impacts and human-wildlife conflict 3. Plan for optimal water supplies, taking into account possible future expansion and environmental flows in the watershed; follow more detailed guidelines in Chapter 7 4. Consider climate change patterns and extremes, and make the designs climate informed 	
Design	<ol style="list-style-type: none"> 1. Ensure that site designs retain as much vegetation cover around and uphill from the site as possible, for water supply, disaster risk reduction, shade and conservation value 2. Promote energy efficiency, including alignment of buildings (e.g. in cold climates, site new classrooms to face south so that rooms have as much light and heat as possible in winter; adopt renewable energy as much as possible (see Chapter 5 for more details) 3. Promote water efficiency; consider multiple water sources (e.g. gravity fed supply in the watershed and rainwater harvesting) for water security (see Chapter 3 for more details) 4. Ensure that sanitation facilities have safe disposal of sewage and waste water, with no risk of contaminating surface or ground water (see Chapter 7 for more details); consider installing biogas for effective use of sewage and energy efficiency 5. Reuse and recycle as much building debris as possible, to reduce environmental impacts from disposal of debris, and extraction of new materials 6. Select new building materials that have low environmental impact, if possible sourcing locally; in particular take into account sources of timber, stone, sand and gravel (see Chapter 3 and WWF (2016a) for more details) 	
Implementation - Construction and Operation	<ol style="list-style-type: none"> 1. Source building materials locally where possible, ensuring they are extracted with minimum environmental impact (particularly timber, stone, sand and gravel) (see Chapter 3 and WWF (2016a) for more details) 2. Manage the construction site including drainage to minimize impacts such as soil erosion, landslide and flood, taking into account downstream areas 3. Manage waste effectively from construction and regular school operation, including reuse, recycling and responsible disposal (see Chapter 4) 4. Restore vegetation where needed, especially in school grounds and watershed of the school water supply; plant trees for shade. 5. Consider planting hedges rather than having high walls, which could be dangerous in an earthquake 6. Use soil bioengineering where appropriate (in combination with small-scale civil engineering if needed) to reduce the risk of flooding, soil erosion and landslides (see chapter 12) 	

	<ol style="list-style-type: none"> 7. Install early warning system where feasible if the school is at risk of hazards such as flooding 8. Engage the community in construction as much as possible, in keeping with GESI principles 9. Use green recovery and reconstruction as an educational opportunity; highlight green recovery and reconstruction issues such as energy conservation, watershed conservation, and environmental health, which are already in the school curriculum, in classes and in practice during reconstruction of schools 10. Use local curriculum time and courses on the environment, as well as traditional curriculum subjects such as math, science, social studies, Nepali and English, to highlight environmental issues including climate change; invite local experts to participate 11. Mobilize teachers and students to address environmental issues, for example through Ecoclubs or WASH Clubs; encourage students to take environmental messages home to their families and communities 12. Celebrate special occasions such as World Environment Day, National Sanitation Week, Earth Day or the School Anniversary Day to carry out environmental activities, engaging the whole school 13. Organize environmental competitions (e.g. art, essay or debating competitions) to raise environmental awareness 14. Encourage students in higher education institutions to do projects and thesis on green recovery and reconstruction 	
Monitoring and Evaluation	<ol style="list-style-type: none"> 1. Undertake regular monitoring of environmental conditions in the school, school grounds, and in the watershed upstream and downstream from the school, and any positive and negative environmental impacts the school is having 2. Make changes as needed to reduce adverse environmental impacts and improve the environmental conditions of the school and its surroundings 	

GESI considerations

Promote GESI sensitive approaches to school reconstruction, including employment of local labor and craftspeople in reconstruction, ensuring that the poorest, most marginalized members of the community and women can benefit. Ensure that school design and construction do not adversely impact local people (for example, competition for water supplies, or risk of causing floods or landslides that would affect people living in vulnerable sites). When reconstructing sanitation facilities, ensure separate, adequate facilities for female members of staff and adolescent girls.

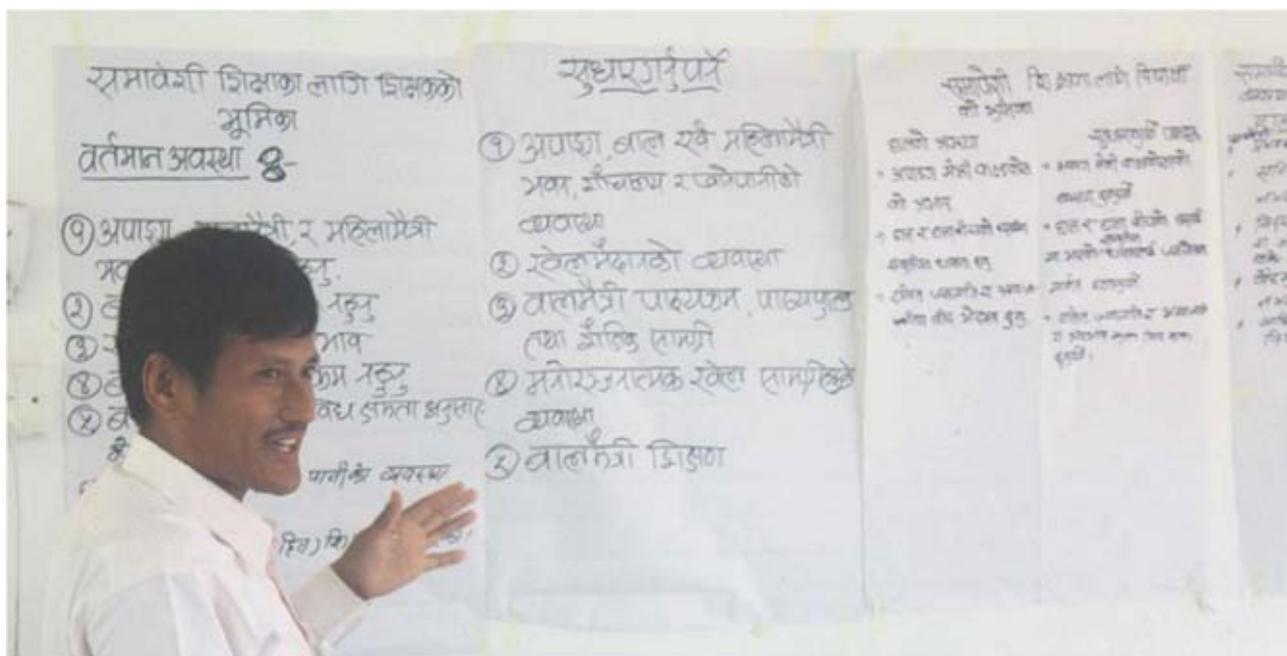
Climate change considerations

Take into account the fact that weather events are likely to become more extreme in the future, and avoid potentially hazardous sites (e.g. where flooding or landslides may occur after very heavy rain or snow melt). Ensure adequate drainage and management of runoff, and make sure that downstream flooding and erosion will not be exacerbated by runoff from the site. Restore local forest in the water catchment, recognizing that healthy forest is more likely to be resilient to climate change, and continue to provide ecosystem services such as water supplies and protection from flooding and landslides.

Climate-smart, green Disaster Risk Management Plan for Mahendrodaya Secondary School

The Shree Mahendrodaya Secondary School had no disaster plan in place when the earthquake struck, and according to its Principal, Kamal Bahadur Thapa, it was the only affected school in its VDC. Hariyo Ban helped the school to build back safer and greener, and prepare for future disasters. Support included education in emergency training, a 'school-in-a-box' kit, and support to for drinking water and toilet repair. A workshop was held on climate change adaptation and disaster risk reduction, with participation by community members, teachers, students, members of the school management committee, the Ward Citizen Forum, and the local health post representative. Participants learned about environmentally sound practices in recovery and reconstruction, and undertook a participatory vulnerability and capacity assessment of the school. Major hazards identified included windstorms, earthquakes, insufficient drinking water, and landslides. From this the school prepared a climate and disaster risk management plan for disaster management and preparedness, in line with the Comprehensive School Safety Framework and Flagship 4 of the Nepal Risk Reduction Consortium on Community Based Disaster Management.

Before starting to implement the plan they made an inclusive decision to ensure that reconstruction activities would not negatively impact the environment. They also decided to give priority for local labor, and ensure participatory monitoring. To stabilize a bank in front of the school they needed to build a gabion wall, so they collectively did a local survey to decide on the least damaging place to extract stones. They plan to plant grass to stabilize the soil and prevent erosion. To improve the quality of their new water supply they aerated the water. Their disaster risk management plan is now annexed to the school improvement plan.



Shree Mahendrodaya Secondary School preparing its disaster risk management plan

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(Source: CARE Nepal, Hariyo Ban Program)

Relevant policies and legislation

Nepal Forest Act 1993 and Forest Regulations 1995
Nepal National Parks and Wildlife Conservation Act 1973
Nepal Conservation Area Government Management Regulations 2000
Nepal Solid Waste Management Act 2011

Further reading

Guidelines for Developing Type Designs for School Buildings in Nepal. Department of Education, ADB and JICA. 2016

Minimum Standards for Education: Preparedness, Response, Recovery. Inter-Agency Network for Education in Emergencies. 2010.

Environment Marker Guidance Note. UNEP and UNOCHA. 2014.

Guidebook for Planning Education in Emergencies and Reconstruction—Chapter on Environmental Education. UNESCO and International Institute for Educational Planning. 2010.

Center for Environment Education Nepal Webpage. www.sajilo.com/ceen/

Resource Center on Mainstreaming the Environment into Humanitarian Action. Education Section, UNEP. postconflict.unep.ch/humanitarianaction/01_01.html

Guidance Note: Environment in the Emergency Education Response. Nepal Education Cluster. 2015. www.wwfnepal.org



Involving students as well as parents and other community members in school reconstruction and disaster management planning means that they have good understanding of the issues and ownership of the process, and the plan is more likely to be implemented effectively. It is important to ensure that everyone participates, including girl students who can bring specific inputs (for example, the need for separate toilets for adolescent girls).

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Background

Climate change is increasing the frequency and scale of disaster hazards in Nepal, and this trend will continue in spite of efforts to mitigate global warming. Hazards include erratic rainfall, flash floods and prolonged drought (United Nations Development Programme (UNDP) 2003, World Bank 2008).

In Nepal, average temperature increased between 1977 and 1994 at a rate of 0.06°C per year; and is projected to increase by another 1.2°C by 2030, 1.7°C by 2050, and 3.0°C by 2100 (Ministry of Environment 2010), although this rate will depend on future trends in greenhouse gas emissions. Maximum temperatures are increasing faster than the minimum temperatures indicating a widening temperature range (Xu et al. 2007).

While projections of future rainfall trends are less clear an overall increase in rainfall is projected, but with geographic variations (for example, there is likely to be a decrease in the mid-hills). Greater climatic extremes are projected, such as intensity of rainfall, and drought (Ministry of Environment 2010). There will likely be increased variability between years: for example, extreme dry years followed by extreme wet years.

Changes in climatic conditions, sometimes combined with changes in land use, are already affecting communities and ecosystem services in Nepal. Reports of water supplies drying up, crop failure due to erratic rainfall and increased hail storms, and increased flooding and landslides due to more intense rainfall are common (Karki et al. 2009; Hariyo Ban Program led community vulnerability assessments). As glaciers retreat melted ice often forms glacial lakes, creating a risk of glacial lake outburst floods (GLOFs). Hazards will continue to

occur and intensify as climate change advances. Impacts on ecosystems seem to be taking longer to manifest, likely due to the resilience of natural systems, although changes may be occurring undetected because of the low level of research on this topic. Furthermore, as climate change advances natural systems may suddenly reach tipping points from which they will not be able to recover (for example, a run of years with exceptionally dry pre-monsoon conditions could result in a series of serious forest fires that forests are unable to recover from). Major changes are projected for several forest types in Nepal (Thapa et al. 2016), which will have profound impacts on the people and wild animals who depend on them.

As people cope with and adapt to climate-induced change, they may place additional stresses on the environment (for example, turning to forests for livelihood activities such as firewood sales when agriculture fails). These stresses may make it more difficult for ecosystems to remain resilient, and impair their ability to deliver services such as water supplies and protection from floods or soil erosion. Human-wildlife conflict may increase because climate change could increase contact between wildlife and people (e.g. through competition for increasingly scarce water resources, or through increased presence of people in forests).

Climate change may also compound the effects of non-climate induced hazards and increase the level of risk. For example, while earthquakes occur as a result of tectonic processes, climate change can exacerbate their effects on people and the environment. Very heavy rainfall may trigger landslides on slopes that become unstable during an earthquake; or GLOFs may be more likely after very heavy precipitation or sudden snow melt if their moraine walls have become unstable in an earthquake.

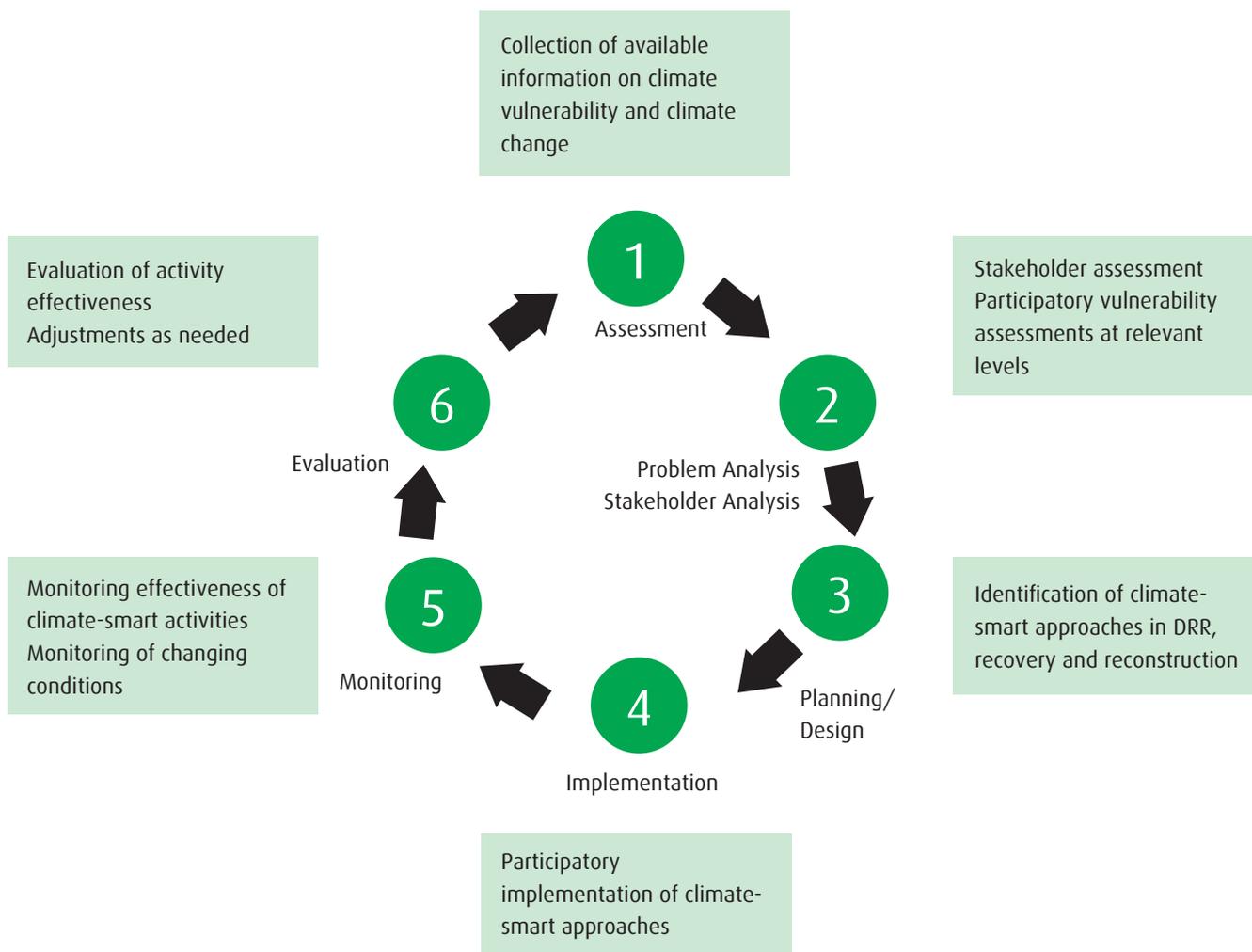


Climate change is advancing rapidly in Nepal; more erratic precipitation in the future is likely to cause or exacerbate disasters such as prolonged drought and extreme flooding.
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Key principles for climate-smart DRR, recovery and reconstruction

1. Understand existing and future potential climate hazards and vulnerabilities, and mainstream these when planning and implementing DRR, recovery and reconstruction work.
2. Since there is an irreducible amount of uncertainty around the magnitude, frequency and nature of future climate hazards, anticipate a wide range of potential climate changes and promote approaches that consider multiple hazards (for example, both extreme drought and floods).
3. Take into account differential vulnerabilities to climate change (for example poor people, women and marginalized groups may be especially vulnerable) and incorporate this in disaster management.
4. Since people are dependent on ecosystem services, promote approaches in disaster management that build and maintain resilience of ecosystems to climate change so that they can continue to provide these services for as long as possible; avoid placing new stresses on ecosystems that may reduce their resilience to climate change.
5. Incorporate ecosystem services as part of the package to help vulnerable people to withstand disasters better, taking advancing climate change into account.
6. Promote low carbon development practices during DRR, recovery and reconstruction, contributing to national and global efforts to reduce greenhouse gas emissions and raising awareness on the issue.

Project cycle and climate change intervention points

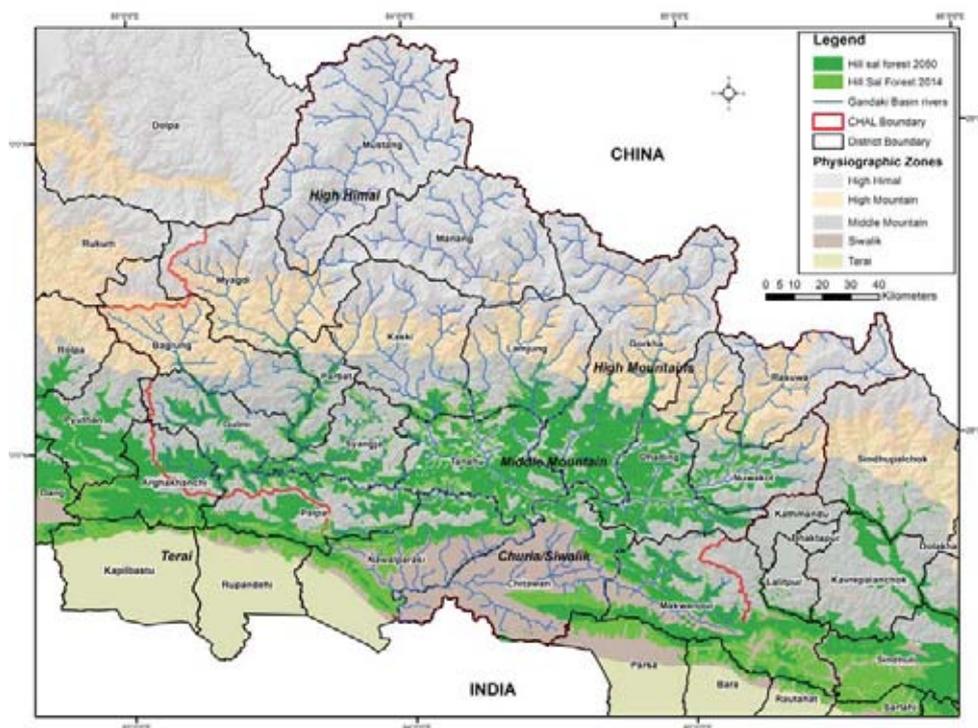


Key Steps to Achieve Climate-smart Recovery, Reconstruction and DRR

Stage of project cycle	Activities	Stage of disaster cycle
Initial Assessment	<ol style="list-style-type: none"> 1. Assess how climate change may make this type of disaster worse in the future (note that absolute proof will be difficult; use language like ‘climate change can make events like this more common/extreme’) 2. Participate in PDNA and REA if carried out; raise awareness about climate change trends and impacts now and in the future, and implications for reconstruction 	
Problem Analysis and Stakeholder Analysis	<ol style="list-style-type: none"> 1. Undertake stakeholder analysis at appropriate level 2. If local climate vulnerability is unknown, undertake rapid climate vulnerability assessments with stakeholder involvement, taking into account the needs of the most vulnerable (often women, marginalized and poor households) 	
Planning/ Design	<ol style="list-style-type: none"> 1. Prepare participatory local adaptation plans of action (LAPAs) with communities at risk, that increase their capacity for disaster management planning and implementation 2. Ensure that ecosystems are valued and used as a tool to build community resilience; ensure that disaster management efforts do not undermine ecosystem health, so as to improve chances of continued ecosystem service provision as climate change advances 3. Mainstream resilience-building/climate adaptation into local and national disaster risk management plans; review plans regularly and update them as new climate information becomes available 4. Plan effective and user-friendly early warning systems 5. Plan for low-carbon development practices during reconstruction, including clean energy technologies. (Clean energy contributes towards the country’s commitments to reduce net carbon emissions, as does restoring forests since forests absorb carbon from the atmosphere.) 6. Plan to build in-country capacity to manage the increasing and changing risks from climate change 	
Implementation - Construction and Operation	<ol style="list-style-type: none"> 1. Implement plans in a participatory manner 2. Incorporate the use of ecosystem services to reduce people’s vulnerability to climate-related and other disasters (e.g. promote healthy forests to reduce landslide risk and water shortages; restore floodplains to absorb floods and reduce flooding downstream) 3. Avoid significant negative impacts to ecosystems during relief, recovery and reconstruction, which may increase their vulnerability to climate change and affect the services they provide to communities 4. Improve the network of weather stations in the country, in order to provide more reliable weather forecasting and climate projections 5. Ensure that weather forecasts and projections are readily available to all who need them 	
Monitoring and Evaluation	<ol style="list-style-type: none"> 1. Monitor and evaluate the effectiveness of activities 2. Make adjustments to improve effectiveness based on learning from monitoring and evaluation 3. Monitor the magnitude and frequency of weather-related hazards and their impacts on people, natural systems and infrastructure 4. Pay attention to how vulnerable people may unintentionally degrade ecosystems as they cope with shocks and stressors related to extreme weather and changing climatic conditions 5. Revise vulnerability assessments and plans based on new conditions and information 	



Climate change will have profound effects on many natural resources including forest and freshwater species, affecting their distribution and abundance, and hence availability to local communities who depend on them for their livelihoods and wellbeing.
 © Karine Aigner/WWF



Projected changes in distribution of sal (Nepal's most popular hardwood timber tree species) between 2014 (lighter green) and 2050 (darker green). As climate change advances, the species is projected to move further northwards and upslope into the mid-hills along the river valleys, and upslope within the Churia. It is projected to disappear from some low-lying areas that become unsuitable for it.
 Note: the modelling to produce this map used the Intergovernmental Panel on Climate Change (IPCC)'s A2A greenhouse gas emissions scenario to project the future distribution; it is the highest emissions scenario and was used because recent assessments indicate that greenhouse gas emissions during the 2000's exceeded the highest predictions by the IPCC (see WWF 2016b for more details). However, there are many uncertainties associated with climate projections, and this result should be used in combination with other types of information.
 © WWF Nepal, Hariyo Ban Program

GESI considerations

Since some people are more vulnerable to disasters and to climate change than others (often women, poor and marginalized people), find out through participatory climate vulnerability assessments who are most vulnerable. Climate vulnerability assessments in Nepal typically assess vulnerability to climate-induced disasters as well as vulnerabilities in other sectors, as per the National Adaptation

Programme of Action (Ministry of Environment 2010). These vulnerabilities may range from women being unable to swim, or not being allowed to leave the home unaccompanied; to poor and marginalized people living in sites at risk of flood or landslide, or particularly vulnerable to disasters since they do not have resources to recover from shocks. If possible, design resilience building/climate adaptation activities as part of DRR/recovery/reconstruction to reduce their vulnerability to disasters and climate change.

Integrating climate adaptation plans with local disaster risk management plans

In Nepal there have been separate tracks for planning climate adaptation and disaster risk reduction at VDC level. Adaptation has been covered through climate vulnerability assessments and local adaptation plans of action (LAPAs), under the National Adaptation Programme for Action (NAPA) (Ministry of Environment 2010). Disaster risk reduction has been planned through the local disaster risk management plans (LDRMPs). In Nepal there is often substantial overlap between these plans, because of climate-related disasters. It does not make sense to have them separate, since isolated plans that are not part of the VDC planning process risk sitting around collecting dust and not being implemented. Pilots have been carried out to integrate LAPAs and LDRMPs in Lamki Chuha Municipality and Pathraiya VDC in Kailali district, and Chandrapur Municipality in Rautahat district, with support from Hariyo Ban Program. The next step is to mainstream the integrated plans into local level planning, which will hopefully make their approaches more sustainable and leverage greater amounts of funding for implementation.

(Source: CARE Nepal, Hariyo Ban Program)

Relevant policies and legislation

The United Nations Framework Convention on Climate Change (1992), to which Nepal is a party.
National Adaptation Programme of Action (2010)
Climate Change Policy (2011)
National Framework on Local Adaptation Plan for Action (2011)
National Adaptation Plan – in preparation at the time of writing
Natural Calamity Relief Act (1982)
Local Self Governance Act (1999)
National Strategy for Disaster Risk Management (2009)

Further reading

National Adaptation Plan Formulation Process: Approach Paper. Ministry of Population and Environment. 2016.

Temporal and Spatial Variability of Climate Change over Nepal (1976-2005). Practical Action. 2009.

Climate Change in Nepal: Impacts and Adaptation Strategies. Ajaya Dixit, Institution for Social and Environmental Transition Nepal. <http://www.wri.org/our-work/project/world-resources-report/climate-change-nepal-impacts-and-adaptive-strategies>

Vulnerability Assessment and Adaptation Planning: Training of Trainers Manual. CARE Nepal, Hariyo Ban Program. 2014.

Integrating disaster risk reduction and climate change adaptation: lessons from Hariyo Ban Program, Nepal. CARE Nepal, Hariyo Ban Program. 2016.

Mainstreaming climate adaptation in local development planning: A reflection from the Hariyo Ban Program, Nepal. CARE Nepal, Hariyo Ban Program. 2016.

The benefits and challenges of integrating an ecosystem approach in community climate adaptation in two landscapes in Nepal. WWF Nepal, Hariyo Ban Program. 2016.

Importance of forests in recovery and reconstruction

Forests play important roles in reducing disaster risk, and in providing resources and services for disaster relief, recovery and reconstruction. They are particularly important in Nepal where they help to stabilize the young, fragile geological landscape. Healthy forests that are managed for multiple purposes (e.g. natural resource provision, reliable clean water supplies, controlling soil erosion, and reducing the risk of landslides and/or flooding) help with disaster risk reduction and also community disaster preparedness.

In the immediate aftermath of a serious disaster if many people are displaced in rural areas there will likely be a large need for poles and other forest products for building temporary shelters, and space for people to shelter in. There will probably also be an increased need for firewood and drinking water from forests, and possibly medicines and food. If this is short-term and pressure is not too great it is likely that forests will be able to provide refuge and resources without serious long-term impacts, especially if they were well managed and in good condition before the disaster. However, if there is heavy or prolonged pressure there may be significant damage to forests and the ecosystem services they provide, putting local communities at greater risk in the future.

If there is much building damage in the disaster there will be high demand for timber during reconstruction. Therefore, it is important to use the latest available information to plan for meeting this demand in a sustainable way, if possible from forests within the country, though import of timber may be necessary if the disaster is very widespread and severe.

Key principles for forestry during disaster recovery, reconstruction and DRR

1. Maintain healthy forests for provision of forest resources and ecosystem services that reduce disaster risk.
2. Increase understanding of key drivers of deforestation and forest degradation, and work to reduce them at appropriate levels.
3. After disasters promote efficiency in use of forest resources, and enhance supply of forest products, ensuring that extraction is sustainable in the long term.
4. Engage local communities in forest management at all stages of the disaster cycle.
5. Consider special needs of different social groups: follow Gender Equality and Social Inclusion (GESI) principles.
6. Take climate change into account when undertaking long-term recovery in forests, allowing for more extreme weather events and rising temperatures.

Timber and firewood salvaging

Many householders were able to salvage undamaged timber from the rubble of their homes and reuse it for reconstruction. Broken timber was used for firewood. Some communities were able to cut timber from trees which were uprooted in landslides (2% of forests were destroyed by landslides in six of the worst affected districts (NPC 2015)). This helped reduce demand for new timber and firewood.

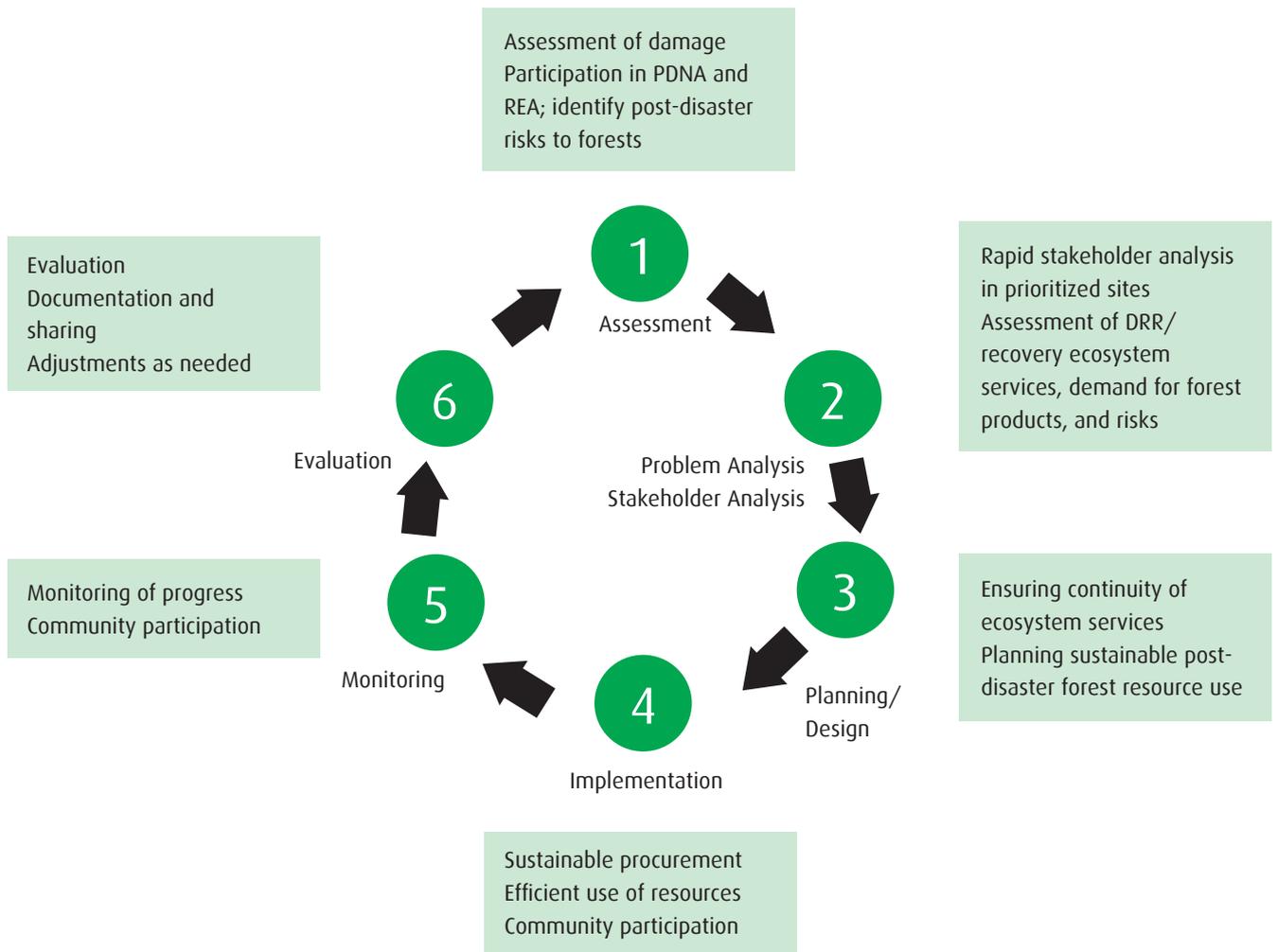
(Source: Hariyo Ban Program)



Many forests in Nepal are managed by local communities; the forests help reduce risk of landslides and floods, regulate water supplies, and provide natural resources for local people including women, poor and marginalized people. This one is the forest of the Bhakarjung community in Kaski; the forest forms part of the Phewa lake watershed, and helps to reduce sedimentation of the lake .

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Project cycle and environmental intervention points in forestry



Key Steps for Sustainable Forest Operations in Support of Reconstruction and DRR

Stage of project cycle	Activities	Stage of disaster cycle
Initial Assessment	<ol style="list-style-type: none"> Undertake assessment of damage to forests, community and government forest institutions, and forest management infrastructure Review immediate risks to forests (e.g. illegal timber extraction and wildlife poaching if forest management has ceased as a result of the disaster) and take action where possible Participate in PDNA and REA if undertaken; draw attention to potential environmental risks to forests during recovery and reconstruction 	 
Problem Analysis and Stakeholder Analysis	<ol style="list-style-type: none"> Undertake stakeholder analysis Evaluate ecosystem services provided by forests to upstream and downstream communities, especially in hazard prone areas Review likely demand for forest products and services during recovery and reconstruction 	 
Design	<ol style="list-style-type: none"> Ensure that ecosystem services provided by forests are maintained during the reconstruction process across different sectors, especially in areas that are hazard-prone (including providing inputs to any integrated resettlement planning or land use planning) When timber demand for reconstruction is very high, plan to source it from less affected districts to spread the load and ensure extraction is sustainable in the long run Plan for timber treatment and seasoning to increase lifespan of timber and reduce future demand Promote sustainable forest management to increase longer term production of timber and other products in areas where it is feasible to do so, while not sacrificing ecosystem services for DRR, or biodiversity values Promote timber production on private land Consider maintaining a national standing timber reserve for future large-scale disasters Respect protected area boundaries and regulations during recovery and reconstruction, and avoid extraction of forest products or other impacts in recognized biodiversity important areas (seek expert advice if needed) Promote alternative energy and energy saving technology to reduce firewood demand Take the special natural resource needs of women and poor and marginalized groups into account when planning for reconstruction When doing long-term planning of forests for DRR, disaster preparedness and production, consider potential impacts of climate change (see below) 	  
Implementation - Construction and Operation	<ol style="list-style-type: none"> Evaluate and select sources of timber with the community and district forest office, based on resource limitations (annual allowable harvest), environmental impacts and cultural acceptance; do not use illegally harvested timber Ensure timber use is efficient (Chapter 3) and timber is seasoned and treated Build capacity of communities and technicians for sustainable forest management as needed In the longer term, implement sustainable forest management for multiple purposes (DRR and production) 	  

Monitoring and Evaluation	<ol style="list-style-type: none"> 1. Develop criteria and indicators for forest management and biodiversity conservation and use them for regular monitoring 2. Conduct periodic evaluations with community participation 3. Document and share results and lessons 4. Make adjustments as needed 	
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Supply of timber after the 2015 earthquake

There was a huge demand for timber after the 2015 earthquake, initially calculated at 0.55 million m³ in the PDNA (NPC 2015). The Department of Forests (DoF) calculated that this demand could be met in-country if softwoods and other hardwoods were used for reconstruction in addition to the much preferred sal timber, and if the timber was harvested over a period of five years from private land, community forests and government forests. In 2016 DoF produced a Directive on Timber Production, Supply and Management for Earthquake Victims that facilitated timber production, while aiming to keep management sustainable in the long term. Measures included giving priority to earthquake affected people for timber cut in Chure; allowing community forests to use any block of their forests to harvest the annual allowable cut, with priority for dead, fallen and over-mature trees; and allowing community forests with out-of-date operational plans to harvest timber as per the annual allowable harvest provision of the previously approved operational plan, within a certain time limit.

(Source: DoF 2016)

Timber treatment

Sal timber is resistant to insect attack, but timber of many other tree species is not. There is little practice of treating timber in Nepal, which means that insect-susceptible timber used in construction has to be replaced quite frequently. This increases timber consumption, and pressure on forests. After the 2015 earthquake, with support from Architects without Borders, timber treatment with borate was tested in Nepal. Freshly cut timber is soaked in heated borate solution. Borate is less harmful to the environment than many other treatment products, and is cheap. It is already used in some places in the country to treat bamboo. At the time of writing tests are being carried out to determine optimum treatment regimes that are practical to use at community forest level. Community level pilot demonstration sites are being established in Kavre district, with support from WWF Nepal at the request of DoF. If successful, the approach will be scaled up. Timber treatment of softwoods and other susceptible species is not required at higher altitudes (over about 2,000 m) because it is too cold for insect attack.

(Source: WWF and Hariyo Ban Program)

Climate change considerations

As climate change advances, long-term rise in average temperature, and greater and more frequent weather extremes, will increasingly affect Nepal's forests. For example, forests may be susceptible to increased drought or flooding, or to a series of severe fire seasons in consecutive years due to drier than normal pre-monsoon weather. They may be more susceptible to attack by pests and disease, and these may spread into new areas as a result of rising temperatures. In the longer term significant changes to forest types are projected, with greatest change at lower altitudes and more resilience at higher altitudes in the upper coniferous forest zone (WWF 2015b). Initial studies show that many species are likely to be

able to survive at higher altitudes than they did previously, and at the lower end of their ranges conditions may become unsuitable. However, different species are not equally resilient (WWF 2016b). Species with narrow distribution limits and very specific requirements are likely to be less able to adapt to climate change.

This has great significance for restoration of forests after disasters and for DRR and disaster preparedness, since trees are long-lived. Selecting tree species that are likely to persist in an area in the light of climate change will help build resilience of ecosystems and hence people. See WWF (2016b) for more specific recommendations in this rapidly evolving approach.



Demand for timber increased greatly after the 2015 earthquake, for reconstruction. The Government of Nepal produced a Directive on Timber Production, Supply and Management for Earthquake Victims which aims to facilitate timber production over the next few years to meet demand, while keeping forest management sustainable in the long term.

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GESI considerations

Women, and poor and marginalized groups are particularly dependent on forest resources for household use and sometimes for livelihoods. Poor and marginalized people may be more dependent than others on ecosystem services for disaster risk reduction, for example if they are forced to live in marginal areas under steep slopes or in flood zones. These groups are likely to be more dependent on forests during the relief and recovery stages following a disaster, and women may have increased workloads in collecting water and fuel at this time. Their needs should be clearly understood, and

provisions made for access to resources, or development of acceptable alternatives (e.g. alternative energy; and alternative livelihoods that reduce forest dependence). They should also be prioritized in DRR and disaster preparedness planning, including their likely differential vulnerability to climate change.

Poor and marginalized people and women should be encouraged to participate actively in the management of their forests and ensure that they receive their share of benefits from community forests, including any harvesting of timber for reconstruction.

Relevant policies and legislation

Nepal Forest Act 1993 and Forest Regulations 1995

Nepal National Parks and Wildlife Conservation Act 1973

Nepal Conservation Area Government Management Regulations 2000

Directive on Timber Production, Supply and Management for Earthquake Victims. 2016.

Soil and Water Conservation Act 1982

Environmental Protection Act 1996

Community Forest Development Guideline 2009

Further reading

Building Material Selection and Use: An environmental guide. WWF Nepal. 2016

Timber: A Guide to the Planning, Use, Procurement and Logistics of Timber as a Construction Material in Humanitarian Relief. International Federation of Red Cross and Red Crescent Societies, UNOCHA and CARE International. 2009.

Green Recovery and Reconstruction Toolkit. Module 5. World Wildlife Fund & American National Red Cross. 2010. <http://green-recovery.org/>



Tree nurseries play an important role in producing seedlings and saplings for restoring landslide sites. Local communities should be involved in selecting the species used, as they know the local growing conditions and can also carefully harvest products such as building materials and fruits once the vegetation is established and the site is stabilized.

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Value of soil bioengineering in DRR, recovery and reconstruction

The 2015 earthquake resulted in many landslides, some of which destroyed infrastructure, forests, agricultural land and houses. More landslides occurred in the following monsoons on slopes made unstable by the earthquake, and there continues to be increased risk due to unstable slopes and cracks in the land.

This chapter focuses on practical soil bioengineering efforts to stabilize and protect small-scale, shallow landslide sites since they were a priority after the earthquake. Larger scale and more complex landslide treatment is outside the scope of this guide; please refer to Department of Soil Conservation and Watershed Management (2016) for more comprehensive information on landslide surveying, prioritization and treatment. Mercy Corps (2014) provides detailed information on the theory and approaches of soil bioengineering including those illustrated in this Annex. Devkota et al. (2014) offers a practical guide for community level soil bioengineering along roads.

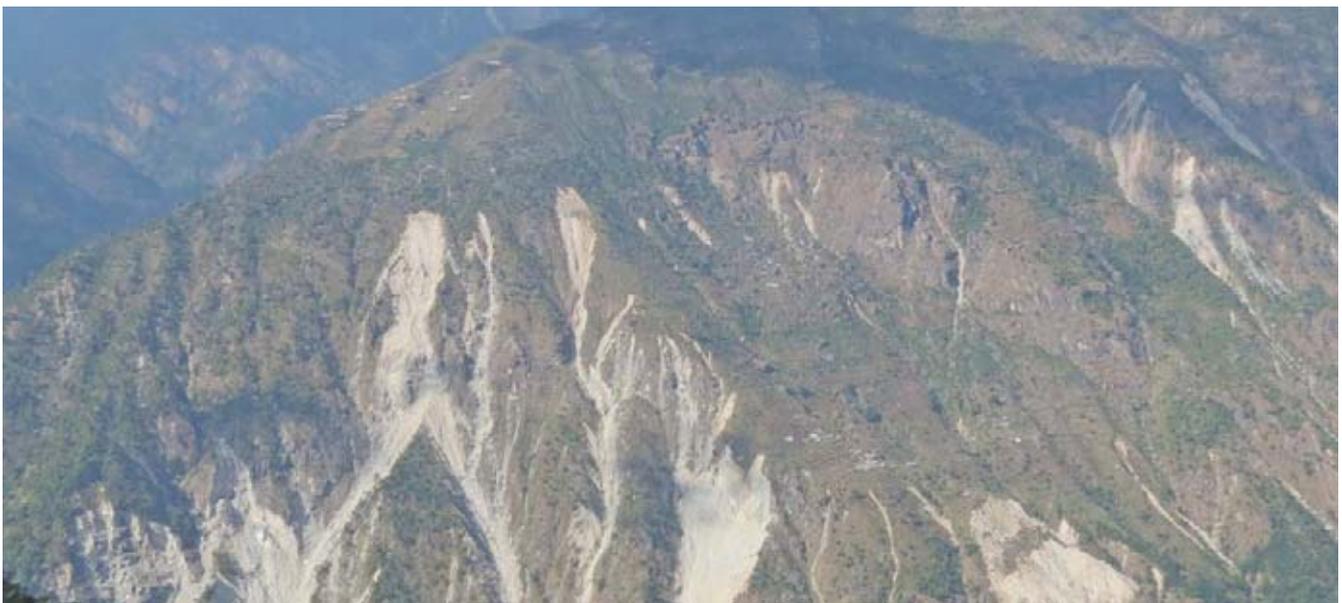
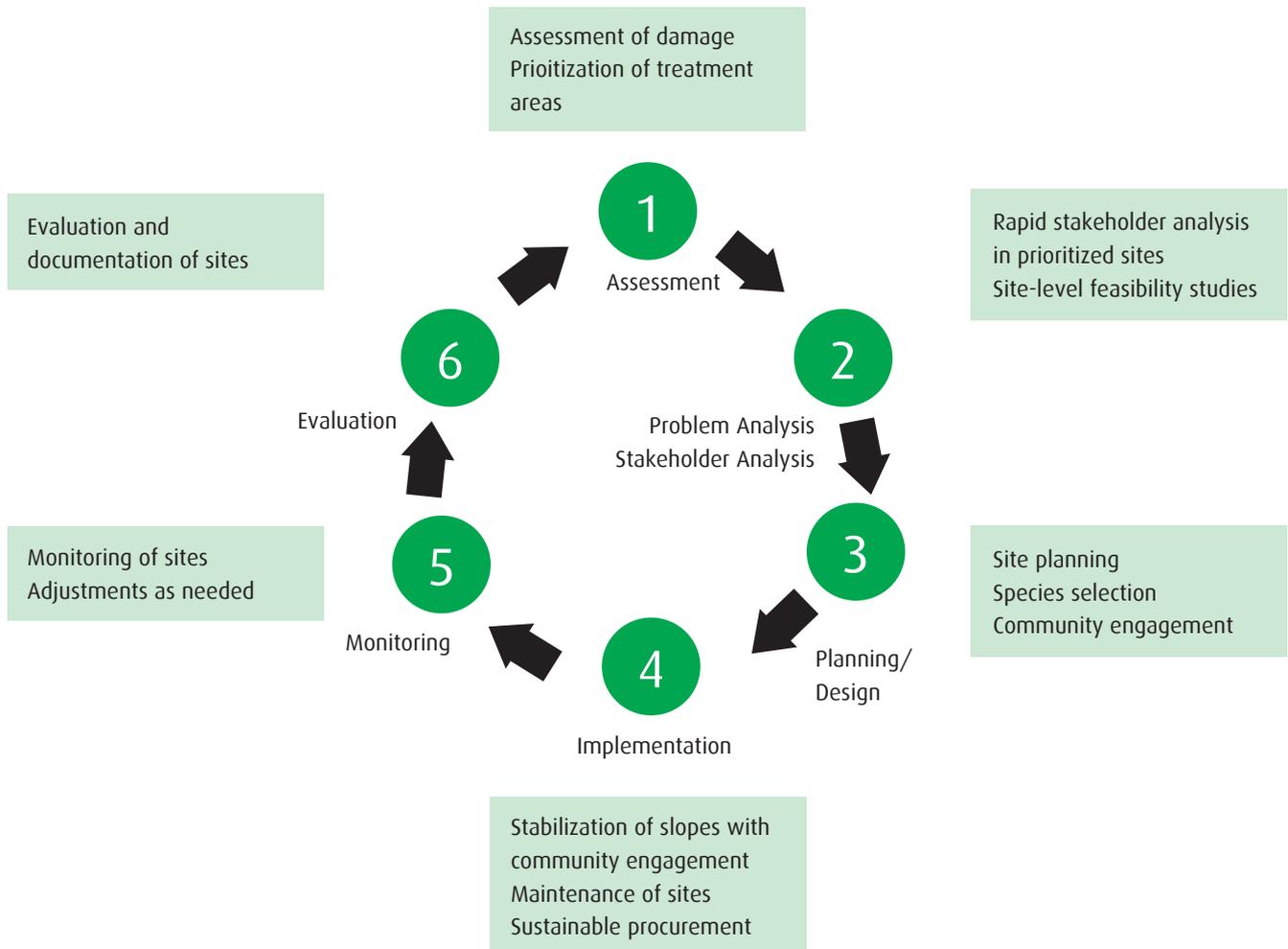
In some situations in shallow landslides soil bioengineering is a sustainable approach to tackle this problem, using a combination of live and dead plants and plant parts are used as building materials for erosion reduction and upland slope protection. Based on an engineering concept,

it is relatively low in cost and material needs compared to “hard” engineering approaches, and avoids having to completely overhaul the slope. It blends well with the natural environment. Nepal has many locally available indigenous tree, shrub and grass/legume species with good soil reinforcing capacity at different depths that can be used effectively for slope stabilization; many of these can provide products for use by local communities. More detail is given in Annex 2.

Key principles for soil bioengineering

- Use technical engineering expertise to assess feasibility and lead design of soil bioengineering works
- Ensure active local community participation in and ownership of soil bioengineering activities
- Select local plant species that are suitable for soil bioengineering and the specific site, are likely to persist in light of climate change, and are favored by local communities
- Ensure that marginalized people and women benefit from increased protection, labor opportunities and natural resources resulting from the project
- Select the soil bioengineering techniques most suited to the characteristics of the site, taking into account climate change trends
- Ensure post-construction care and maintenance until the vegetation is well established

Project cycle for soil bioengineering



Landslides in the six districts most affected by the 2015 earthquake are estimated to have destroyed 2% of forest cover (NRA 2015), including in Rasuwa district (in the photograph). Some landslides threaten settlements, infrastructure and farmland. The Department of Soil Conservation and Watershed Management's 2016 landslide guide provides comprehensive guidance on surveying and prioritizing landslides for treatment, and treatment methods.
 © WWF Nepal, Hariyo Ban Program/Judy Oglethorpe

Key Steps to Achieve Sound Soil Bioengineering for Reconstruction and DRR		
Stage of project cycle	Activities	Stage of disaster cycle
Initial Assessment	<ol style="list-style-type: none"> Undertake broad level assessment of damage including environmental factors (e.g. surveys of landslides and damage caused, and areas at risk from landslides, particularly near infrastructure, settlements and agricultural land; look also at downstream impacts) Prioritize areas for treatment, and identify those with good potential for soil bioengineering 	
Problem Analysis and Stakeholder Analysis	<ol style="list-style-type: none"> Undertake rapid stakeholder analysis near prioritized sites, including any local groups (e.g. community forest user groups, water user groups) and determine their concerns about the site and interest in being involved Undertake rapid feasibility study for soil bioengineering at site level Monitor the road system for existing slope stabilization works, and their degree of effectiveness 	
Design	<ol style="list-style-type: none"> Prepare a site plan for soil bioengineering in collaboration with the local communities Ensure adequate site drainage and handling of runoff in the plan Study the local plant species composition; work with local communities to identify plant species which can be used for soil bioengineering, and that are useful to them (see Annex 2 for more characteristics) For long-lived tree species, verify the likely resilience of the species to climate change in that site Test plant species in combination with different soil bioengineering techniques for their suitability for winter planting 	
Implementation - Construction and Operation	<ol style="list-style-type: none"> Stabilize unstable slopes through application of suitable plant species using the most appropriate soil bioengineering methods, either alone or in combination with civil engineering structures if needed Use local labor, and low-cost indigenous materials Develop a plan with the communities for them to maintain the site until the plants are well established 	
Monitoring and Evaluation	<ol style="list-style-type: none"> Monitor the site and make adjustments as needed. Evaluate the effectiveness of the soil stabilization, and reduced risk Document and communicate the activities, successes, failures, and lessons 	

GESI considerations

When prioritizing sites for soil bioengineering treatment, the vulnerability and needs of marginalized communities and women should be taken into account as well those of other groups. When selecting plant species for use in soil bioengineering, include species important to these groups, who are often more forest-dependent than others. Ensure that they are represented and heard during community meetings and planning sessions, and that they are given priority for labor opportunities during project construction, care and maintenance.

Climate change considerations

When drawing up soil bioengineering site plans, take into account the likely effects of climate change including more intense weather events. This includes heavier downpours in the future, and longer periods of drought, so select hardy plants that can tolerate a range of conditions, and structures that can withstand more extreme conditions. Since in the longer term temperatures will rise, avoid species that are currently near the lower altitudinal limits of their range, especially when planting on exposed south-facing slopes. Using a variety of long-lived species rather than only one species can help reduce risk of attack by disease and pests that are likely to increase with climate change. Ensure that site drainage is adequate, allowing for more intense runoff in the future.

Landslide stabilization with soil bioengineering in Dhodre, Gorkha district

In Dhodre, Gorkha district, a landslide developed on a steep slope where torrential rainfall, coupled with poor water management, caused gully formation and massive erosion. The earthquake made the landslide worse, blocking a road below. Local people were very concerned. Immediate action was needed to stabilize the site and prevent further gullying. This site was surveyed by the Hariyo Ban Program's soil bioengineering consultant, Dr. Madhuban Lal Maskay, and selected as a pilot demonstration site.

The problem was discussed with Dhodre Community Forest Users Group, and community members were briefed on the best techniques to stabilize the site. These included small-scale civil engineering measures (gabion wall) in combination with soil bioengineering methods: hedge brush layering/brush layering; grass slip planting; palisades; fascines; vegetative propagation of bamboo; and bamboo crib walls. The fascines and palisades slowed drainage. Community members worked with the consultant to select plant species, and the work was undertaken with local labor. Within six months the site was showing good results (see photos). After the monsoon, the community took responsibility for watering the plants during the dry season until they became well established. However, one challenge was control of livestock on the site due to open grazing; at this early stage the plants were still vulnerable to browsing and trampling. The community forest users group worked to raise awareness among the livestock owners about the importance of controlling livestock in order to protect the site and avoid further landslides.

Community members from Dhodre were subsequently invited to Simjung VDC to share their experiences so that Simjung could use the soil bioengineering techniques in similar sites.

(Source: WWF and Hariyo Ban Program)



Bamboo crib wall after 10 weeks (Dhodre, Gorkha)
© WWF, Hariyo Ban Program/Madhuban Lal Maskay



Constructing brush layer (Dhodre, Gorkha)
© WWF, Hariyo Ban Program/Madhuban Lal Maskay



Constructing Palisades in series to protect a long, narrow gully
© WWF, Hariyo Ban Program/Madhuban Lal Maskay

Further reading

Guideline on Landslide Treatment and Mitigation. Department of Soil Conservation and Watershed Management. 2016.

Community-based bio-engineering for eco-safe roadsides in Nepal. Devkota et al. University of Lausanne, International Union for Conservation of Nature, Nepal and Department of Soil Conservation and Watershed Management, Government of Nepal. Lausanne, Switzerland. 2014.

Bio-Engineering for River Training and Slope Protection Work: Training Manual for Field Technicians Working in Disaster Risk Reduction. Mercy Corps. 2014.

Road side bioengineering, Site Handbook. Department of Roads. 1999.

Biotechnical and soil bioengineering slope stabilization: a practical guide for erosion control. By Gray and Sotir. Wiley. 1996.

Vegetation structures for stabilizing highway slopes. A manual for Nepal. Howell, Lawrance, Clark and Sunwar. 1991.



Kamala Ghale in Pairobesi participated in restoring this landslide which was threatening her village; a combination of gabions and soil bioengineering was used to stabilize the slope.

© WWF Nepal, Hariyo Ban Program/Nabin Baral

Importance of flood risk management in DRR and reconstruction

Flooding is a natural process in Nepal, and not all floods are bad. For example, floods recharge water tables, flush out pollution, bring beneficial nutrient-rich fine sediment to rejuvenate flood plains and low-lying fields, and enable breeding of many fish species. However, as settlements and infrastructure are constructed in flood risk areas, and human activities increase the extent of flooding, vulnerability to floods increases.

Parts of the low-lying Terai experience frequent floods during the monsoon months, and flood-prone areas in the midhills and mountains also flood on occasion. Apart from heavy rainfall or snow melt, flooding may be caused by GLOFs, and the breaching of temporary dams created when avalanches or landslides block rivers. Floods can also result from human activity such as dams, landfills and settlements that are not designed, managed, monitored or maintained properly, as well as clearing of forests in watersheds. In Nepal’s geologically young landscape, floods are often accompanied

by coarse sediment deposition and changing of river courses. Climate change can exacerbate flooding due to more extreme weather events; these are likely to intensify and become more frequent as climate change advances.

Around the world, over the years as flood risk has grown there has been a shift from flood control to flood risk management. Evidence confirms that conventional engineering to control floods is often not sufficient and may even exacerbate flooding, for example by building embankments along rivers which can restrict the ability of flood plains to absorb flood water, forcing more water downstream. Current better management practices call for a holistic and integrated approach that brings in multiple disciplines, in order to build resilience and reduce vulnerability for both people and the environment. The integrated approach works at a river basin or watershed level. It is recommended to focus first on non-structural methods such as land-use planning to manage flood risk and then as required utilize combined soft or natural/nature based flood management methods with hard engineering as needed.

Integrated Flood Risk Management Methods

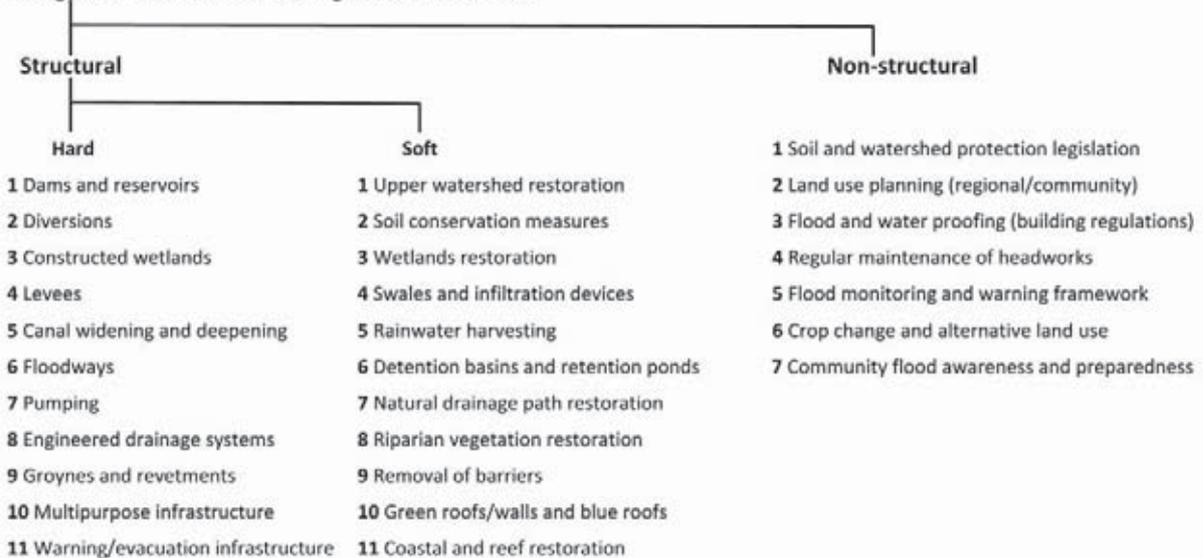


Figure: Structural and non-structural flood risk management methods

(Source: WWF 2016)



Flooding of Khahare khola in Kaski district in July 2015 after very heavy rain, which also caused landslides and tragic loss of life. In the photograph injured people are being evacuated by the Armed Policy Force for treatment.
© CARE Nepal, Hariyo Ban Program/Samjhana Wagle



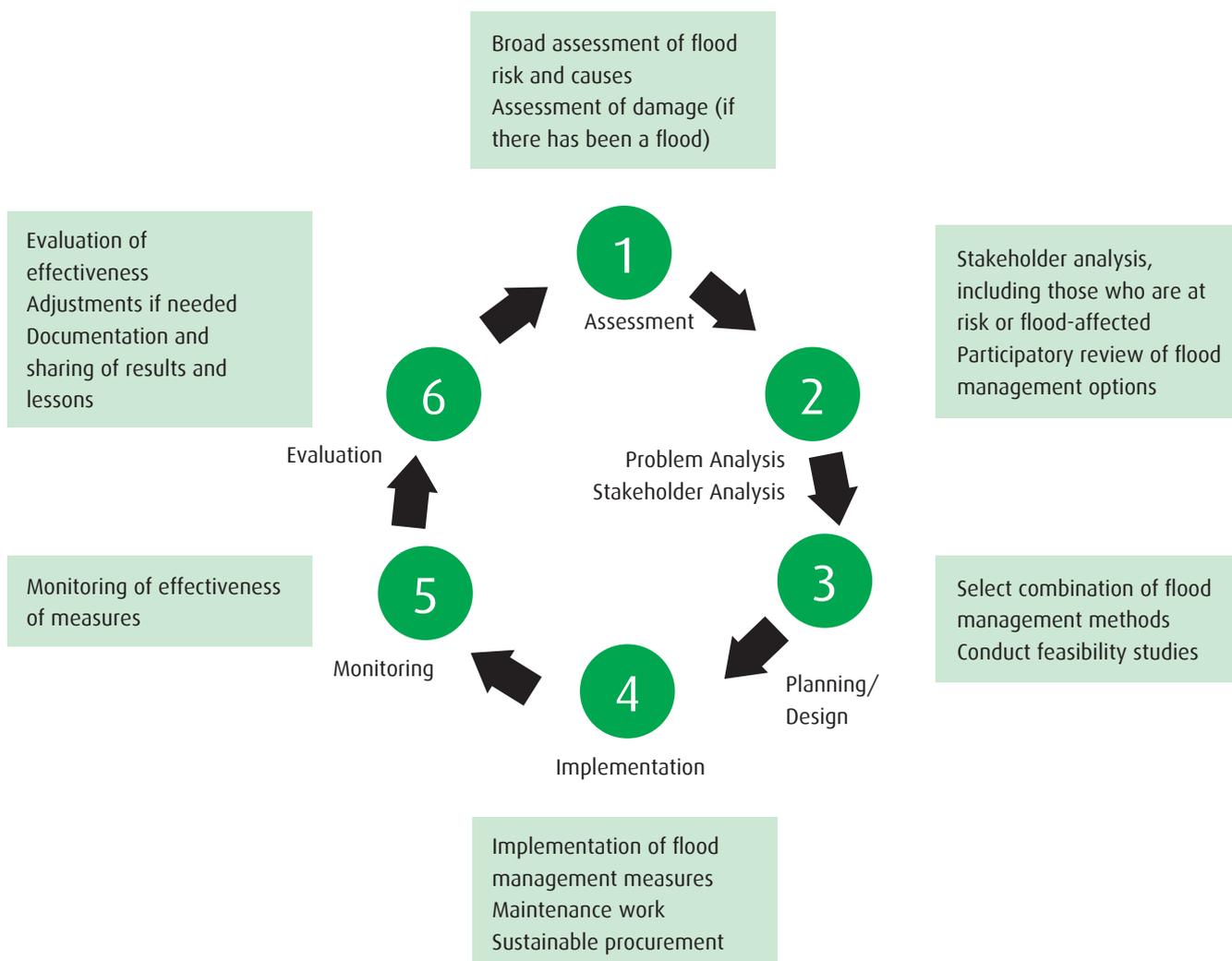
Kerunge khola in Nawalparasi district. Previously the river flowed in a narrower channel with fields to the side, but floods deposited material from upstream landslides and soil erosion, burying farmland and depriving the local community of their livelihoods. Now the water flows beneath the deposits, and the community has had to establish another water source as well as developing alternative livelihoods.
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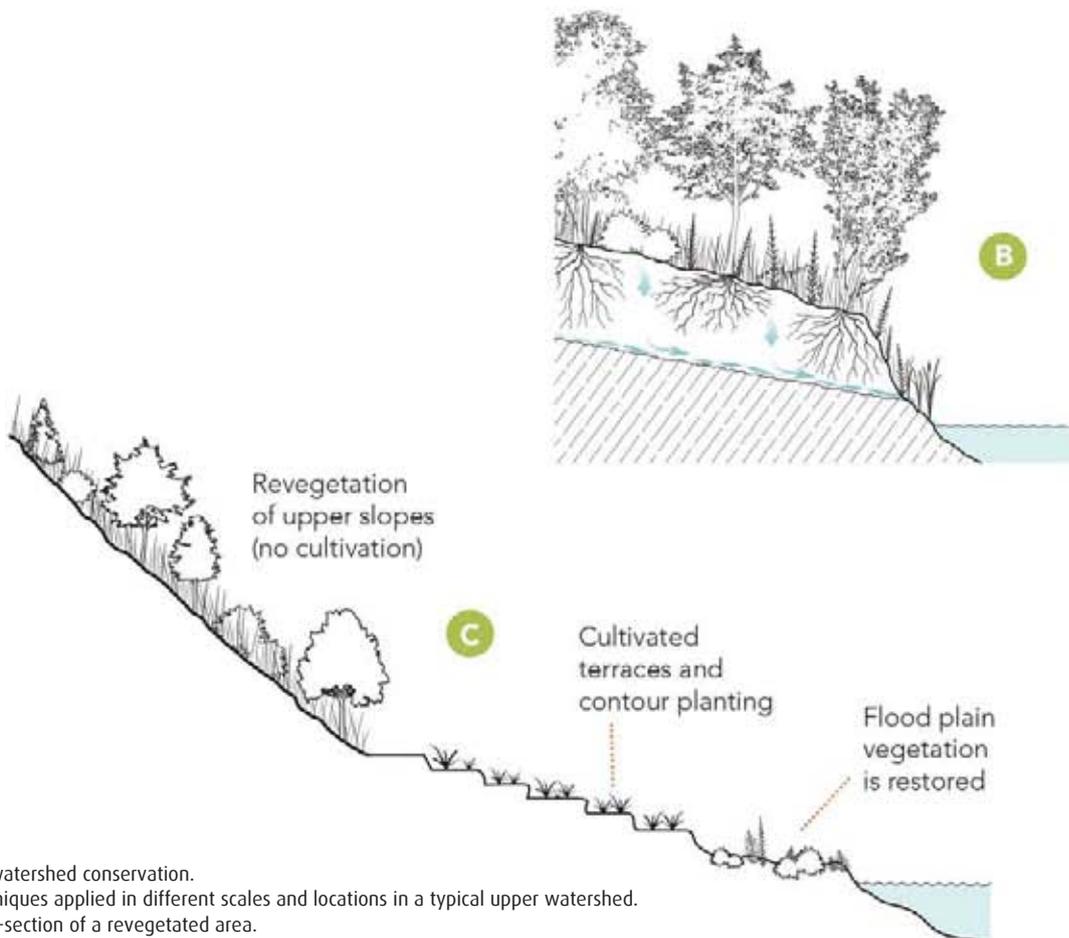
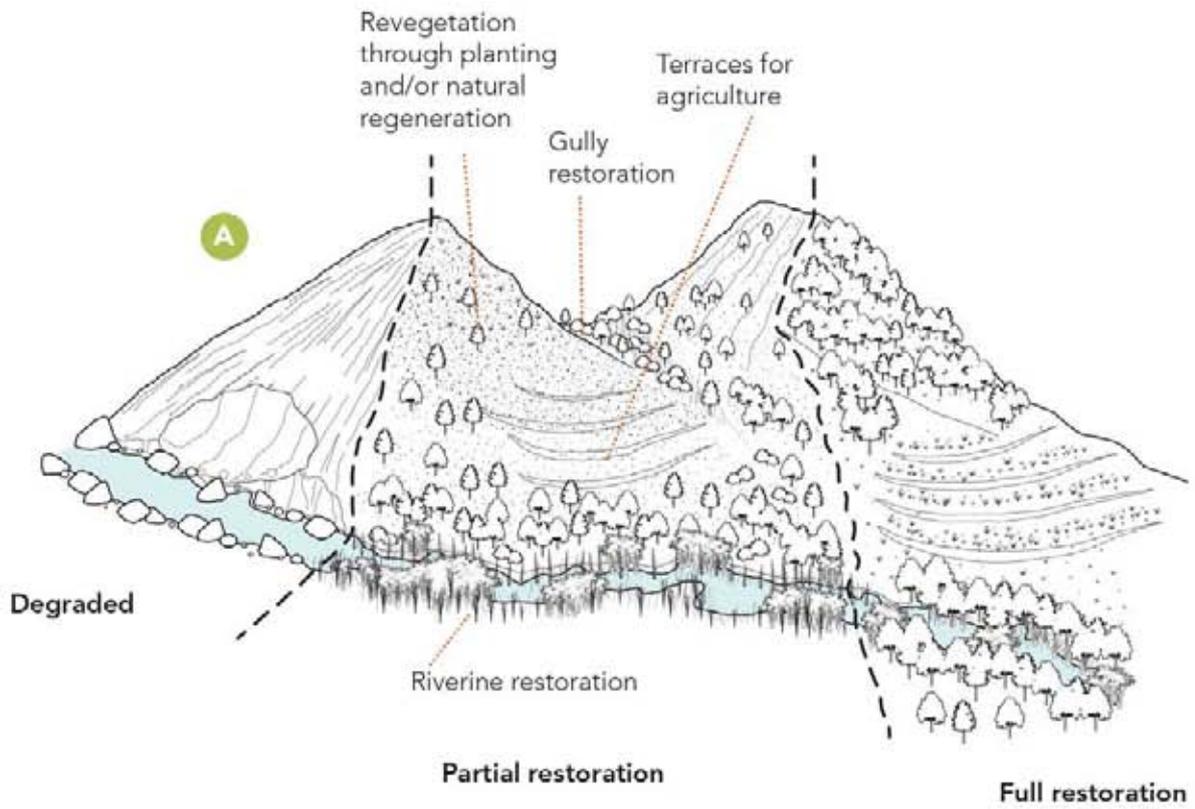
While much of this chapter focuses on disaster risk reduction, there are also opportunities during reconstruction after a major flooding disaster to improve measures by building back safer and greener. For disaster risk reduction, some of the principles and practices in this chapter may be integrated in local disaster risk management plans (LDRMPs) or in DRR components of climate adaptation plans (community adaptation plans of action or LAPAs). Flood management is a very extensive subject and can only be touched on briefly in this guide. For more information please refer to *Natural and Nature-based Flood Management: A Green Guide* (WWF 2016). Mercy Corps (2014) provides practical guidance on bioengineering for flood risk reduction in Nepal.

Key principles for flood management

1. Flooding is a natural process and not all floods are bad.
2. In cases where flooding is a problem, take a holistic approach to flood management, integrating soft and hard structural methods with land-use planning, legislation and community preparedness
3. Work in the watershed or river basin as a unit
4. Restore or enhance ecosystem functions as part of the solution
5. Work with both upstream and downstream stakeholders to ensure understanding of the issues and the importance of adopting better practices
6. Take into account the vulnerability of poor and marginalized people and women when planning for flood management
7. Take climate change into account, anticipating the risk of larger and more frequent floods in the future

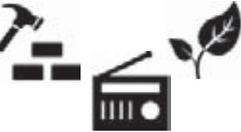
Project cycle for flood risk management





Upper watershed conservation.
 A. Techniques applied in different scales and locations in a typical upper watershed.
 B. Cross-section of a revegetated area.
 C. Some low-cost soil conservation measures.

(Source: adapted from WWF 2016)

Key Steps for Flood Risk Management		
Stage of project cycle	Activities	Stage of disaster cycle
Initial Assessment	<ol style="list-style-type: none"> 1. Conduct a contextual analysis to understand key issues in the watershed/basin including types of flooding and other geographic, climatic, environmental, social and economic aspects 2. Undertake a flood risk assessment. 3. After a flooding disaster – assess damage and causes of flooding 	
Problem Analysis and Stakeholder Analysis	<ol style="list-style-type: none"> 1. Undertake a stakeholder analysis 2. Understand risk and climate uncertainties 3. Set preliminary flood risk management objectives with stakeholders collaboratively, usually in the following categories: <ul style="list-style-type: none"> ▪ reducing and managing flow entering a flood plain ▪ improving flood drainage and increasing flood protection in a floodplain ▪ improving adaptation and preparedness to flooding 	
Design	<ol style="list-style-type: none"> 1. Identify appropriate combination of methods for flood risk management 2. Analyse for social, political, environmental, economic and financial suitability in the local context 3. Ideally first apply non-structural methods and then if needed include structural (soft and/or hard) methods as part of integrated approach 4. Ensure methods are: appropriate for types of interventions; applicable for the scales of interventions; and suitable for the flood types 5. Conduct feasibility studies and environmental assessments, and review designs 	
Implementation - Construction and Operation	<ol style="list-style-type: none"> 1. Construct/establish structural methods 2. Mobilize non-structural methods (e.g. land use planning, early warning systems) 3. Ensure proper operation and maintenance 	
Monitoring and Evaluation	<ol style="list-style-type: none"> 1. Monitor effectiveness of the different methods individually and in combination 2. Evaluate effectiveness of individual methods and in combination 3. Make adjustments as needed, including scaling up, scaling down, or decommissioning 4. Document results and lessons and share them 	

GESI considerations

Marginalized people are often more vulnerable to flooding than others. For example, they may be forced to live in areas with higher risk of flooding because they have no other options. They also often have no resources to help tide them over the shock of a flood. Women, children and differently abled people are also often more vulnerable. For example, they may not be able to swim; in some cultures women are not allowed to leave the home unaccompanied by a man. Women and girls may be vulnerable to gender-based violence in communal shelters after major floods. Floods may affect resources managed by women: for example, drinking water may be contaminated, or they may not be able to access

forest resources such as firewood during floods. Special provisions should be made for vulnerable groups during flood management planning. This could include, for example, early warning systems that reach them in time to get to safety; provision of life jackets; and safe shelters.

Climate change considerations

With increased frequency and intensity of extreme weather events expected as climate change advances, flooding is likely to become more frequent and severe, and floods are likely to reach higher levels in the future. Apart from more extreme events, parts of Nepal are expected to have higher average annual rainfall in the future so there will be more

water overall. The 'hundred-year flood' may become the ten- or twenty-year flood. Climate change effects can be exacerbated by changes in land use, with less water retention in watersheds due to loss of forests and greater runoff from more impervious surfaces. Greater frequency and height of

floods should be taken into account during land-use planning, and for settlements, agriculture, industry and infrastructure. In some flood-affected communities, drought is already a hazard or will become one, and the impacts of drought therefore should also be considered when selecting and designing flood management methods.

Relevant policies and legislation

Water Induced Disaster Management Policy 2006

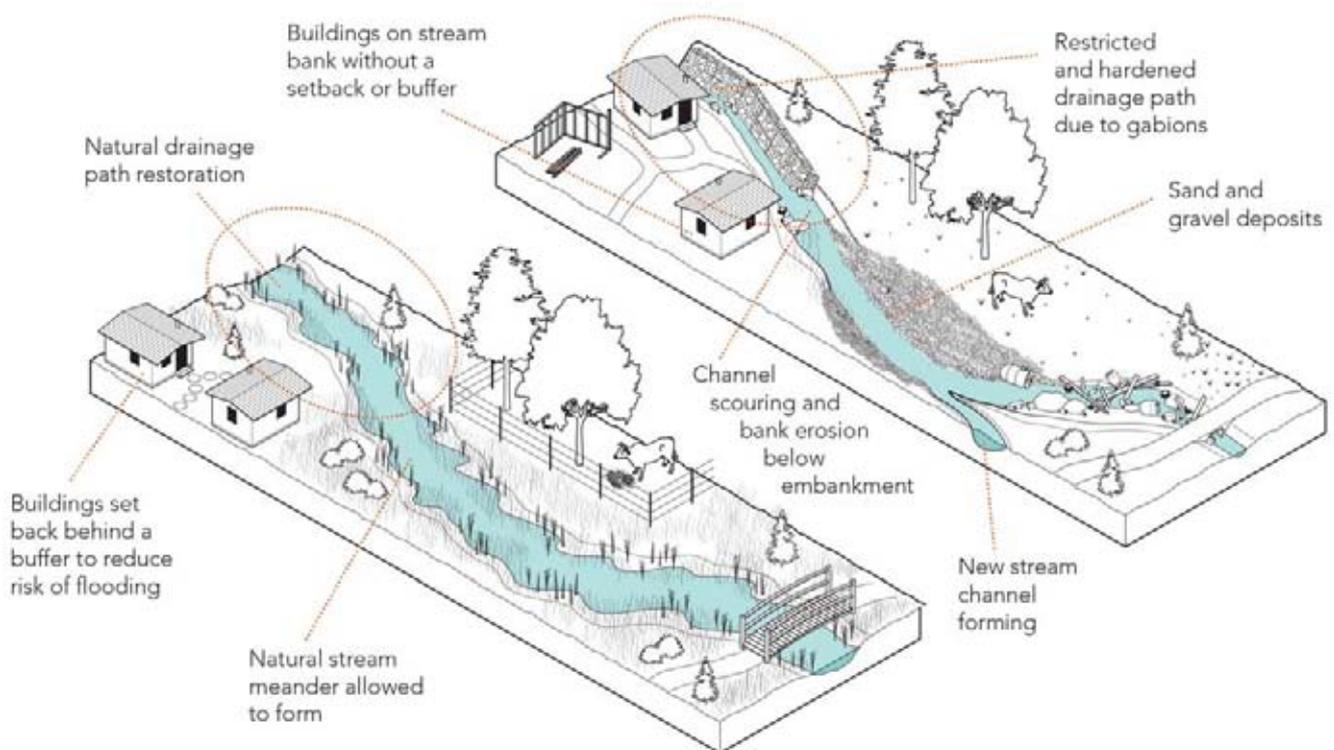
Further reading

Natural and Nature-Based Flood Management: A Green Guide. WWF. 2016.

Bio-Engineering for River Training and Slope Protection Work: Training Manual for Field Technicians Working in Disaster Risk Reduction. Mercy Corps. 2014.

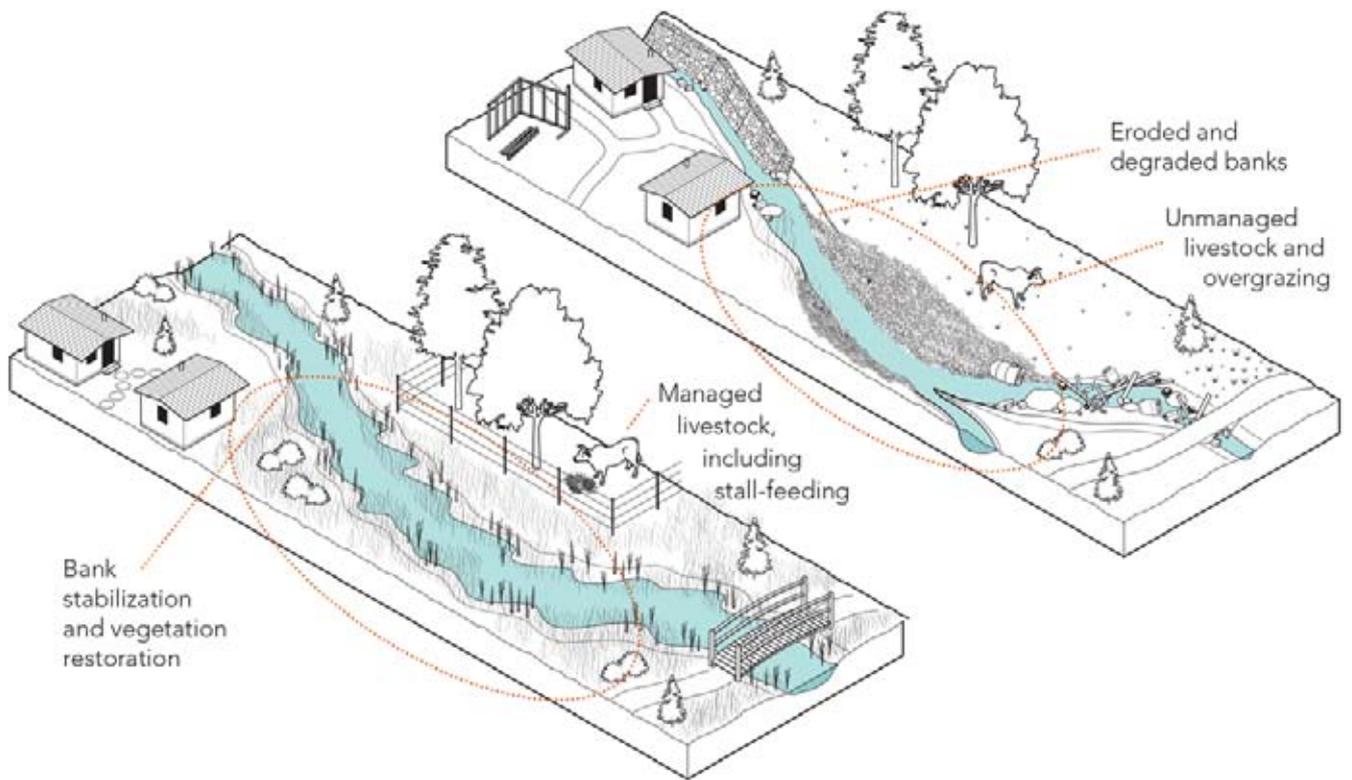
Formulating a Basin Flood Management Plan. Associated Programme on Flood Management. 2007. http://www.apfm.info/pdf/ifm_tools/Tools_Basin_Flood_Management_Plan.pdf

Flood Management in a Changing Climate. Associated Programme on Flood Management. 2009. <http://www.gwp.org/globalassets/global/toolbox/references/flood-management-in-a-changing-climate-apfm-wmogwp-2009.pdf>



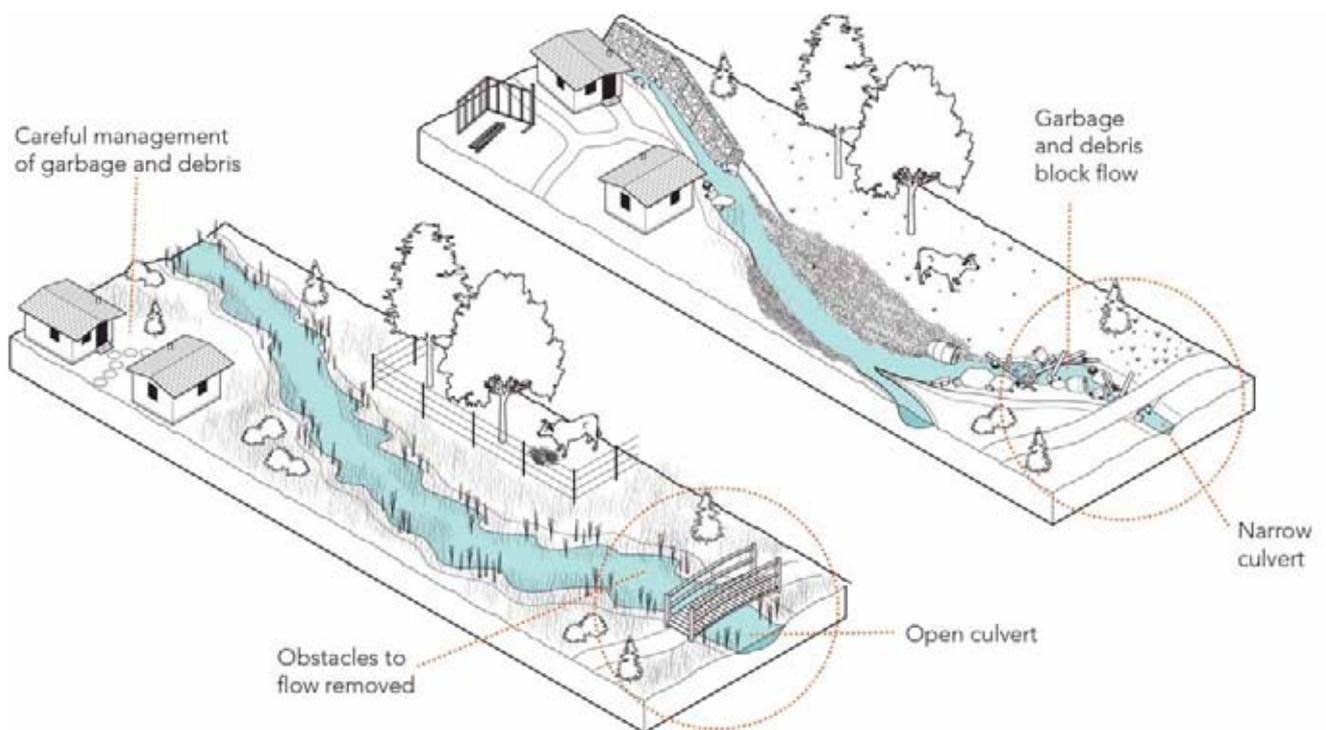
Drainage paths are often hardened, which can result in scouring of the streambed and banks, and downstream sedimentation, flooding, and cutting of new river channels (right-hand figure). Identifying and restoring natural drainage paths (in the left-hand figure) helps drainage of storm water while reducing the risk of problems downstream.

(Source: adapted from WWF 2016)



Denuded flood plains and river banks provide much less resistance to flow or protection from erosion (right-hand figure). Restoring natural vegetation and habitats along the stream and in the flood plains (left-hand figure) helps reduce erosion, scouring and river cutting during high flows and floods. The plant roots bind the soil, and the vegetation cover helps to slow down the water when sudden surges in water level occur. Restoration plans should take into account the needs of local people, and alternative management systems may need to be developed (e.g. for livestock). Side benefits may include harvesting of flood plain resources, e.g. thatching grass.

(Source: adapted from WWF 2016)



Accumulation of garbage and other debris, and construction of culverts that are too narrow for the stream can restrict flow and cause or exacerbate flooding and river cutting (right-hand figure). Removing barriers to streamflow improves the capacity of waterways, especially small and medium sized streams (left-hand figure).

(Source: adapted from WWF 2016)



Upper watershed protection reduces risk of erosion and landslides, and provides clean water supplies and other natural resources for local people. This photograph is from the Madi valley in Annapurna Conservation Area.
© WWF Nepal, Hariyo Ban Program/Judy Oglethorpe



Restoring flood plain vegetation helps to slow down floods, absorb flood water and fine sediment, and reduce flood risk, especially in small and medium sized streams and rivers. This restoration site in Shree Jyoti Community Forest User Group recovered quickly after livestock were moved to another area to graze.
© WWF Nepal, Hariyo Ban Program/Judy Oglethorpe

Once environmental factors have been incorporated into a project’s objectives, activities, outputs and outcomes, regular monitoring and evaluation are necessary to monitor progress towards objectives and identify unintended consequences and areas in which a project may need to be modified. Environmental indicators should be developed for this purpose. They follow the same standards as do indicators for other sectors. Primarily they should be SMART: specific, measurable,

achievable/available, relevant, and time-bound. Ideally they should cover inputs, outputs (process indicators), and outcomes/impacts. Note that some impacts take longer to manifest in the environment than in many other sectors: for example, forest regeneration, and may not be measurable during the lifetime of a project so indicators have to be selected carefully. Examples of environmental indicators are presented in the table below.

Pre-defined environmental indicators

Sector	Common effects of humanitarian activities on the environment	Indicator (Note: these are intended to be general guidance indicators that may be tailored to the program and made SMART)
WASH (Chapter 7)	Increased stress and demand on existing water resources	<ul style="list-style-type: none"> ▪ Change in supply/quality of freshwater ▪ Separate water points for humans and livestock ▪ Latrines and fenced livestock located downstream from water sources
	Decrease in water quality	<ul style="list-style-type: none"> ▪ Dirty water disposal is separate from clean water supplies ▪ Incidence of water borne diseases such as diarrhea and typhoid is decreasing
Agriculture and Livelihoods (Chapter 8)	Presence of toxic chemicals, fertilizer or pesticide use	<ul style="list-style-type: none"> ▪ The purchase and use of chemical pesticides classified by WHO as being in toxicity classes 1A and 1B is discontinued ▪ Animal manure is recycled for use as fertilizer ▪ Inorganic fertilizers are used ▪ Evidence of pesticide/fertilizer runoff into water supplies
	Loss of soil fertility or erosion	<ul style="list-style-type: none"> ▪ Agricultural activities are taking place without terracing on slopes steeper than 20° ▪ Rainwater/irrigation water runoff is controlled ▪ Crops are rotated regularly ▪ Livestock carrying capacity is determined ▪ Measures to mitigate erosion have been implemented
	Unsustainable resource use (e.g., fodder; fish)	<ul style="list-style-type: none"> ▪ Change in extraction rate ▪ Increased fodder production on private land ▪ Environmentally sustainable local agricultural activities are practiced

Settlements, Building Construction and Infrastructure (Chapters 3, 6 and 9)	Land degradation (loss of forest or wetland)	<ul style="list-style-type: none"> ■ Rate of harvesting forest products has exceeded replacement capacity ■ Vegetation important for erosion control, wind breaks, or shade is being protected ■ Areas prone to soil erosion have been identified ■ A drainage network has been constructed ■ Construction project has resulted in the draining of wetlands or other habitats
	Unsustainable material resource use (e.g., sand, timber)	<ul style="list-style-type: none"> ■ Change in extraction rate or method of resource extraction (sand/timber) ■ Quantity of materials originating from unsustainable sources ■ Environment-friendly procurement policy exists
Waste Management (Chapters 4, 7)	Increased hazardous waste production, inappropriate storage of hazardous waste	<ul style="list-style-type: none"> ■ Change in amount and type of hazardous waste produced ■ Health of staff and local population
	Groundwater contamination from health-related products and waste	<ul style="list-style-type: none"> ■ Change in water quality
	Pollution	<ul style="list-style-type: none"> ■ Incinerators are used for disposal of hazardous materials ■ Procurement strategies favor packaging without metal bands ■ Cardboard/paper materials are recycled or composted
Energy (Chapter 5)	Energy and fuel consumption; unsustainable firewood extraction	<ul style="list-style-type: none"> ■ Change in firewood and fuel consumption ■ Distance from where supplies are procured ■ Fuel storage tank leaks

(Source: adapted from WWF and American Red Cross 2010, Module 2)

Monitoring

Very often, existing monitoring methods in other sectors can be adopted for use in monitoring the environment, including:

- Project outputs
- Before and after comparisons of environmental conditions
- Rapid rural appraisal tools
- Interviews
- Remote sensing
- Household surveys
- Market surveys
- Production/consumption data
- Direct observation and measurement
- Physical testing/sampling (e.g. soil and water).

Some tools and methods that have been developed specifically for monitoring environmental indicators include the following:

- Environmental Report Card: it provides a score of "Superior," "Adequate," or "Deficient" based on a project's environmental performance (WWF and American Red Cross 2010, Module 3)

- United Nations High Commissioner for Refugees (UNHCR) Environmental Indicator Framework: this handbook is designed to help field staff and managers working in refugee and related situations apply a basic system of monitoring and evaluation to environment-related activities through the use of indicators (UNHCR and CARE 2009).

Monitoring for environmental indicators can also be facilitated by coordinating with other organizations that are collecting data, e.g., UN agencies and government ministries; it is critical to make sure the data are relevant and reliable for the project's needs.

Methods for measuring environmental indicators are no different than those used for any other indicator. The monitoring methods should help a monitor to measure what needs to be measured in the most efficient, cost-effective, and reliable manner. The more costly and complicated it is to measure environmental indicators, the less likely it is that the measurements will be done. Often, there are indicators that are already being measured by the project that can double as environmental indicators.

Indicators used by the Hariyo Ban Program in recovery and reconstruction

The Hariyo Ban Program was able to use several of its existing environmental indicators when it took on earthquake recovery work, including the following:

- Number of people benefiting from alternative energy (biogas, ICSs, metal stoves), reducing threats to deforestation and degradation
- Amount of greenhouse gas emissions reduced due to alternative energy reducing fire-wood consumption
- Number of people receiving training in natural resource management and/or biodiversity conservation
- Number of forest dependent people with increased economic benefits from sustainable NRM and conservation
- Number of hectares of biological significance (forest, wetlands, and grasslands) under improved management
- Number of policies/strategies related to biodiversity conservation which GoN is supported to formulate/review/analyze

It also added the following new social indicators for earthquake recovery and reconstruction:

- Number of people with increased capacity to recover from disaster and/or for disaster risk reduction
- Length of trail repaired/reconstructed
- Number of person days of employment generated through cash for work
- Number of women-headed households benefitting from recovery work
- Number of women and adolescent girls benefitting from recovery work

(Source: Hariyo Ban Program)

Evaluation

It is not enough to collect the data: it must be analyzed and interpreted to evaluate the project and inform project management decisions. In relation to the environmental factors measured in the project, a good starting point is to determine what is “appropriate,” what is an “improvement,” and what is “degradation,” and to use that information to make comparisons with changes that can be attributed to the project. Environmental changes related to the project can be compared with:

- Baseline: what was measured at the beginning of the project
- Threshold: the tolerable limit for negative impacts
- Target: the minimum desired level of positive impact
- Norm: what the “usual” state is
- Before-after: it is often difficult to compare pre-disaster with post-disaster conditions, but this comparison may be possible if a pre-disaster baseline is available
- Impact (comparison to control): comparing similar areas with and without intervention; this is much easier to do in the intervention time frame of most humanitarian efforts

Data analysis can be enhanced through communication with key stakeholders who live in the project area, or environmental experts who are familiar with the environmental norms and how and why they have changed. Tools like remote sensing are making it increasingly feasible to look at before and after situations. Again, it will be helpful to have the input of experts familiar with the project context and with environmental issues. Even if the project designer knows, for instance, what the pre-disaster state is, he or she may not know:

- If that state is good or bad
- If a particular change in state can be considered substantial and outside of the normal range
- If that change is good or bad

This chapter draws heavily on the GRRT (WWF and American Red Cross 2010).

Further reading

Green Recovery and Reconstruction Toolkit. Module 2. World Wildlife Fund & American National Red Cross. 2010.

Framework for Assessing, Monitoring and Evaluating the Environment in Refugee-related Operations. Module V: Environmental Indicator Framework. UNHCR and CARE International. 2005.



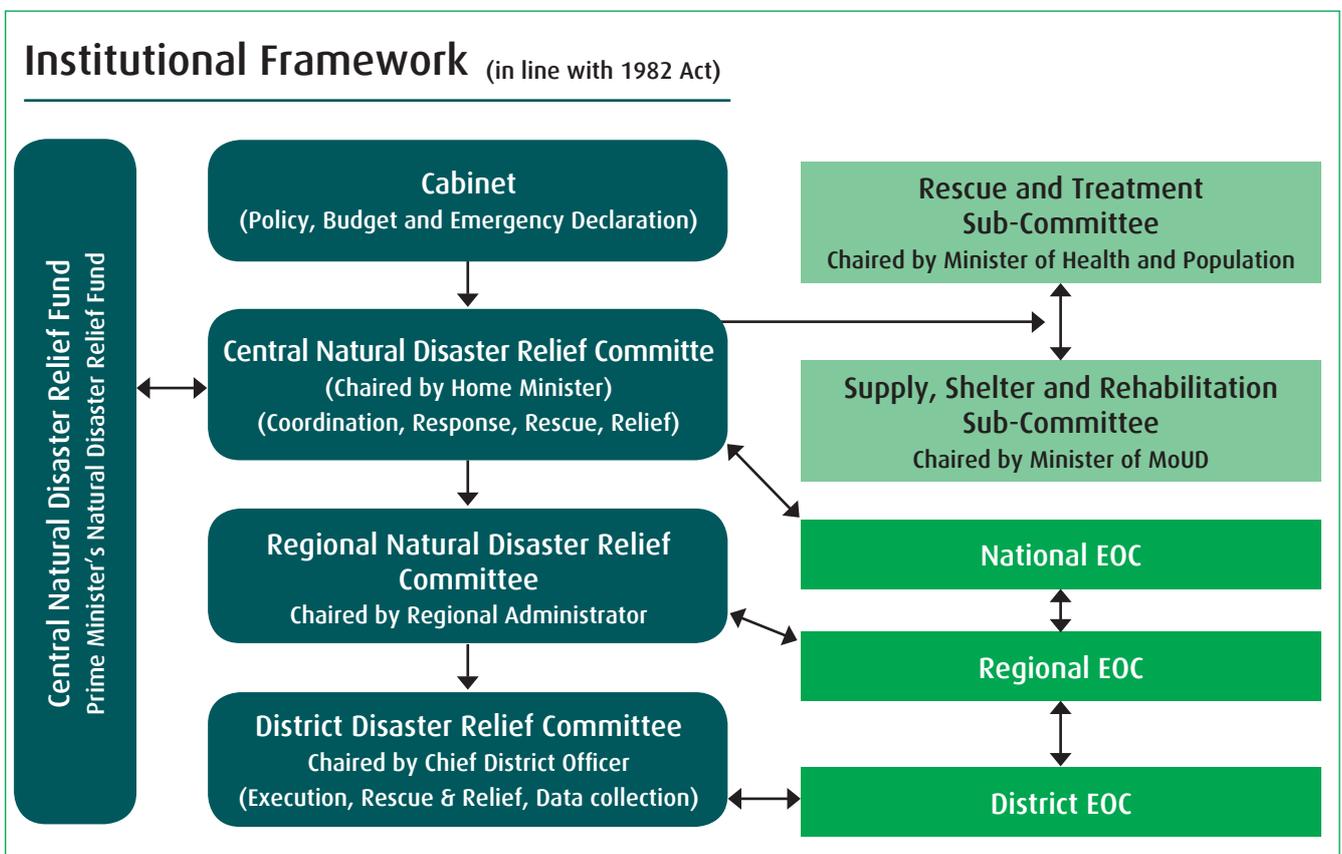
Repair of water supplies, linked to restoration and management of the local watershed, is an important part of many green recovery and reconstruction projects. Monitoring can include indicators on quality and reliability of water supplies; survival rate of seedlings and saplings planted in the watershed; change in forest cover; and occurrence of landslides and soil erosion.

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In light of Nepal’s high disaster risk, GoN has promulgated various laws and policies, including the Natural Calamity (Relief) Act, 1982 and the National Strategy on Disaster Risk Management, 2009. The Act provides for a Central Natural Disaster Relief Committee (CNDRC) chaired by the Minister of Home Affairs at central level, Regional Natural Disaster Relief Committees (referred to as RDRCs elsewhere in this guide) at regional level, and District Natural Disaster Relief Committees (referred to as DDRCs) at district level for overall disaster response in Nepal. In addition, there are Supply, Shelter and Rehabilitation Sub-committees, and a Relief and Treatment Sub-committee at central level. In order to collect, analyze, disseminate and coordinate disaster related information, Emergency Operation Centres (EOCs) are functional at the central, regional, district and municipality level. As specified

in the Local Self Governance Act 2055, local bodies (District Development Committees, municipalities and VDCs) are responsible for disaster preparedness and response.

The Ministry of Home Affairs (MoHA) is the nodal agency for disaster risk management for Nepal, at both national and international level. The National Strategy for Disaster Risk Management, 2009 is based on the Hyogo Framework for Action, and encompasses prevention, mitigation, preparedness, response and recovery. It defines clear roles for different Ministries during different phases of disaster. The thirteenth Five Year Plan (2013/14-2015/16) emphasizes disaster risk management issues as part of sustainable development, prioritizing pre-disaster preparedness through to the recovery process.



Institutional framework for disaster management in Nepal

(Source: redrawn from figure of the Ministry of Home Affairs)

The National Disaster Response Framework was prepared in March 2013 to implement and coordinate a response plan for national level disaster, allocating roles for governmental and nongovernmental organizations. It guides more effective and coordinated national response in case of a large-scale disaster, highlighting actions taken immediately before, during and after disasters in order to save lives and property; maintain law and order; care for sick, injured and vulnerable people; provide essential services; and protect public property. The framework is limited to response preparedness and emergency response at national, regional, district and local level.

National Level Disaster Response

Upon the receipt of actual or potential disaster information from district or local level, the following lead agencies are assigned to carry out operations:

- CNDRC, RDRCs and DDRCs organize emergency meetings in coordination with government agencies, UN agencies, and international and national NGOs as needed
- EOCs at national, regional, district and municipality level coordinate with different organizations to make disaster response activities effective

The following organizations, including the Disaster Management Division of MoHA, work as support agencies in disaster response management:

- CNDRC members; Ministries of Finance, Foreign Affairs, Defense, Health and Population, Federal Affairs and Local Development and Agricultural Development; National Human Rights Commission; Bureau of Statistics; National Seismological Centre; Waste Management Centre; National Trauma Centre; Nepalese Army; Nepal Police; Armed Police Force; Fire Brigade Office; Search and Rescue Teams; RDRCs/DDRCs; District Development Committees; local level government offices; Civil Aviation Authority; Nepal Food Corporation; other relevant ministries, departments and governmental organizations
- National NGOs
- UN Resident Representative/Humanitarian Coordinator and UN agencies (UNDP, UNICEF, World Health Organization (WHO), World Food Program (WFP), Food and Agriculture Organization (FAO), United Nations Population Fund, UNOCHA, International Organization for Migration (IOF), United Nations Human Settlements Programme (UN-HABITAT), UNHCR, United Nations Department of

Safety and Security)

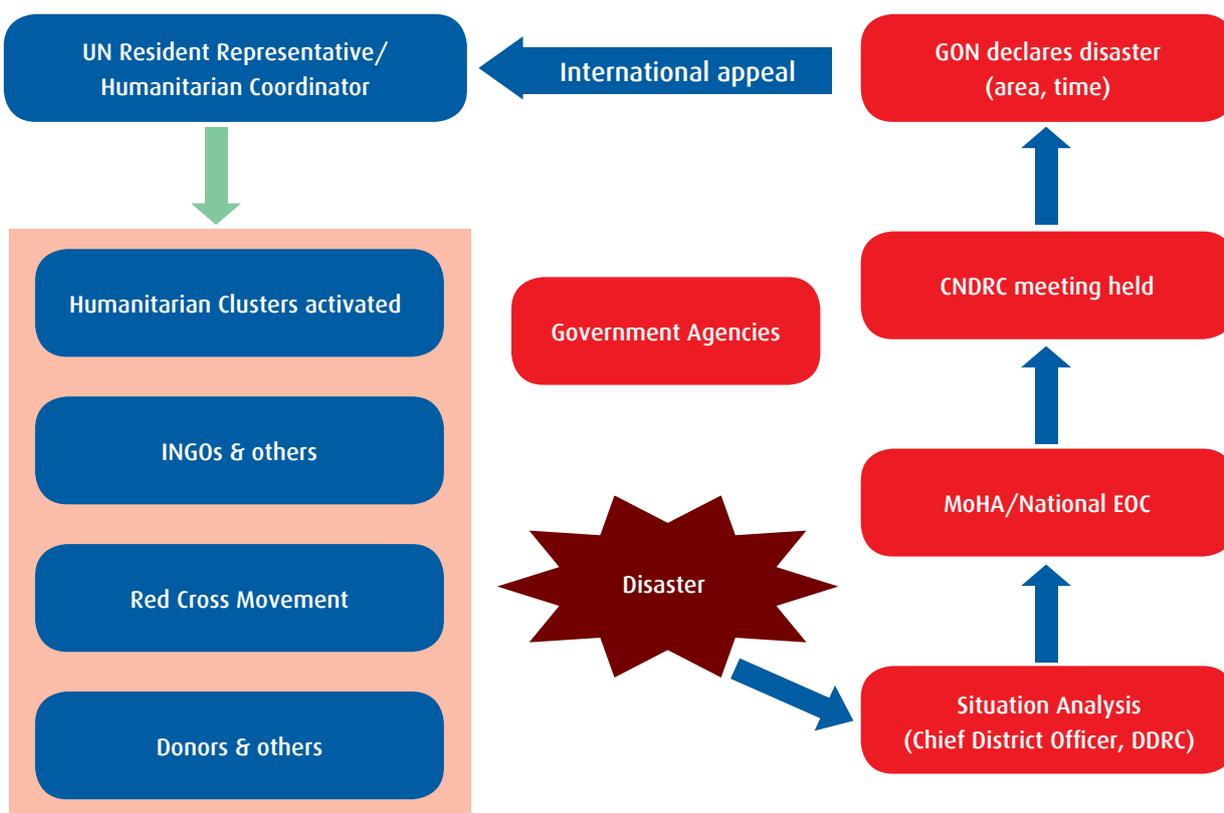
- relevant humanitarian clusters
- multilateral organizations, ICIMOD, international NGOs, Diplomatic Missions, South Asia Association for Regional Cooperation, Red Cross Movement, and International Civil Aviation Organization
- Nepal Red Cross Society, Nepal Scouts, government and private hospitals, Nepal Academy of Science and Technology, Disaster Preparedness Network Nepal, media, community based organizations, community volunteers, medical associations, National Security Services, Press Council, Federation of Nepalese Journalists, Nepal Television, Radio Nepal and other means of communications, Himalayan Rescue Organization, Mountaineering Training Academy, Civil Aviation Association, Nepal Medical Council, Nepal Nursing Council, Federation of Contractors' Associations of Nepal, Transportation Association, Federation of Nepalese Chambers of Commerce and Industry, Telecommunications Authority, Nepal Engineering Association, and other relevant expert agencies

International Assistance for Disaster Response

In case of a major disaster requiring international assistance, the Government of Nepal (Cabinet) may request the UN Humanitarian Coordinator, foreign governments, Red Cross Movement, regional organizations, donor communities, international and national NGOs, political parties, professional individuals, resident and non-resident Nepalese citizens, foreign citizens, and other sources for international assistance in terms of cash or services to respond to the disaster through concerted national efforts and intensified regional co-operation. In normal circumstances, the Ministry of Finance is consulted before an appeal. Once a call for assistance is made by GoN, the United Nations and Red Cross Movement appeal for international assistance to respond to the disaster.

The Ministry of Home Affairs, in accordance with the Guidelines for Accepting International Assistance and Early Registration to be prepared in consultation with the Ministry of Finance, facilitates and coordinates the overall management of international humanitarian communities. During a largescale disaster, the UN Humanitarian Coordinator activates the humanitarian cluster system of Nepal (see Annex 3 for more information on the clusters). GoN nominates a focal person to each cluster in order to respond to the disaster through a coordinated cluster approach. The Central Natural Disaster Relief Committee may also activate the clusters as necessary.

Process for declaring a disaster and launching an international appeal for assistance



(Source: redrawn from figure of the Ministry of Home Affairs)

Humanitarian Cluster coordination responsibilities in Nepal in 2016¹

	Camp Coordination, Camp Management	Early Recovery	Education	Food Security	Health	Logistics	Nutrition	Protection	Shelter	Emergency Communication	Water and Sanitation
Cluster lead (GoN)	MoUD	MoUD	MoE	MoAD	MoHP	MoHA	MoHP	MoWCSW/ NHRC	MoUD	MoIC	MPPW
Cluster Co-lead	IOM	UNDP	UNICEF /SC	WFP/ FAO	WHO	WFP	UNICEF	UNICEF/ NRCS/ UNFPA	IFRC/ UN- HABITAT	WFP/ UNDSS	UNICEF

Inter-cluster coordination is provided by MoHA.

(Source: <http://un.org.np/attachments/cluster-leads-contact-details>)

¹ MoE: Ministry of Education; UNICEF: United Nations Children’s Fund; SC: Save the Children; MoAD: Ministry of Agricultural Development; MoHP: Ministry of Health and Population; UNFPA: United Nations Population Fund; MoWCSW: Ministry of Women, Children and Social Welfare; NRCS: Nepal Red Cross Society; NHRC: Nepal Health Research Council; MoIC: Ministry of Information and Communications; UNDSS: United Nations Department of Safety and Security; MPPW: Ministry of Physical Planning and Works



No single sector or organization can achieve green recovery and reconstruction on its own after a major disaster – it must be a shared responsibility. Here members of the Gorkha District Disaster Relief Committee (DDRC) visit a soil bioengineering site as part of a workshop on green recovery and reconstruction. The DDRC members represent many different sectors at district level.
© WWF Nepal, Hariyo Ban Program/Judy Oglethorpe

Green recovery and reconstruction has to be a shared responsibility after a major disaster – no single organization or sector can do it alone. While there is a very important role for the environmental sector in helping to identify potentially damaging actions and ways to avoid adverse impacts, ultimately everyone involved in DRR, recovery and reconstruction needs to play a part in building back safer and greener, and reducing future disaster risk.

There are several potential barriers to people in other sectors getting involved (WWF and American Red Cross 2010):

- People are not always fully aware of the environmental impacts of their projects and actions
- They may believe that the environment is of secondary importance to the goals of their project
- They may believe that addressing the environment is too costly or too troublesome

Previous chapters of this guide have explained why it is important to consider the environment in recovery and reconstruction activities across different sectors in order to reduce environmental impacts during this phase, and to build back safer and greener to enhance future resilience. This chapter discusses ways for environmental organizations to encourage other sectors to promote mainstreaming of the environment in their work.

Deciding who to work with

The most important actors and most effective leverage points depend on the nature and scale of the actual or potential disaster, what the environmental risks are, and which institutions are most relevant to take action. Often some sectors and disciplines are more important than others depending on the situation. Key actors may be in government, humanitarian structures, the United Nations, donors, NGOs, private sector and/or community-based organizations; they may be individuals such as skilled specialists or individual citizens (e.g. householders). In a major disaster, if a PDNA and/or rapid environmental assessment are undertaken, they can be used to identify major environmental risks, and priority sectors, disciplines and geographical areas in which to focus efforts. Note that priorities may change with time following a major disaster. A stakeholder analysis helps prioritize partners, including those who can influence others.

Often the highest priority actors to work with are not traditional partners for the environment sector, and new relationships need to be established. This can be particularly challenging since there are rapid changes in personnel in disaster response including in humanitarian clusters after a disaster, and also in the Nepal government due to frequent senior officer transfers.

Identifying priorities for GRR action after the 2015 earthquake

After the 2015 earthquake, WWF Nepal and the Hariyo Ban Program participated with many partners on the Environment and Forestry team in the PDNA which helped to think through what the potential impacts of recovery and reconstruction would be. The rapid environmental assessment team worked on this in much more detail, and it became clear that the greatest potential for adverse environmental impacts was through reconstruction of buildings, especially housing but also other buildings such as schools. Extraction of building materials was a particular concern. We also realized that there were potential impacts from the livelihoods and WASH sectors, and strong environmental links that we could promote, such as watershed management. Resettlement would also be an issue for the environment.

In the months after the earthquake we started to work with the most relevant humanitarian clusters, raising awareness by giving presentations and networking, and increasing our understanding of the clusters and their issues by attending their meetings. As the clusters closed down or transitioned to recovery, we worked increasingly with government ministries and departments, especially MoUD and its DUDBC, as well as the Department of Education and the Department of Water Supplies and Sewerage. When the NRA was created we made contact, since all recovery activities were to be planned through the NRA. We participated in the NRA-led Post Disaster Recovery Framework process, and the Environment and Forestry team succeeded in getting green recovery concepts mainstreamed in several sectors. We also worked through our donor, encouraging other USAID-funded recovery projects to adopt green practices.

(Source: Hariyo Ban Program)

Entry points

Entry points need to be sought: these often work well through personal contacts in this fast-moving environment, including contacts and relationships that existed before the disaster. The humanitarian clusters also provide good entry points.

Messaging

Messaging needs to be appropriate for the intended audience. Messages that are developed by environmental organizations for the humanitarian sector should focus on benefits for people. For example, the case for watershed conservation should be made through the benefits of clean water supplies and control of flooding, rather than biodiversity corridors or snow leopards. For this it is important to understand the audience.

Entry points to other sectors

In Hariyo Ban we realized we needed to work with some sectors that we did not partner with traditionally, such as housing. Recruiting an architect with disaster management experience and a wide network of contacts to manage our GRR program provided an excellent entry point to the building construction sectors. The previous work we had done after the 2014 Terai floods with DUDBC through the Center of Resilient Development also helped.

(Source: Hariyo Ban Program)

Response from other sectors

There was a remarkably positive response from many other sectors, who were keen to know what they should do and how to do it in order to ensure their actions were environmentally sound. The fact that Nepal is a highly disaster prone country likely facilitated this attitude: people are often aware of the risks of floods and landslides, for example, and their links to land use practices. The main stipulations of other sectors were that activities should be practical, easy to do, and should not add significantly to the short-term recovery cost or the time for implementation.

(Source: Hariyo Ban Program)

Mainstreaming and reaching to grass roots level

The GRR training program rolled out by the Hariyo Ban Program directly reached to national and district level engineers; policy makers; parliamentarians; and media. It also reached masons by collaborating with the Training Institute for Technical Instruction (TITI) on training-of-trainer programs for mason trainers, and providing environmental inputs through DUDBC to revised rural and urban masons' training manuals. However, we realized that we were not directly reaching communities and householders on a large scale; this was a significant gap since in the owner-driven housing reconstruction householders would in many cases be supervising the masons who rebuilt their houses. We knew that in rural areas local radio is a very effective means of communication with local people. So we partnered with BBC Media Action, providing practical messages that could be incorporated in an ongoing radio program about earthquake recovery, and giving training to local radio station staff in practical green recovery and reconstruction actions that they could incorporate in public service announcements and other broadcasts.

The World Bank requested Hariyo Ban for its green recovery and reconstruction materials and soil bioengineering approach, as it set up environmental and social safeguards in the multi-donor supported Rural Housing Reconstruction Program. The Program was to operate in 14 districts of Nepal, with a great ability to reach to householder level. This was an important way to get green practices promoted in rural housing reconstruction. At the request of the Ministry of Federal Affairs and Local Government we also produced a set of posters with environmental measures for reconstruction, for display at local level.

(Source: Hariyo Ban Program)

Champions

Champions play a huge role in promoting collaboration across sectors and disciplines, and ensuring that green concepts are learned and applied. Champions can come from different sectors, organizations and levels. One of the challenges is that they are overworked after a disaster. Hence having clear, concise messages ready for them to use is very important. Also, since people move around at this time, and many international disaster workers stay for only a short time, it is important not to rely too heavily on a single person, but to develop a good network of champions.

Collaboration within the environment sector

Collaboration among environment organizations and experts is very important, and this was clear during the PDNA and PDRF processes. After the PDNA UNEP played a coordination role, bringing together environmental experts to share information on their post-disaster activities, and linking them with other sectors. In hindsight, more collaboration within the sector could have promoted greater sustainability.

Future needs

Hariyo Ban's GRR program ran from May 2015 till December 2016, when the first phase of Hariyo Ban ended, and with it the funding for the central level GRR program. Ideally it should have gone for longer, given the scale of the disaster and the time taken for reconstruction. It would have been good, for example, to work more with higher education institutions to mainstream GRR into their engineering and other curricula; mentor trainees in GRR mainstreaming as they undertook reconstruction; do further work to reach householder and local authority level; perhaps establish a GRR help desk for earthquake reconstruction; and document lessons more extensively as the reconstruction phase advanced. Hopefully others will fill these roles in the future.



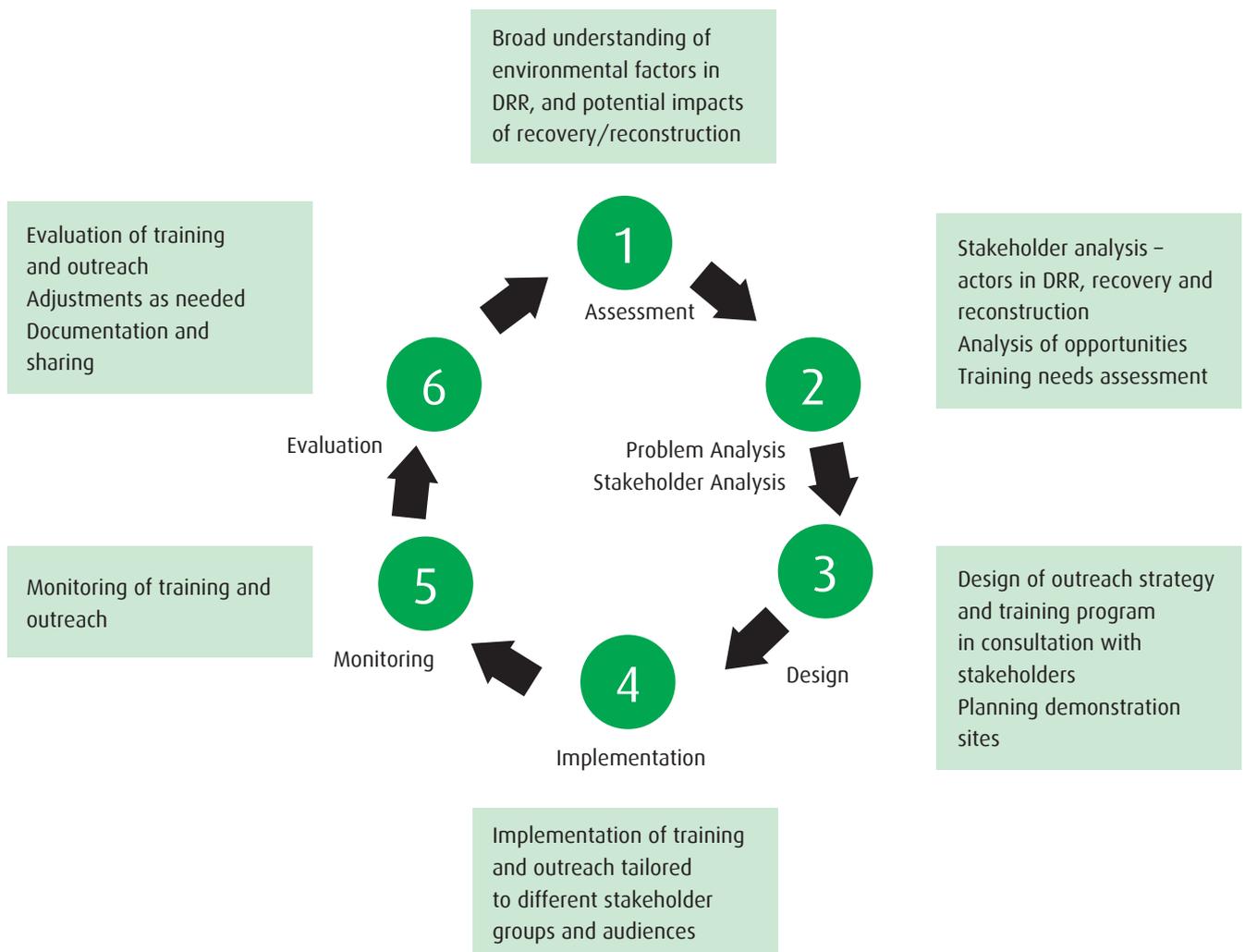
Group work during a planning meeting to discuss existing issues in Nuwakot and Langtang districts after the 2015 earthquake, and possible green recovery and reconstruction activities using support from the Hariyo Ban Program. Participants included representatives of the District Development Committee, district government line agencies, FECOFUN district chapters, Langtang National Park Buffer Zone Users Committee, and local political parties.
© WWF Nepal, Hariyo Ban Program/Judy Oglethorpe

In order for environmentally sound practices to be promoted widely, awareness, capacity and buy-in have to be built in stakeholders at different levels and across many different sectors. This chapter covers training and awareness raising; the project cycle below shows the steps involved. In practice the process is likely to be an iterative one as recovery and reconstruction progress, new environmental impacts emerge, and new opportunities open up to tackle them.

Timing

Ideally training and outreach should be undertaken before a disaster so that people can apply the knowledge to DRR, and also understand the environmental risks from relief, recovery and reconstruction before a disaster occurs. However, it may be difficult to get people to prioritize training beforehand, and outreach and training may not be specific enough for the circumstances of future disasters. Also, many post-disaster

Project cycle for training and outreach in environmental aspects of DRR, recovery and reconstruction



actors may be absent then (e.g. international experts who come in after a disaster occurs). And if training is conducted too far in advance people may forget it, or transfer to other jobs.

If training is conducted after a disaster, timing is also important. Immediately after a big disaster humanitarian aspects take priority, as people are rescued and relief takes place. It may be some time before stakeholders can make time for environmental training, which is seen as non-urgent. Training should be short because people do not have much time to spare. There may be windows: for example, while reconstruction is waiting for funding, or for the monsoon to end. It may be necessary to travel to the trainees rather than expect them to come to the capital city.

Training content

Training should be practical and focus on what the trainees can do to mainstream green practices in recovery, reconstruction and DRR in their field. Use local examples that they can relate to – if they have time, take them to a field site nearby that demonstrates some of the principles you are teaching, and have experts on-site to discuss interventions. Prepare well, and make sure that the level of training is appropriate for the participants; teach in the language they are most comfortable with, and avoid jargon. Since the environment is a complex subject, have trainers from different (but relevant) fields if possible. Ask the trainees to complete an evaluation of the training at the end, to learn how effective the training was and how it can be improved in the future.

Similarly, for outreach focus on specific messages that are appropriate for the audience concerned, and give practical actions that people can take to make their work environmentally sound without taking much longer, or adding significantly more complexity or cost.

Commitments from training participants

Encourage participants to make a commitment to implement GRR or environmentally sound DRR when they finish the training. This may be as simple as committing to procure sand and gravel from a legal and well managed site, or trying out an alternative energy technique in a field site. Since people are often expected to attend many training courses during recovery and reconstruction, this will help them remember the GRR training and encourage them to take concrete action.

Follow-up

Try to follow up with trainees afterwards to see if they need advice or mentoring to put into practice what they have learned, and provide encouragement. If funds are available, a small grants fund may be a very effective way to help mainstream environmental issues, or try our new approaches.



Role-play session during a national level green recovery and reconstruction training workshop after the 2014 Terai floods, organized by the Department of Urban Development and Building Construction, WWF/Hariyo Ban Program, and the Centre for Resilient Development. Participants came from government departments and national and international non-government organizations.

Hariyo Ban Program green recovery and reconstruction training

As part of its post-earthquake GRR work the Hariyo Ban Program had a major focus on training and outreach across different sectors. Training needs assessments at different levels identified key stakeholder groups and their training needs, and during sixteen months the Program collaborated with GoN and trained over 1,000 people. Training was largely based on the Green Recovery and Reconstruction Toolkit (WWF and American Red Cross 2010), and was tailored to Nepal and the needs of participants. Often we were able to add on a day's training to existing workshops and training courses organized by government departments.

Training drew on a pool of technical trainers (Program staff, GoN staff, consultants and guest trainers) with specializations that included livelihoods; building reconstruction; WASH; resettlement; watershed management; soil bioengineering; forestry and conservation.

The training program included:

- **General GRR training for 108 staff of the Hariyo Ban Program, its consortium partners and GRR implementing partners:** multi-disciplinary training for future GRR trainers, and to prepare staff and partners to oversee and implement GRR activities in the field; this was the first course after the earthquake and gave an opportunity to test training materials and training format
- **Broad GRR training for 252 members of District Disaster Relief Committees (DDRCs) in seven severely affected districts:** DDRCs were prioritized because of their coordinating roles in district recovery and reconstruction. Districts were Gorkha, Rasuwa, Dhading, Nuwakot, Sindhupalchowk, Dolakha and Ramechhap; training lasted one or two days and covered GRR practices across multiple disciplines as relevant to the districts.
- **Multi-disciplinary GRR training for 92 district level NGO staff and officials from government line agencies:** these were people who had not been included in DDRC training, and were playing major roles in recovery and reconstruction in some of the most seriously affected districts.
- **Green building reconstruction training for 35 engineers and architects of MoUD and DUDBC from central and district level:** since housing was expected to have some of the largest environmental impacts during reconstruction, government engineers and architects were an important group. This training promoted sound environmental practices including the use of local, reusable and recycled materials in the reconstruction process, and energy and water efficiency, to minimize environmental impacts from resettlement and housing reconstruction.
- **Green school reconstruction for 117 engineers and sub engineers from the Department of Education:** with so many schools to rebuild, staff in the Central Level Project Implementation Unit of DoE received training on sound environmental practices in school reconstruction, and integration of GRR in school activities
- **Green practices in WASH recovery and reconstruction for 35 WASH engineers from Department of Water Supply and Sewerage:** WASH engineers were prioritized because of their role in rebuilding or repairing water supplies, and opportunities to promote good watershed management
- **GRR in forestry for 66 district officials in Department of Forests:** MoFSC organized a workshop for district staff from 31 districts on the new Directive on Timber Production, Supply and Management for Earthquake Victims; Hariyo Ban provided training on green recovery and reconstruction with a focus on timber treatment and soil bioengineering
- **Broad GRR training for 58 Members of Parliament (MPs), 8 political leaders and 10 media representatives from earthquake affected districts:** MPs were prioritized because of their influence in their constituencies and their policy-making roles. Workshops were held for four groups to sensitize and empower participants through enhanced knowledge, and participants made specific commitments at the end of each workshop to promote environmentally sound practices in recovery and reconstruction.
- **Mason training of trainer sessions:** sessions on sound environmental practices were given in mason training-of-trainer courses through TITI and CTEVT
- **Broad GRR training for 38 media representatives:** representatives from print media and television attended a workshop on green recovery and reconstruction to share the issues involved and discuss the role that media can play in promoting environmentally sound approaches
- **Practical GRR training for 27 local radio station staff:** in order to reach house owners in rural areas we were able to add some extra training to workshops organized by BBC Media Action for local radio stations; participants learned about practical actions that could be taken by house owners, like reusing timber from debris and not extracting sand and stone in landslide-prone areas; some subsequently made public service broadcasts with environmental messages

Outreach and training that we did not do but would have been useful

Unfortunately we were unable to do the following:

- Outreach to donor organizations – while we did reach out to some donors like USAID and the World Bank, there were others that we did not reach, and in hindsight this should have had higher priority
- Training for cluster members – we had intended to train members of the most relevant clusters, but in practice many clusters were disbanded before we had developed the training programs, and members were very busy
- Training for members of the Housing Recovery and Reconstruction Platform – we tried to organize this but ran out of time

Communication and outreach

In addition to the formal training and capacity building, WWF, Hariyo Ban reached out to many stakeholders including NRA, UNOCHA, humanitarian clusters, GoN Departments, NGOs and university departments. It also presented at conferences and meetings on GRR at national and international level to raise general awareness and to reach key decision-makers, senior government officials, donors, NGO leaders, parliamentarians, media reporters, and other key audiences. Forums included the Society of Nepalese Architects/South Asian Association for Regional Cooperation of Architects, the Nepal Engineers Association, national workshops on landslides, and a workshop with MoUD/DUDBC and the International Union for the Conservation of Nature (IUCN)'s Eco-DRR Project at the World Conservation Congress.

Looking forward

Many different GoN agencies and civil society organizations played important roles in mainstreaming environmental action into recovery and reconstruction after the 2015 earthquake. While this guide gives many Hariyo Ban Program examples, other organizations were also taking important initiatives. We hope that this guide will encourage others across many sectors to continue and carry forward green recovery and reconstruction, building back safer and greener for more resilient people and ecosystems in Nepal.



Members of Parliament and political party representatives attending a workshop on green recovery and reconstruction, providing them with information on practical, environmentally sound approaches that can be used on the ground in their constituencies and in future policy making.

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Annex 1: Detailed description of integrated settlement planning

By Sanjaya Uprety

Of the various approaches¹ available for settlement planning, integrated settlement planning (ISP) is a very suitable approach for post-disaster situations which GoN intends to use with some communities seriously affected by the earthquake. ISP draws its guiding planning principles from two outcome-oriented processes: first land use planning which focuses on designating and regulating the use of land; and second, physical planning that includes planning of optimum physical infrastructure based on the land use plan. Combined, these two planning processes are known as 'comprehensive planning'. When prepared under normal circumstances, comprehensive planning deals with different contexts and is time-consuming. In post-disaster reconstruction when there is more urgency, ISP can be used. It is a process-oriented 'strategic planning' activity that enables more rapid planning to respond to the urgency and build back better. In ISP, planning decisions are made strategically in consultation with the affected people and relevant stakeholders.

ISP provides an opportunity to mainstream sustainable recovery and reconstruction as envisaged by the Sendai Framework for Disaster Risk Reduction 2015-2030 (United Nations Office for Disaster Risk Reduction 2015). This Annex outlines the process of environmentally responsive ISP for post-disaster reconstruction. Building largely upon the GRR approach, it provides guidelines to mainstream and integrate environmental concerns in the ISP process so that a healthy human-environment relationship is maintained for sustainable living.

Please refer to the project cycle figure in Chapter 2 to see the following stages illustrated.

1. Initial Planning Assessment/Preparation

The Initial Planning Assessment is the first step towards the ISP process that includes participatory assessment of damage, mapping of affected communities, environmental impact assessment and suitable site selection. Specific tasks are:

a. Damage Assessment

Damage assessment is an on-site assessment of the extent of damage or loss of physical assets that occurred due to the disaster, that helps understand and identify the various dimensions of damage and its implications (viz. vulnerability) in the ISP process. This information is mostly documented in damage assessment reports prepared by the government or other development organizations working in the area, and should be made available for those involved in reconstruction. For environmental interventions in ISP, the following activities need to be considered:

- Review existing information to identify the extent of damages and make on-site verification to update it using a participatory approach to obtain a realistic inventory of damages. This should include:
 - ▶ damage that has occurred to the natural environment
 - ▶ any existing geological damage assessment to assess the land vulnerability in the existing settlement
 - ▶ damage to physical and social-economic infrastructure focusing on the implications for the natural environment

¹ Physical development planning, structure plan, strategic plan, outline plan and so on. These are largely similar plans which overlap considerably in content. In this context, the contents of integrated settlement plans are similar and sometimes considerably overlap with the others.

b. Assessment of the affected communities

An assessment of community willingness is important in selection of reconstruction sites and an appropriate approach for the planning phase. After the disaster, the community may be willing to carry out owner-driven reconstruction if feasible, or may desire to resettle voluntarily.

- ▶ Select community on the basis of urgency for reconstruction or resettlement, their willingness and commitment
- ▶ Seek community commitment and consensus for the reconstruction or resettlement project
- ▶ Evaluate community knowledge, attitudes and practices on human-natural environment relationships to adopt an appropriate approach in the planning phase
- ▶ Assess existing or potential local grassroots networks and institutions working on the environment
- ▶ Carry out rapid appraisal to understand issues such as gender, poverty and livelihoods that have impacts on the natural environment.

c. Environmental Assessment

Disasters cause various damages and stresses to the natural environment that have implications for settlement planning in terms of natural resource use, ecosystem services such as water provision and landslide protection, and biodiversity conservation. It is therefore important to undertake environmental impact assessment of potential resettlement areas to understand local environmental values, direct damage by the disaster, and potential environmental impacts of resettlement, possible mitigating measures, and ways to integrate them in settlement planning at both regional and local levels for sustainable living.

- ▶ Review existing documents/reports/studies to mainstream environmental issues, concerns and implications into the ISP
- ▶ Study the existing environment in terms of its biodiversity, physical attributes and importance using existing literature, local environmental experts and participatory learning with communities
- ▶ Identify environmentally sensitive areas that have implications in the selection of sites
- ▶ Outline the natural resource use pattern by the dependent community in order to understand the broad environmental issues associated with it.

Note that if there are very strong environmental risks from resettlement that cannot be adequately mitigated, a decision should be made at this stage to leave this area alone and seek an alternative site.

d. Prepare illustrative maps and drawings

Mapping is a key component in the ISP process as it provides valuable information regarding future disaster risk and reconstruction strategy. The cadastral information (viz. land size, boundary, ownership etc.) when combined with geospatial information (viz. land use, infrastructure, slope, elevation, conservation values including vegetation, corridors, wildlife distribution, etc.), provides a geospatial data set which plays an instrumental role in identifying suitable land, and planning for resettlement and disaster risk reduction strategy. Identify possible site locations by assessing and mapping:

- ▶ Existing land use, cadastral and geo-spatial information such as land size, boundary, locational attributes, slope, elevations etc.
- ▶ Social infrastructure information such as proximity to towns/villages, access infrastructure such as roads and trails, and health and educational facilities
- ▶ Natural resources and biodiversity such as forests, wetlands, grasslands, watershed areas, protected areas, buffer zones, wildlife areas, migration routes, etc.
- ▶ Hazard mapping highlighting areas that are affected by or vulnerable to a particular hazard such as earthquakes, landslides, flooding, geological situations

2. Stakeholder Mapping and Analysis

Stakeholder analysis is an important step in ISP where possible stakeholders that are likely to affect or be affected by a proposed settlement planning are identified. They are prioritized according to their impact on the ISP process and the impact the process will have on them. Key considerations should include:

- Identification of disaster-affected people to be resettled/relocated and people living near the new site of relocation/resettlement
 - ▶ Formulate the selection criteria for stakeholders, ensuring inclusion of the most vulnerable and disadvantaged groups, and women
 - ▶ Identify the priority stakeholders according to gender, marginalization, poverty and dependency on forests.
 - ▶ Understand the multicultural dimensions of the affected people/groups in terms of cultural needs, preferences and priorities
 - ▶ Identify local and central government officials involved in planning process including officials with responsibility for environmental management (including district forest offices and protected area offices)
 - ▶ Identify development partners (international and national NGOs) working in reconstruction and recovery sectors

3. Site Selection

Perhaps the most crucial step of the ISP process is the selection of suitable sites for reconstruction/relocation. Although many factors determine the selection of post-disaster reconstruction sites, the factors contributing to their sustainability plays an important role in increasing community resilience to future disaster. The selection should thus be based on the basic principles of sustainable settlements, which require an understanding of the context of the site, the local ecosystems and ecosystem services, and implications of the proposed development. The selection should be based on parameters that provide opportunity to promote biodiversity conservation including restoration of sites after reconstruction, both from previous degradation and impacts of settlement construction than cannot be avoided. Consider factors contributing to the sustainability of the selected site and its development, analyzing:

- Strengths of the site that can enhance safer local living with the least possible threats to the environment
- Weaknesses of the site that may compromise the safety, wellbeing and the economic opportunity of the community, and the negative impact resettlement may have on the environment
- Opportunity the site provides for sustainable infrastructure development (green infrastructure, waste management, energy efficient housing etc.) to conserve and promote the natural environment and biodiversity.
- Threats that the selection of site will have to the human and natural environment

The key considerations should include:

- Review of existing planning documents², if available, for the reconstruction sites under consideration, to identify existing environmental issues and problems.
- Identification of other planning proposals (viz. settlement, market sites, access roads, other infrastructure, agriculture, open spaces etc.) in order to assess their implications for a possible settlement as well as for conservation and natural resource management.
- Assessment of the site's suitability for development, based on hazard mapping and risk assessments to avoid hazardous and risky areas that are vulnerable to earthquakes, floods and landslides, taking into account likely future climate change.
 - ▶ Avoid locations on flood plains and steep slopes (construction on slopes should ideally be limited to 5 to 10% slopes, and wherever possible slopes should not exceed 30%)
 - ▶ Check planning regulations which provide guidelines to site selection
 - ▶ Avoid locating settlements near environmentally sensitive areas (Viz. national parks, important biodiversity areas, natural corridors, wetlands, etc.)
- Consider making the judicious assessment of carrying capacity of the site and its resource base to avoid stress on natural resources and its degradation
- Consider choosing sites with beneficial microclimate and aspect (e.g. south-facing in cold climates)
- Consider the impacts of resettlement on existing vegetation and ecosystem services
- Assess the natural resource needs and sourcing options for the new settlement; avoid over-exploitation of natural resources and environmental degradation

² In Nepali context, such plans may exist in various forms (Viz. Master Plan, Periodic Plan, Physical Development Plan, Structure Plan, Local Area Development Plan, protected area management plans, forest management plans, sectoral plans such as urban development, agriculture, irrigation, water, energy, transport, health, education)

- Consider the locational attributes in terms of restoration of livelihoods, food production, and socio-economic connections with the surrounding settlements, market centers and cultural centers
- Make a realistic assessment of potential sources of water and energy, and the options for waste disposal during the site selection process
- Assess the site access situation, preferably selecting sites that already have good access to social and economic infrastructure to avoid isolation; try to avoid having to open up new access roads
- Assessment the need and potential for hazard mitigation measures using environment friendly measures (e.g. restoring flood plain function to reduce flood risk; promoting soil bioengineering for slope stabilization measures)



4. Design

a. Disaster Preparedness

Disaster preparedness is another important step that needs to be considered in the ISP process to create a resilient settlement. It includes undertaking vulnerability analyses and community based risk assessments.

- Carry out a participatory disaster vulnerability analysis to identify at-risk households and groups (including women, children, the aged, differently abled, marginalized and poor people) and their level of vulnerability; this should include vulnerability to climate change in the new site, as much as can be assessed at this stage before the community has experience of the site (CARE 2014)
- Assess capacity and skills of vulnerable groups to analyze and understand the natural hazards (types and nature of hazard etc.) that affect their life
- Assess the vulnerable groups' knowledge, capacity and the practice in mitigating the hazard risks from disasters and climate change
- Assess vulnerability of the local ecosystems to disasters and climate change, including non-climate stresses that can reduce their climate resilience
- Carry out community based risk assessment to map natural hazards and climate change hazards and possible mitigation measures (viz. local disaster risk management plan and local or community adaptation plan of action, LAPA/CAPA) to inventory the potential risks and possible mitigation measures, and to enhance the community's awareness and understanding of risks.
- As far as possible integrate the LDRMP and CAPA/LAPA to avoid parallel processes: this has already been piloted with good results (CARE 2016)
- Then mainstream them in the ISP process

b. Planning and Design

Drawing on the integrative functions of the comprehensive plan, the ISP process aims to select reconstruction or resettlement sites in such a way that their development prospect is integrated with both regional and local socio-economic infrastructure and ecosystem processes. At local level, the ISP process integrates different land uses with development of physical infrastructure

(roads, housing, water supply etc.) and social infrastructure (schools, markets, hospitals etc.). For the sustainable settlement, such integrated development should adopt GRR practices in the planning, such as safe site planning and layout, green infrastructure, wise sourcing of building materials, energy efficient buildings, and conservation of the natural environment (forest, flora and fauna, wildlife, water source etc). The rest of this guide provides guidance on many of these aspects in more detail. This process should be as participatory as possible.

c. Land Use and Infrastructure Planning

The land use plan is an instrumental component of the ISP to identify and organize the preferred land uses through the allocation and zoning of land for specific uses based on regulation of and intensity of use. This will help determine the density and the carrying capacity of the settlement based on what physical infrastructure is planned. Environmental considerations to make in the land use and infrastructure planning are:

- Review existing planning documents if available, along with environmental policies, strategies and guidelines, and consult with environmental experts familiar with the area, to identify key environmental concerns that need to be integrated with land use and infrastructure planning
- Identify critical ecosystem services (ideally the value of this natural capital, and the economic value of different land uses in different zones, should be quantified in order to assess their full value when making tradeoffs during planning; very often ecosystem services such as water supplies and landslide prevention are under-valued)
- Adopt mixed-use zoning where feasible through the integration of residential, ecological and economic land uses to promote home-based business for restoration of livelihoods of forest dependent communities
- Adopt single-use zoning where needed to conserve culturally and environmentally sensitive areas (forests, protected areas, watershed areas, biodiversity important areas, wetlands, river rights of way, heritage sites) with clear land use definition and regulation
- Emphasize pedestrian modes of transport as far as possible to reduce environmental pollutants.
- Integrate green concerns & principles of sustainability in the guidelines of design and construction of buildings and physical infrastructures (viz. road, drainage, water supply, waste disposal, sanitation etc.)
- Clearly outline sustainable planning techniques to implement the ISP prepared through community participation in resource sharing (Viz. LR technique to avail land for infrastructure development)
- Throughout this process ensure close consultation with the community, including different groups

d. Site Planning

Site planning is another important step to achieve the goal of environmentally sustainable ISP. An environmentally sustainable site plan locates building footprints along with physical infrastructures in such a way as to minimize adverse impacts on the surrounding environment and ecosystems. Key considerations are:

- Review the overall ISP or any other existing plans before commencing the site planning in order to understand the environmental context of site planning
- Consider investigations to determine the permeability, structure and geology of the site.
- Consider elevated land with mild slopes for site development ranging from 5-10% slope. In rural areas with little flat ground, areas for settlement and infrastructure should preferably not exceed 30% slope.
- Consider re-clustering of the houses and avoid sparse development for efficient infrastructural resource sharing, but also consider proximity to agricultural land, water sources, and forests for firewood and other resources
- Consider climate responsive site layout planning (orientation, natural slope for drainage, rainfall, wind etc.) in order to make it energy efficient. Take into account likely future climate change, both more extreme weather events such as more intense rainfall and more prolonged droughts, and rise in temperatures, and the impacts they may have.
- Retain existing vegetation as far as possible; if restoring vegetation use indigenous species where possible, and take climate change into account when selecting long-lived tree species.
- Integrate soil bioengineering and local knowledge based solutions for hazard mitigation measures in site planning.
- In the case of a new site, try to locate it in relation to normal livelihood activities (e.g. agriculture, forests), and where feasible link livelihood opportunities with environmental approaches to infrastructure development (recycling, reducing and reusing waste, etc.)
- Integrate the planning of service and utilities (water, energy and waste management) in site planning to minimize environmental impacts.
- Integrate access and approach road/paths with provision for plantations that can contribute to the greening of the site.

5. Plan Implementation

The implementation of ISP in Nepal has many challenges, especially since the public sector has resource limitations to acquire much needed land for climate-smart settlements and service infrastructure development, constraining the development of the physical environment of the settlement. As such, choosing the appropriate planning technique that can contribute to infrastructure improvement by availing land through community participation is important. In the past the government has successfully used the land readjustment technique, in which the community participates to make land available for infrastructure development, in order to develop residential areas (Viz. LR/Land Pooling projects in Kathmandu Valley and other parts of the country). In the context of post disaster reconstruction, the PDRF 2016-2020 (NRA 2016) categorically mentions policy prescription for the use of LR to implement the land use and infrastructure development proposals prepared under ISP. The key considerations needed to implement integrated settlement plans include:

- Explore the possibility of using participatory land development techniques to develop climate responsive site layouts and physical infrastructure development plans for settlement development
- Assess the possibility of carrying out ISP using Access Improvement Schemes or Land Readjustment (LR) for in-situ reconstruction.
- Use and promote sustainable building construction practices (Chapter 3) so that the demand for construction materials does not exert heavy pressure on the natural environment
- Ensure sustainable, legal and responsible means of material sourcing during implementation
 - ▶ Use only raw materials that are produced in an environmentally acceptable manner, and avoid using materials extracted from sensitive areas.
 - ▶ Investigate the purchasing policy or green procurement guidelines and avoid the use of hazardous materials, such as asbestos.
 - ▶ Identify and verify that supplies and raw materials come from environmentally friendly practices and suppliers
 - ▶ Avoid illegally logged timber and favor certified timber for the implementation of the plan
- Include environmental concerns in procurement planning (viz. including environmental specifications in procurement documents)

6. Monitoring and Evaluation

The monitoring and evaluation of the ISP can be carried out in two stages; the first being the monitoring and evaluation of compliance with the participatory process needed to prepare the plan, and second, the evaluation of the plan's effectiveness and outcomes during implementation. Key considerations for effective monitoring should include:

- Ensure community monitoring of the planning process and plan implementation
- Ensure strict compliance with environmental guidelines during planning and implementation
- Set environmental indicators for effective monitoring of the plan's environmental goal
- Evaluate the outcomes during different stages of plan implementation and disseminate lessons learned to improve planning and implementation

Annex 2: Soil bioengineering for slope stabilization and protection

By Madhuban Lal Maskay

Introduction

The 2015 earthquake resulted in many landslides, some of which destroyed infrastructure, forests, agricultural land and houses. More landslides occurred in the following monsoons on slopes made unstable by the earthquake, and there continues to be increased risk due to unstable slopes and cracks in the land. This annex focuses on practical soil bioengineering efforts to stabilize and protect small-scale, shallow landslide sites since they were a priority after the earthquake. Larger scale and more complex landslide treatment is outside the scope of this guide; please refer to Department of Soil Conservation and Watershed Management (2016) for more comprehensive information on landslide surveying, prioritization and treatment. Mercy Corps (2014) provides detailed information on the theory and approaches of soil bioengineering including those illustrated in this Annex. Devkota et al. (2014) offers a practical guide for community level soil bioengineering along roads.

Soil bioengineering is a sustainable approach where a combination of live and dead plants and plant parts are used as building materials for erosion reduction and upland slope protection. This is based on an engineering concept and is relatively low in cost and material needs. Required skills are available in rural areas in Nepal, however remote they may be. Soil bioengineering may be used in combination with “hard” engineering structures.

The advantages of soil bioengineering are:

- Environmental compatibility
- Social acceptance
- Cost effectiveness
- Plant products that can be harvested
- Technology that can be adopted by local people
- Easy to maintain
- More effective as time passes
- Income generation opportunity for local people during construction
- Often a useful alternative to civil engineering in small, highly sensitive or steep sites

The public’s increased environmental consciousness often makes soil bioengineering solutions more acceptable than “hard” engineering approaches alone. Soil bioengineering creates a nearly natural environment which blends with its surroundings, and is often cheaper than “hard” engineering structures.

The approach described in this Annex is conservation-oriented, sustainable and participatory, with emphasis on using local resources for construction. It also helps to develop local capacity to restore and maintain hill slopes in places where this is the best technique for protecting unstable hill slopes.

Based on evidence from studies, and rehabilitation work supported by WWF/Hariyo Ban Program, this chapter describes how soil bioengineering has been effective in slope stabilization in sites in four districts where erosion or shallow landslides were triggered by the 2015 earthquake along roads. It has provided local employment, built local community capacity for this approach, and the sites have also been used to train engineers and members of district disaster relief committees (DDRCs).

Steps in soil bioengineering on roadsides

See chapter 10.

Technical expertise

An engineer from the relevant local government office should assess sites for soil bioengineering feasibility, and design the work using accepted methods, ensuring that the operations are not harmful to people or environment. Once local people have training and practical experience they may be able to undertake these techniques in other, similar sites that do not require complex engineering.

Selection of suitable plant species

When selecting plant species, the following attributes are desirable for successful soil bioengineering approaches on hill slopes:

- Pioneer plant character (good growth on degraded sites, landslides, gullies, new road slopes)
- Quick growth
- Drought resistance
- Quick and easy propagation, e.g. cuttings, direct broadcasting of seeds
- Propagation possibilities during dormant winter season
- Dense and deep rooting system
- Resistance to grazing and browsing and protective qualities
- Good production and multipurpose use
- Easy management and maintenance
- Locally available within practical hauling distance
- Capability to grow with the existing vegetation around the site
- Likely to persist at the site as climate change advances (resilient to more extreme weather events and increase in average temperatures)

Demonstration site selection

For the Hariyo Ban supported soil bioengineering work, sites were selected in close consultation with the local forest user committees, followed by survey, design, planning and construction.

Local community involvement

The execution of the work was done with active participation of the local communities. This ensured that local people benefited from employment during construction, and plant species were selected which will be useful to them in the future. Since the soil bioengineering works are solving local problems such as threats to village access, loss of agricultural and forest land, threats to settlements and schools, and downstream sedimentation, there is greater buy-in and ownership. As long as they understand the principles involved and the future benefits for their development, local people should be motivated to maintain the sites, watering plants and protecting them from livestock, in the initial stage until the system becomes mature. Local people gain practical experience which enables them to replicate this work in other, similar sites. In order to ensure care and maintenance of the site a local committee should be engaged (e.g. community forest user group), or a conservation committee should be formed.

Local people in Dhodre, Gorkha, worked on a soil bioengineering demonstration site supported by the Hariyo Ban Program after the earthquake. They were subsequently invited to Simjung VDC to share their experiences so that Simjung could use the soil bioengineering techniques in similar sites.

Timing of soil bioengineering establishment

While at first glance it seems counter-intuitive to do soil bioengineering works during the dry season, in practice planting during the dry, dormant season has yielded good results. As long as the young plants can be watered during the first dry season and protected from livestock, as the weather warms up they can establish root systems that equip them to better withstand the coming monsoon, helping avoid them being washed out of the unstable soil by heavy rain or runoff, and enabling them to start protecting the soil in their first year.

Soil bioengineering techniques

Optimum techniques depend on local conditions at each site. The main ones used were:

- **Bamboo crib wall** (a type of gravity retaining structure useful for stabilizing wide steep slopes)
- **Brush layering/hedge brush layering** (very effective in preventing shallow sliding of embankments; can be used to create a stable composite earth mass)
- **Palisades** (used for protection of small but deeper, narrow gullies and shallow V-shaped rills)
- **Fascines** (used for a variety of slope stabilization purposes)

Bamboo crib wall: this is a type of gravity retention structure used to stabilize wider areas on steep slopes. If needed, several rows of crib walls may be constructed, one above the other. As construction timber is often not easily available or is expensive, bamboo is used instead to construct the crib wall. Green bamboo poles have the advantage of sprouting shoots from nodes and putting down roots which increase the stability of the slope. Fill materials for the crib-wall are generally found on-site. Bamboo crib structure technology has been tested in Kathmandu, Dhading, Gorkha, Kaski and Rasuwa (Nepal) and Himachal Pradesh (India) and has been shown to successfully stabilize loose soil and fragile slopes along hill roads. See Figures 1 and 2.



First layer of stretcher and header of the bamboo crib wall completed



Live cuttings inserted between first and second layer stretchers



Five layers of crib wall construction completed to stabilize the base of the slope



Results: bamboo sprouting and starting to put down roots

Figure 1: Construction steps of Bamboo crib wall and results after 7 weeks (Dhodre, Gorkha)



Figure 2: Bamboo crib wall after 10 weeks: other plant species establishing (Dhodre, Gorkha)

Brush Layering: This technique creates terraces across the slope that act as horizontal drains, intercepting seepage and improving water management, and hence increasing the stability of slopes. It uses live cuttings of woody plants to reinforce the terraces. Live branch cuttings 2 to 4cm in diameter and 50 to 150cm in length are placed on the terraces at right angles to the line of the trench and covered with soil, leaving their tops protruding from the slope. The terraces should have an inclination of at least 10° to the outside so that branches can root along their entire length. Brush layering can be applied in steep slopes up to 2:1 (Figure 3).

Drainage fascines: These are bundles of live branch cuttings that are placed in shallow trenches, either horizontally or slightly inclined, and are mainly used to regulate water on mountain slopes in order to arrest erosion and shallow mass wasting (Figure 4). The cuttings root and provide stability to the trenches.



Figure 3: Construction steps of brush layering (Dhodre, Gorkha)



Figure 4: Fascines installed in Budhathum, Dhading and Dhodre, Gorkha

Palisades: Palisades are suitable for protection of small but deeper, narrow gullies and shallow V-shaped rills. The palisade forms a strong barrier and traps materials moving down the slope (Figures 5 & 6). The technique uses stems or branch parts of living plants as initial and primary soil reinforcing and stabilizing material.



Dhodre, Gorkha 2016

Figure 5: Live cuttings / poles driven into the ground - several rows of Palisades.



Figure 6: Construction steps for palisades in series to protect a long, narrow gully (Dhodre, Gorkha).

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Conclusion

Soil bioengineering in the hills of Nepal offers a sustainable and environmentally sound approach to stabilize and repair slope failures in order to protect settlements, infrastructure, fields, forests and wetlands. It has proved to be technically effective and low-cost compared to “hard” engineering approaches, and avoids having to completely overhaul the slope. Nepal has many locally available indigenous tree, shrub and grass/legume species with good soil reinforcing capacity at different depths that can be used effectively for slope stabilization. Participation and ownership by local communities is an important element of success, including for care and maintained during the establishment phase. For this a conservation committee should be formed in the local community if one does not already exist.

Additional reading

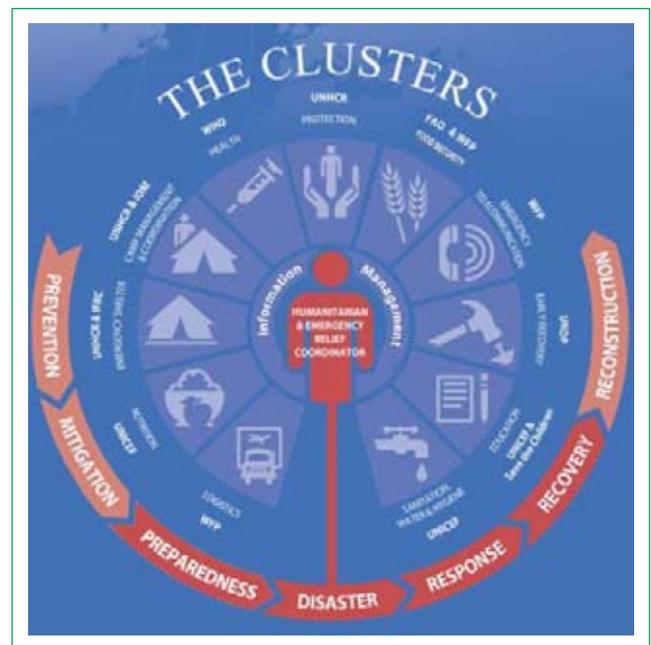
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Annex 3: United Nations Cluster System

Over the years the United Nations has developed a ‘cluster approach’ which takes a sector-based response after major disasters for more efficient and effective coordination. The cluster approach groups international humanitarian actors, national and local authorities, and civil society organizations around a sector or service provided during a humanitarian crisis. Each cluster is led by a designated agency, and forges partnerships among its members. This helps identify gaps and avoids overlaps in service delivery, promotes coordination, and ensures that the emergency response is as strategic, prioritized and efficient as possible, with clear definition of roles and responsibilities.

The cluster approach includes the environment as a cross-cutting theme that should be considered across all the technical clusters.

The Figure below shows the clusters and the organizations that normally coordinate them. Note that not all clusters may be established after an emergency. Clusters work during the emergency response period; sometimes Early Recovery Clusters are also established (e.g. in 2015/16 the Housing Recovery and Reconstruction Platform was established once the Shelter Cluster closed, led by the International Organization for Migration and UN Habitat).



The Cluster System

Environmental inputs to Clusters in Nepal in 2015

After the 2015 earthquake in Nepal, WWF and the Hariyo Ban Program presented the case for ensuring environmentally sound recovery at an inter-cluster coordination meeting. Hariyo Ban staff then worked with the Shelter, Food Security and Education Clusters to identify ways that cluster members could reduce adverse impacts on the environment, and strengthen ecosystem services to reduce risk of future disasters, drawing on results of the post-earthquake rapid environmental assessment. The Education Cluster produced a briefing sheet for its members; Hariyo Ban produced briefing sheets for the Food Security and Shelter Clusters. The practical measures in the briefing sheets have largely been incorporated into this guide (WWF Nepal 2015c and d; Nepal Education Cluster 2015).

Annex 4: Glossary

Disaster risk: Potential disaster losses (in lives, health status, livelihoods, assets, and services) that could occur to a particular community or a society over some specified future time period.

Disaster risk reduction: The practice of reducing disaster risks through systematic efforts to analyze and manage the causal factors of disasters, including reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.

Ecosystem: Dynamic complexes of plants, animals, and other living communities and the nonliving environment interacting as functional units. Humans are an integral part of ecosystems.

Green recovery and reconstruction: Adopting environmentally sound recovery and reconstruction practices after a disaster that do not place additional pressure on the environment, and that help to strengthen ecosystems that safeguard livelihoods and reduce disaster risk in the future.

Hazard: A potentially damaging physical event, phenomenon, or human activity that may cause the loss of life or injury, property damage, social and economic disruption, or

environmental degradation. Hazards can include latent conditions that may represent future threats and can have different origins: natural (geological, hydrometeorological, and biological) or induced by human processes (environmental degradation and technological hazards).

Resilience: The capacity of a system, community, or society potentially exposed to hazards to adapt, by resisting or changing, in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures.

Vulnerability: *Human* vulnerability is the relative lack of capacity of a person or community to anticipate, cope with, resist, and recover from the impact of a hazard. *Structural or physical* vulnerability is the extent to which a structure or service is likely to be damaged or disrupted by a hazard event. *Community* vulnerability exists when the elements at risk are in the path or area of the hazard and susceptible to damage by it. The losses caused by a hazard, such as a storm or earthquake, are often proportionally much greater for more vulnerable populations, e.g., those living in poverty, women, and marginalized communities.

WWF Nepal

PO Box: 7660, Baluwatar, Kathmandu, Nepal

T: +977 1 4434820, F: +977 1 4438458

Email: hariyobanprogram@wwfnepal.org, info@wwfnepal.org

Website: www.wwfnepal.org/hariyobanprogram