

CONCLUSION AND WAY FORWARD

Potential damages in Ksedi River watershed (Ajgada Village) were estimated to be USD 57,042 while implementation cost of adaptation options was estimated approximately USD 622,277. Focus on ecosystem based adaptation options will provide high benefit to cost return in terms of avoided damages and considering engineering options will be efficient in flood and erosion control in initial stage rather than its high cost.

There are data gaps regarding cost and effectiveness of different adaptation options which limits the informed decision making. Developing flood model, flood height damage curve and flood vulnerable maps specific to the site will help decision makers to implement site specific adaptation options. Alternative adaptation measures can be explored and further research on ecosystem service value is essential for accuracy of economic analysis.

Note: All estimated costs are calculated in 2014



▲ Hybrid Option (EbA and EO)

COMMUNITY VOICE



EbA in Upstream for Sustainability of Churia Range

Mr. Kumar Singh Karki (66) of Udayapur district is a chairperson of Trijuga Conservation Campaign.

He realized that the main problem of the river originate from the Churia range is the high sedimentation which affect the downstream community, agricultural land and crops. In dry season, the water sources are dried out which affect entire watershed and makes passive forest (without wildlife). He hopes implementing adaptation options in upstream will control flood and sedimentation. He was fascinated by EbA research on Ksedi River watershed conducted by IDS Nepal and said "this kind of research and its implementation is essential for Churia range and hope it will continue in other areas as well".



No Sign of Wildlife in Dry Season

Mrs. Falguni Chaudhary is inhabitant of Ksedi River watershed, Udayapur district.

She felt that Flood and sedimentation in Ksedi River became a sorrow for the village and agricultural production. To collect fodder and green grass during dry season, she has to walk more than 2 km from the village. Due to lack of water resources in upstream forest, she had to take water from village and said "there is no sign of wildlife in dry season".

FOR FURTHER INFORMATION

ICIMOD

International Center for Integrated Mountain Development (ICIMOD)

Khumaltar, Lalitpur, Tel: 977-1-5003222
www.icimod.org



Integrated Development Society Nepal (IDS Nepal)

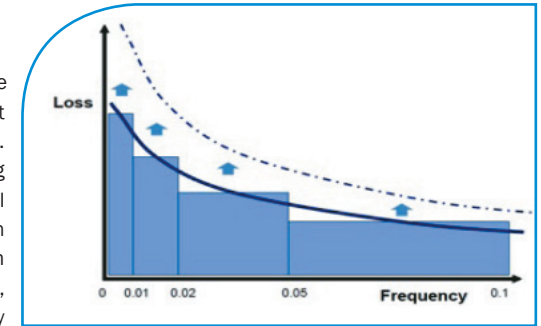
Baluwatar, Kathmandu, Tel: 977-1-4427329, 4445565
www.idsnepal.org

SUMMARY OF STUDY REPORT

Economic Analysis of Flood related possible Ecosystem based Adaptations (EbAs) and Engineering Options (EOs) for Climate Change Adaptation in Ksedi River Watershed, Udayapur, Nepal

BACKGROUND

Globally, out of the 170 countries in the Climate Change Vulnerability Index (CCVI) ranked over the next 30 years, Nepal is ranked 4th by Maplecroft (2012). The adverse effects of climate stimuli including variability and extreme events will put additional stress on overall development of Nepal, so as in Churia range. Churia range gradually elevated from Terai plains up to 1,800 meters from the sea level, stretched almost the entire length of the country from east to west with a width of 10 to 20 km. Churia range have common morphological features: coarse-grained, loose rocks and thin layer of soil, resulting into a fragile topography and, therefore, unsuitable for farming. IDS Nepal conducted study on "Economic impact assessment of climate change in key sectors in Nepal" highlights that as climate change increases high river flows, this leads to more damaging and frequent floods. Both these changes will alter the loss-frequency curve of river flood damages.



▲ Possible change in the loss-frequency curve (loss in \$ against annual probability) and average annual expected damage (sum of columns) before (solid line) and after climate change (dotted line)

This study was conducted by IDS Nepal in support of International Center for Integrated Mountain Development (ICIMOD) to economically analyze the adaptation options, EbAs and EOs, which can serve as a decision making tool for efficient planning and sustainable adaptation options.

OBJECTIVE

- To document all possible adaptation options: ecosystem based adaptations, engineering and hybrid options
- To carry out economic analysis of individual ecosystem based adaptations and engineering options
- To recommend appropriate and cost effective ecosystem based adaptations and engineering options for implementation.



▲ Flooding in Udayapur district

METHODOLOGY

The methodology of this case study is based on study of Lami Town (Rao et al, 2013), where a highly flood prone village was selected for comparing adaptation options. Through stakeholder and expert consultations, feasible EbA and EO to mitigate probable floods in village and catchment area were listed. Economic analysis of these options and the different combinations were assessed using cost benefit analysis. The economic analysis considered the cost of implementation and the benefit retained from implementation of the options including avoidance of damage.



Focus group discussion with community ▲



STUDY SITE

MoAC and FAO have identified several hazards in Udayapur district during their Participatory Vulnerability Assessment (MoAC and FAO, 2011). Ajgada is an area with a small group of dwellings/ hamlets in Hadiya VDC, Ward 4 of Udayapur district. Its center lies at a latitude of 26.4600 and longitude of 86.5120 and it has an elevation of 120 meters above sea level. Physiographically, Ajgada lies in Trijuga basin in North and Churia range in southern part. Ksedi River, comprising Chhedi (East and West) and Gairwahi rivulets, flows in this settlement which is rain-fed river and its watershed is in the Churia range. People have migrated since 2039 B.S. in this settlement from various hilly districts like Khotang (primarily), Bhojpur, Solu and uphill of Udayapur resulting in 92 households comprising 15 HHs Dalits and 45 HHs of disadvantaged group residing in Ajgada.

▲ Ksedi River watershed

LOSS AND DAMAGE ASSESSMENT

The assessment of loss and damage of study area provides considerable figures, estimating average damages per household to be NRs 37, 419 (US\$ 388) in each flood event. The agricultural land was affected because the level of river and cultivated land is almost at same contour and most of the land lies in alluvial plain. In Ajgada, both land and settlement of Dalit's are in the river bank which affect their livelihood and increase their vulnerability to flood. They have to spend large amount of money to reclaim land, constructing retaining wall (bamboo wall) and raise the river bank to protect their land. Each household contribute voluntarily for construction of gabion in support of District Soil Conservation Office (DSCO) but these constructions are inundate in sand, increasing the threat to the village.

RESULTS AND DISCUSSIONS

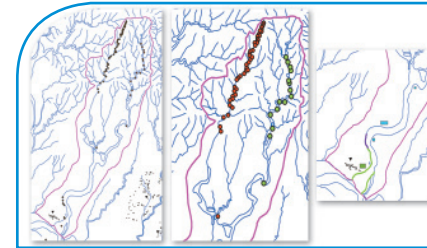
The study outlines various adaptation options to implement in Ksedi River watershed (5.9 sq. km.) along with estimated cost of EbA is about USD: 62711.15 and of EO is USD: 543359.64.

Recommended Adaptation Measures

Ecosystem based Adaptation	Engineering Options
General plantation, Bamboo wattle, Amrio plantation, Nursery establishment, Bamboo plantation, Natural wetland, Fire Management, livestock management and Monitoring & Support.	Gully check dam, River check dam, Revetment, Spur, Embankment, Structured wetland and Catch drain.

Avoided Damage: Avoided damages are calculated using the information provided by inhabitants of Ajgada village and district level stakeholders that are incurred when no actions are taken for flood prevention. Hence they are taken as estimate of benefits of taking action. To estimate loss due to flood in this community, we consider the flood of year 1996 as baseline because it has most severe impacts and implications till now leading to estimated loss of around USD 56,861.

Ecosystem Service Value (ESV): The combination of spatial, primary data and economic analysis was used to determine the Forest ecosystem service value of Ksedi River watershed. ESV is estimated based on Focus Group Discussion and Key Informant Survey in Ajgada village and using benefit transfer methodology. The estimated value is USD 230,551.20.

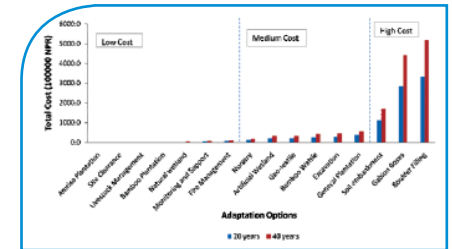


▲ Scenarios

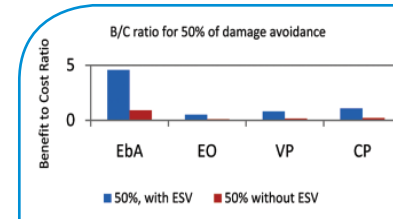
Least Cost Analysis: In this analysis, least cost approach was used to estimate cost of each options and those were ranked. Engineering options are most expensive due to labor and material cost to construct the structures. Ecosystem based adaptations are cheap but take longer time for its effectiveness against flood and erosion. Further research on effectiveness of the adaptation options is essential so as to provide relevant information to decision makers to implement the approaches.

Scenarios: The four scenarios are:

- Scenario 1: Ecosystem based Adaptation Options (EbA)
- Scenario 2: Engineering Options (EO)
- Scenario 3: Catchment area (CA) – Hybrid: This scenario include both EbAs and EOs and consider as the source control.
- Scenario 4: Village Protection (VP) – Hybrid: This scenario also include both EbAs and EOs but focuses on the low land i.e village area.



▲ Total cost to implement adaptation options for all identified sites of Ksedi River Watershed.



▲ Benefit to cost ratio for each scenario of adaptation options with assumed percentage of damage avoidance

Impact study in Ksedi River watershed ▼



Benefit-Cost Analysis: Benefit cost analysis was performed for each adaptation options and for the four scenarios integrating different types of benefits to present whether or not the adaptation options should be implemented. In EbA and CP scenario the benefit to cost ratio is above 1 and Annual Net Present Value (ANPV) was positive, when ecosystem service values are integrated otherwise both analysis are negative. The results in which the ANPV or the benefit-cost ratios were higher are actions or scenarios for which Ksedi River watershed would receive more benefit for each rupees spent. When engineering structures are implemented, the cost will be high and so benefit to cost ratio become less than one. EbA options could not provide efficient results to prevent flood in initial stage, so decision makers should consider engineering options to achieve optimum result.